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THE

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THE

# ELECTRICAL ENGINEER.

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## NOTES.

**Institution of Civil Engineers.**—The council of this institution has now issued the complete pass list of the October, 1903, examinations held at home and abroad. This shows that of the candidates examined in London for admission as students 36 were successful, also a total of 58 succeeded in attaining to the required standard entitling them to join the associate membership. The list further shows that 11 candidates examined abroad passed the examinations, and will be admitted to the membership of the institution.

**Telegraphs on the Congo.**—The Belgian and French Governments have come to an agreement relating to the establishment of telegraph communication between the Congo Free States and the French Congo. Under the agreement a submarine cable is to be laid between Brazaville and Kinshassa, the cost of which is to be borne equally by the two countries concerned. It is proposed to use Morse registering apparatus in the stations at either end of the cable. The tariff will probably be 2½d. a word, with a minimum rate of 10d. per message.

**Standard Beams.**—The Engineering Standards Committee has issued a list of standard sections of beams, which has been prepared by the Committee on Bridges and Building Construction, of which Sir Benjamin Baker, K.C.B., is chairman. This branch of the committee's work does not come much within our sphere, but we may say that the list appears to be a very complete one, bearing evidence of prolonged enquiry and research on the part of the committee responsible for it. The list may be had from Messrs. Crosby Lockwood and Son, the official publishers to the committee.

**Electricity at Rangoon.**—A few weeks ago we mentioned that there was a scheme on foot for providing the city of Rangoon, in India, with electric light and tramways, and we learn that the plans are now about to be realised. The Rangoon Municipality have received the proposals with favour (although placing some rather burdensome restrictions on the promoters), and they are recommending the Local Government to grant a license. Tenders were in the first place invited for carrying out the scheme, and that submitted by the Brush Electrical Company has been accepted as the most favourable of any sent in.

**St. Marylebone Electric Light.**—Another stage in the St. Marylebone electric light imbroglio will be reached on the 19th inst., when the ratepayers will be asked to approve the action which the Borough Council have taken in regard to the means for raising the required loan for the purchase of the Metropolitan Electric Supply Company's undertaking. A great point has been made of the fact that the Council did not see fit to consult the ratepayers before pledging their credit to the tune of nearly a million and a quarter sterling, and, doubtless, the Council will be strongly attacked at the meeting for their shortcomings in this direction. The Bill by which the Council hope to be vested with the powers of an electric lighting authority will be submitted to the ratepayers, on whose decision will rest the future action of the Council in their unfortunate entanglement.

**The Faraday Society.**—With part vi., vol. iii., of the *Electro-Chemist and Metallurgist*, the official organ of the above society, the purchaser is presented with an excellent portrait of Dr. J. W. Swan, F.R.S., the venerable first president of the society. The proceedings of the society at the second ordinary meeting also are reported in this issue, the papers being "Total and Free Energy of the Lead Accumulator," by Dr. R. A. Lehfeldt, with discussion, and "Bitumen in Insulating Compositions," part i., by Mr. D. A. Sutherland. A valuable feature of the *Electro-Chemist* is the abstracts of papers relating to electro-chemistry and metallurgy given in each issue.

**"Science Abstracts."**—We have received part 12, vol. vi., of this publication, and we are particularly pleased to read the notice which is attached above the signature of Mr. W. G. McMillan, the secretary of the institution. It states that in the next (January) number abstracts will be given of papers published in November and part of December, 1903, and it is hoped that in future the abstracts will keep up with current work. Certain arrears which had accumulated before the Institution of Electrical Engineers took over the publication will appear in the next few numbers. Under the energetic control of Mr. McMillan outside help has been called in to assist the permanent abstractors in bringing the publication more up to date. The value of *Science Abstracts* in the future will be greatly enhanced by the fact that it will contain abstracts of recently published articles, the interest in which has not subsided.

**Polarisation Capacity.**—According to an abstract of a paper by Mr. F. Krüger in the *Journal* of the Chemical Society, the author, starting with the theory of electrical double layers, has developed a theory of polarisation capacity, partly resembling that of Warburg in its formal expression, but more comprehensive, and capable of interpreting the behaviour of all electrodes. The capacity is definitely related to the frequency of the alternating current, and the change in this relationship with change of concentration may be correctly deduced from the author's theory. This has been verified by experiments with mercury electrodes immersed in (1) $N H_2SO_4$, saturated with mercurous sulphate; (2) $N$KCNS + $N$/100HgCNS; (3) $N$KI + $N$/100$HgI_2$; (4) $N K_2S$ + $N$/100HgS. It should be noted that the theory leads to correct results on both sides of the maximum in the surface tension. In considering the influence of dissociation on the phenomena of polarisation, the author adopts the hypothesis that the velocity of ionic reactions is not infinitely great, but commensurable with the period of the alternating current.

**An Optical Pyrometer.**—In a recent issue of the *Scientific American* an optical pyrometer, designed by the

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Morse Thermo-Gauge Company, of Trumansburg, New York, is described. The principle of the apparatus consists of comparing the temperature of an incandescent carbon filament with that of the interior of a steel furnace. The incandescent lamp used for the purpose is mounted in a tube, through which the operator views the interior of the furnace. The current going through the lamp can be varied over a wide range by means of a rheostat, and by calibration beforehand the temperature of the filament on a known current is ascertained. By looking at the molten metal in the furnace through the coils of the filament, the operator can tell the exact point at which equal temperature is reached. If the temperature of the filament is lower than that of the furnace it appears as a dark spiral against the background, whereas if it is higher than that of the furnace it appears as a bright spiral when viewed against the molten or heated metal. The apparatus seems a most ingenious one; but the prior determination of the temperature of the filament corresponding to a mean current would appear to be one difficulty of the method, and another is that this ratio will afterwards vary as the carbon filament deteriorates with use.

**Power for Traction in a Large City.**—An idea of the magnitude of electric railway and tramway development is afforded by an examination of the equipments of the power stations of Greater New York, which are detailed in our American contemporary the *Electrical Review*. The power obtainable from all the railway generating stations now in operation, at the nominal rating, is 142,170 kw., which does not include an additional 10,800 kw. in generators about to be installed in one of the larger stations, and 15,000 kw. in storage batteries which can be drawn on for one hour. Allowing an overload rating of 40 per cent. of the nominal rating of the power stations, the total power available for moving cars in New York City is 224,970 kw., or nearly 300,000 h.p. In addition to this, the new units already contracted for will give an additional output, at a nominal rating, of 10,800 kw.; and the nominal rating of the equipment at the power-house for the Rapid Transit system will be 50,000 kw. when completed. This will add to the total overload rating of 224,970 kw. about 90,000 kw.; but by the time all the new units are in operation there will, undoubtedly, have been other additions in several of the older stations. The figures point to a minimum of 425,000 h.p. as the overload rating of the railway power stations of Greater New York in the near future. There is, however, every likelihood that this total will be greatly exceeded.

**Electrical Industry in Spain.**—In a paper published in a recent issue of the *Elektrotechnische Zeitschrift*, D. Blumenthal accounts for the fact that electric lighting is used in Spain to a larger extent than in other European countries by the prohibitory cost of gas lighting there. A graphical record is given of the development of electric central stations since 1878, when the first station was put into operation. The present figure for the total plant capacity appears to be 100,000 kw., corresponding to about five watts per inhabitant. The number of central stations being worked in Spain at present is about 1,000. The electricity works of Madrid are installed according to the most recent practice, and include machines of a total output of 16,600 kw. and 70 kw. of secondary batteries. This averages 66 installed watts per inhabitant, as compared with 48 watts per inhabitant in Berlin. Of late years water power has been utilised to a large extent, and electric light has found its way now even to the house of the poorest man. These hydraulic central stations are mostly alternating-current plants, serving in most cases to supply quite a number of localities with electric energy. They are devoid of any complicated switching and regulating apparatus, so that they can be superintended by unskilled persons, the light being mostly paid for in a lump sum at so much per day per lamp. Wherever some control of the consumption is desirable, as, for instance, in smaller cities, so-called "current limiters" are installed, automatically interrupting the current when a certain fixed number of lamps simultaneously burning is exceeded. The financial results from many of these works are favourable, dividends as high as 30 and 35 per cent. having been paid.

**World's Production of Rubbor.**—With an ever-increasing use of rubber in manufacturing, it is disappointing to have to record a gradual diminution in the supply. Some figures have been published purporting to show the total production of rubber in different parts of the world, and according to these the production in the two years from 1900 to 1902 decreased by some 3,500 tons—that is to say, whereas the total output in 1900 was 57,500 tons, that in 1902 was only 54,000 tons. This decrease is certainly not a large one, but it is important as showing the tendency of the rubber supply to diminish. It is very instructive to examine the figures given for the different countries. Our two main sources of supply are Brazil, Peru, and Bolivia, and East and West Africa and the Congo country. From the first group the total supply in 1900 was 25,000 tons, and from the second 24,000 tons, but whereas in the former case the production has increased, it has appreciably decreased in the case of the latter. Thus, Brazil, Peru, and Bolivia contributed 30,000 tons to the world's supply in 1902 as against 20,000 tons for East and West Africa and the Congo country. A small supply is now being had from the Straits Settlements, but in 1902 the output was only 1,000. In every other case the production shows a decrease. The various states of South America gave 3,500 tons in 1900 and 1,000 tons in 1902, Central America and Mexico gave 2,500 tons and 2,000 tons respectively, Java, Borneo, etc., 1,000 tons in 1900 and nothing in 1902, and similarly the supplies from Madagascar and Mauritius, and India, Burma, and Ceylon have ceased altogether. Thus, of the total supply of 54,000 tons in 1902 as much as 50,000 tons came from Brazil, Peru, and Bolivia, and East and West Africa and the Congo country, which remain the world's chief sources of supply.

**Monophase Traction**—Series motors approach to some degree the elasticity of steam-engines, but for their dissipating in starting part of their energy on passive resistance. As these motors should therefore be fed at variable voltage, monophase motors seem to be especially available for electric traction purposes, allowing of high-tension currents being used, and necessitating only one feeding wire, in addition to the rails serving as the return circuit. The series monophase motor designed by Dr. Finzi (*Elettricista*, November, 1903), when working at constant voltage, automatically regulates its speed according to the load, the speed being inversely proportional to the latter for high values of the torque required. It permits of the regulation of the voltage when starting being effected without losses, and of the speed being varied within very extensive limits. On the other hand, it is not able to use directly high voltages, and is at present only applicable to relatively low frequencies. The characteristic curves of the motor, as given in the original paper, have several advantages. Thus, comparing the monophase and continuous-current motors designed for speeds of 22 km. per hour, the former will require in starting 9·4 watt-hours per ton, whereas the figures necessitated by the direct-current motor are as high as 12·35 watt-hours. As regards the energy absorbed during a trial run by the two motors

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under equal conditions, for mean speeds of 17·5 km. per hour and about 2¼ starts and stops per kilometre, the integrations of the diagrams give for the monophase car, weighing 9 45 tons, 45 watt-hours per ton-kilometre, and for the continuous-current car, weighing 9·65 tons, 70 watt-hours per ton-kilometre. Calculating the power factor from the experimental curves obtained, the value 0 7 was obtained in starting; whereas at the generating station the power factor, including the line, transformer, and motor, averaged during the run 0·8, varying between 0·6 and 0 95.

**Steam-Turbine Rights.**—The important announcement is made from America that Mr. C. A. Parsons has disposed of the full rights to manufacture in the United States and Canada the well-known Parsons steam-turbine for all purposes to Mr. George Westinghouse on behalf of the Westinghouse Machine Company, of Pittsburg, Pa. One of the chief purposes for which the Parsons turbine will be turned out in future at this company's works is marine propulsion, and we understand that a special department will be organised at these works with that object. A determined effort is to be made to introduce the turbine on all classes of vessels, including warships of every type, and it is significant that the United States naval authorities propose to devote a sum of £5,000 for experiments with steam-turbine engines. To a limited extent the applicability of the steam-turbine to steamships has been tried by the United States navy in the case of the yacht "Revolution," which was equipped with a Curtis turbine. But while the performance of the craft was creditable for her class, it was found impossible to determine the important question of steam consumption with a vessel of this description. It is notable, however, that the Curtis turbine has been constructed in a form suitable to marine propulsion, and that further experiments are to be made with it on board a warship, probably of the cruiser type. But although the application of steam-turbines to warships is only now approaching the experimental stage on the other side of the Atlantic, it is instructive to note that in the United States alone there are to-day some 60,000 h.p. of the stationary type used in connection with electric light and power, and 150,000 h.p. more are now under construction at Pittsburg, where units as large as 8,000 h.p. are being built Mr. Westinghouse already regards the turbine as "the engine of the present," and having acquired the full manufacturing rights in America of the Parsons type, he has declared his intention of building up a great marine turbine industry in that country.

**The Edison Accumulator.**—Mr. Hospitalier has published in a recent issue of *L'Industrie Electrique* an account of a series of tests which he has made with the Edison nickel-iron storage battery, and which were carried out in conjunction with other tests made by the Central Laboratory of Electricity in Paris. In his experiments Mr. Hospitalier made a series of 21 charges and discharges partly under so severe conditions that a lead cell would have been put out of service, while the Edison cell was not hurt. From his tests and those of others the author concludes that the Edison battery can be used with charge and discharge rates which would be excessive for the lead cell, while the Edison battery is not hurt, nor does it lose any considerable amount of capacity. From curves, given by the author, it appears that the ampere-hour capacity was about 175, 162, 160, 155 for discharges at 30, 60, 90, 120 amperes respectively. The difference between the mean voltage at the terminals for discharges at 30 and 120 amperes was less than 0·2 volt. The durability of a storage battery is indicated by the total energy given by the battery during its life per kilogramme of its weight. The best lead cell—*i.e.*, the Fulmen cell—tested in the accumulator tests of the French Automobile Club in 1899 gave 1 5 kilowatt-hours per kilogramme. The tests of the Edison battery have shown that it has a capacity at least twice as great. The disadvantages of the Edison cell are its higher price and the fact that its useful voltage is about 1·1, against 1·9 for the lead cell. This means more cells, more connections, etc. The efficiency of the lead cells in the Automobile Club tests, for the low charge and discharge rates used, was between 70 and 75 per cent. The efficiency of the Edison battery, when charged at 60 amperes and discharged at varying rates, was 50 per cent. The author states, however, that this superiority of the lead cell is only apparent, since a fair comparison would require equal rates of charge and discharge. The volume of the Edison cell per normal watt is smaller than that of the lead cell; the volume per watt-hour, however, is greater. The author concludes that the Edison accumulator represents an important and incontestable advance for electric automobile purposes.

**Resistance of Plane Surfaces.**—Before the Institution of Civil Engineers on Dec. 22 Dr. T. E. Stanton read a paper on the resistance of plane surfaces in a uniform current of air. The paper deals with the results of experiments made in the engineering department of the National Physical Laboratory on the distribution and intensity of the pressure on thin plates and combinations of plates placed in a uniform current of air, and is intended as the first part of a research on the nature and distribution of the pressure of the wind on structures. By a uniform current of air is meant a current in what is known as "eddying motion" as distinguished from stream-line motion, the mean velocity at any point in the direction of flow being uniform across the current. This condition of motion is considered to be the nearest approximation to that of winds of fairly high intensity. The main object of the present research was to determine, if possible, a general relation between the velocity of the current, the dimensions of the plates, and the resultant pressure, as it was felt that experiments in the open air could not be undertaken with any prospect of success until some general relation of the kind had been established. The results of the experiments show that, under the given experimental conditions, a definite relation of the kind existed, and may be stated thus—for similar and similarly situated plates or combinations of plates in a uniform current of air, the intensity of pressure is the same for the same velocity of current and general atmospheric conditions. On the assumption that the motion of the wind approximates to that of a uniform current as defined above, the above relation shows that the distribution and intensity of the pressure of the wind on structures may be studied experimentally by means of models of the structures set up in a current of air produced by means of a fan, as in the present case. In illustration of this, the results of experiments made on models of roofs and lattice girders of simple form are given in the paper. Tabulated results are also given for the cases of parallel plates at varying distances apart, plates inclined at varying angles to the direction of the current, and rectangular plates of varying ratio of length to width.

**Single-Phase Railway Systems.**—There have been introduced within the last year or so two or three systems of single-phase railway working, which have attained a measure of success in the experimental field sufficient to give strong ground for belief that the single-phase method will mark a new era in electric railway operations before very long. Those we call to mind at the moment are known as the Finzi and the Arnold systems respectively,

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and the latter, we believe, is being installed as an experiment on an extensive scale on one of the American roads. As to its performance under practical operations it is as yet too early to speak, but many eulogistic accounts of the Arnold system have appeared in the pages of the American technical Press. Yet another single-phase system, about which excellent reports are to hand, is the invention of Messrs. Winter and Eichberg. This system has been taken up by the Union Electricitäts - Gesellschaft, and has been operated experimentally on the Continent. The principal trials have been made on the line between Johannesthal and Spindlersfeld. It is a part of the Prussian State Railways, 2½ miles long, and a car equipped on the Winter-Eichberg principle has been in regular operation on it since August last. Of the total weight of this car of 52 tons, the electrical equipment accounts for six tons. There are two motors mounted on the same truck, each of 120 h.p., and the car can be controlled from either end. A small transformer on the car supplies current for driving the braking air-pump, for the controllers, and for lighting. The voltage on the line is 6,000 volts, with a frequency of 25 cycles. The Winter-Eichberg motor, in common with all recent variable-speed alternating-current motors, is of the commutator type. It possesses two windings, the primary and the secondary, the latter being joined to a commutator, and supplied with current at low E.M.F. by means of brushes connected to the low-potential side of a variable-ratio transformer. In practical operation the line voltage of suitable value for transformation is impressed directly upon the primary windings, while a low E.M.F., suitable for commutator operation, is derived by transformation for the secondary circuit. Messrs. Winter and Eichberg have recently taken out a patent in this country for various improvements in details of construction, and we hope that some reliable information will be forthcoming before very long with regard to the practical operation of the system.

**The Manufacture of Electric Accumulators.**—To-day, being the first of the year 1904, there comes into force a set of rules drawn up by the Home Secretary, under the powers of the Factory and Workshop Act of 1901, for regulating the manufacture of electric accumulators, and they apply to all factories and workshops in which such apparatus are made. Our legislators, in their wisdom, have declared the manufacture of electric accumulators to be "dangerous," and the rules have been prepared with the object of protecting the workpeople employed in this business. In this respect the duties of the employer are both numerous and varied, but not unduly onerous. To provide efficient ventilation, every room in which casting, pasting, or lead burning is carried on must contain at least 500 cubic feet of air space for each person, and the rooms have to be constructed so as to allow of through ventilation. An important provision is concerned with the separation of the different processes, and lays down that each of the following processes shall be carried on so as to secure effectual separation from one another—*i.e.*, (*a*) manipulation of dry compounds of lead; (*b*) pasting; (*c*) formation, and lead burning necessarily carried on therewith; and (*d*) melting down of old plates. Another important rule is to the effect that manipulation of dry compounds of lead in the mixing of the paste or other processes shall not be done except (*a*) in an apparatus so closed, or so arranged with an exhaust draught, as to prevent the escape of dust into the workroom; or (*b*) at a bench provided with (1) efficient exhaust draught and air guide so arranged so as to draw the dust away from the worker, and (2) a grating on which each receptacle of the compound of lead in use at the time shall stand. Ample provision is also made for the surgical examination of the employés at least once a month, and the inspecting surgeon has the power to suspend any worker in his discretion. Then follows a number of regulations with regard to overalls to be worn by the employés, the provision of cloak and dining rooms, the introduction of food, drink, or tobacco into the workshops, washing, baths, and cleaning, in all of which matters the employer must follow the directions given. On their part, the persons employed have to conform to certain regulations which are destined to preserve health and cleanliness among them. They have to submit themselves to medical examination, and if suspended may not work in a lead process in any place in which electric accumulators are manufactured without the written sanction of the surgeon. For the rest, they must exercise the greatest care in the cleaning and washing of their hands and bodies, and must refrain from introducing or keeping any food, drink, or tobacco in any room in which a lead process is carried on.

**A "Coal Battery."**—This is the title given to a new form of cell for recovering electrical energy direct from coal, which is described *in extenso* by Mr. Hugo Jone in the *Western Electrician*. In the apparatus as explained the battery consists of an outer steel vessel containing metallic tin as the positive element, a porous cell of carbon containing a carbon negative element, mercuric oxide as the oxidant, and an aqueous solution of caustic potash, maintained at a temperature of 160deg. C., as the electrolyte. The tin is electrolytically attacked at the expense of the mercuric oxide on the other side of the diaphragm, falling to the bottom of the outer vessel as stannous oxide. The mercuric oxide is reduced to metal, and sinks to the bottom of the porous pot, whence it is withdrawn by means of a siphon. The mercury recovered is dissolved in nitric acid, and the mercuric nitrate is heated to convert it into fresh oxide ready for further service, the acid vapours evolved being treated with air and steam to regenerate the nitric acid. The stannous oxide is reduced to metal in a flat-hearthed furnace by means of coal, and the surplus heat from this reduction is caused to effect all the reactions above described. In this way, except for inevitable losses, only coal and atmospheric air are consumed, and the current is said to be generated from carbon and oxygen. In the article in our contemporary Mr. Jone fully describes the plant used, which includes a reverberatory furnace for the reduction of the stannous oxide. The products of combustion pass along flues, first raising steam in a boiler, next heating a horizontal drum through which a spiral conveyor forces the mercuric nitrate, then playing round the sides of the galvanic elements, and finally passing to the shaft amongst the coils of a pipe in which the air required to oxidise the nitric acid and to feed the furnace is warmed. The mercury recovered from the cells is forced into a closed and jacketed pan standing over the plant, when it is treated with nitric acid and steam from the boiler. On opening a valve the mercuric nitrate falls into the drum, and the nitrous fumes evolved in the drum and in the pan, together with some steam, pass into an adjacent condenser, when they are oxidised by means of hot air, yielding nitric acid again, which is collected in a suitable receptacle. The efficiency of the cell is claimed to be from 85 to 90 per cent. and the consumption 3lb. of tin per electrical horse-power hour. The E.M.F. is said to be 1·06 volts, a cell holding 1·5 gallons of liquid yielding 23 amperes with an external resistance of 0·02 ohm. Mr. Jone claims that the efficiency of the whole apparatus, in terms of the latent chemical energy of the coal burnt, is about 66 per cent. We understand that several patent applications are pending, and consequently for the present

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certain improvements which have been made in the apparatus described above cannot be made public.

**Electrical Power on Railways.** — An Act of Parliament which is destined to play an important part in the development of electric traction in railway locomotion comes into operation to day, having received the Royal assent on the last day of the 1903 session. The Act is entitled the "Railways (Electrical Power) Act, 1903," and its large importance lies in the fact that, with the object of facilitating the introduction and use of electrical power on railways, the Board of Trade may, on the application of railway companies, make orders for a variety of purposes therein defined, and such orders shall come into operation and have effect as if enacted by Parliament. Thus, in one stroke, the costly and often prolonged parliamentary procedure is got rid of, and a quick and inexpensive process substituted. The Board of Trade may, if they think fit, hold a local enquiry, but this is not compulsory, and they are vested with full power to authorise any railway company to substitute or employ electric traction in railway working and "for any other purpose." The last words are very wide, and seem to cover lighting, telegraphy, telephony, and other power purposes; but, of course, it is confined to use on the railway, and not away from it. Though nothing is said in the Act as to the mode of use, it may be taken that the Board of Trade regulations and model clauses providing against injury to the electrical apparatus of other parties and interference with the currents, whether or not the earth is used as the return circuit, will strictly apply. The second important provision in the new Act authorises a railway company to construct and maintain generating stations or other electrical works on any land belonging to the company. This is a departure from the usual practice, which is that the parliamentary notice must specify the uses to which the lands for the taking of which compulsory powers are sought are to be put. From the wording of the clause "on any land belonging to the company," it appears that a railway company may set up a generating station on any land belonging to it, no matter for what purpose it may have been acquired originally. If, however, compulsory power to acquire land for a generating station is sought, the order must under this Act be confirmed by Parliament. Another object of a Board of Trade order issued under this Act may be to authorise agreements between a railway company and any corporate body or other person for the supply to the railway company of electrical power, plant, and equipments. This clause was no doubt framed in the anticipation that many railway companies might prefer to take their electrical energy from power companies or municipal corporations near their lines instead of themselves erecting generating stations. Under other clauses the Board of Trade may sanction any modification of working agreements consequent on the introduction of electrical power, and may autherise the issue of additional capital for carrying out new works; and they must provide for the safety of the public, and for due publicity being given to the intention of railway companies to apply for orders under the Act; and if they hold a local enquiry they shall hear any objections of local authorities and private persons that may be made, and shall refuse to make or shall modify the order so as to remove any objection they may uphold. Such are, shortly, the provisions of this important Act, which is calculated to quicken and stimulate the activity in the application of electric traction to steam railways. Its leading features are that orders require the imprimatur of the Board of Trade, but not of Parliament, except in the case of compulsory acquisition of land for generating stations, that the erection of generating stations may be sanctioned by the Board on any land already belonging to railway companies, and that in the event of opposition to any order, a Board of Trade enquiry may be held by an official or nominee of the Board under the Board of Trade Arbitrations Act of 1874.

**Water Power in Canada.**—In a recent issue of the *Electrical World* Mr. Alton D. Adams contributes the first part of an exceedingly interesting article on the electrical development of Montreal, Canada, which he describes as "the greatest centre of transmitting power"—not even excepting San Francisco. It is asserted that Montreal consumes more electrically-transmitted water power than any other city in the world. This power is drawn from three generating stations, located on as many different rivers at distances that range up to about 85 miles from the central sub-station in the city. The superlative capacity of the water-driven apparatus in this electrical supply system seems evident from a statement of the figures for the generating and sub-stations. At Chambley power-house, on the Richelieu River, 17 miles from the central sub-station in Montreal, the combined capacity of the main electric generators is 16,800 kw. The Lachine power-house, on the St. Lawrence, five miles from the same sub-station, contains main generators of 6,000 kw. total capacity. Both of these power plants are devoted exclusively to the operation of the Montreal system. Neglecting the total equipment of the great power-house at Shawinigan Falls, on the St. Maurice River, which is operating under a head of 145ft, and in which three turbines are installed at present, having a capacity of 6,000 h.p. each, and generators of 3,750 kw, and whence energy is transmitted 85 miles to a sub-station in the suburbs of Montreal, the capacity of transformers at this sub-station is 5,000 kw., and they require about 6,000 kw. in generator capacity at the Shawinigan plant. The total rating of the present generators in water-power stations, devoted to electrical supply in Montreal, is thus 28,800 kw. The capacity will shortly be increased in two directions. A 50-year contract requires the company operating the Shawinigan plant to deliver up to 20,000 h.p. for electrical supply in Montreal. Still another water-power located at Soulanges, on the St. Lawrence, is about to be developed and transmitted for the city system. In anticipation of the increase of capacity at the water-power plants, the sub-stations in Montreal have been equipped beyond immediate requirements. The combined capacity of the step-down transformers at present installed is 39,500 kw., or 52,000 h.p. Besides the water-power plants and sub-stations already named, the system includes five steam-power stations, with a combined capacity of 5,700 kw., which are now held as a reserve for the water-power system. The largest of these steam-driven stations has a capacity of 2,400 kw., and has been remodelled and made fireproof during the past year. The area of supply of electric light and power in Montreal and the island of that name extends about 14 miles along the river front, and with an average width of between three and four miles back from its bank. Within this area there are at present served 11,152 consumers using arc and incandescent lamps, and 870 using motors, besides the cities and towns that are supplied with street-lighting. The total number of private lamps supplied, arc and incandescent, is 299,903 in the first case, and 1,514 in the second, while 1,109 motors are supplied with an aggregate capacity of 19,172 h.p. These last figures seem to indicate that the utilisation of water power has made the operation of motors an exceptionally important part of the Montreal system. Of the several companies which control this great system the Royal Electric Company is the oldest, its formation dating from 1884,

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## THE NEW ELECTRICAL LABORATORIES OF THE CENTRAL TECHNICAL COLLEGE.*

BY JOSEPH GRIFFIN.

The rapid advances in electrical engineering necessitate the continual addition of new appliances for the purpose of carrying out experiments and testing by the most modern methods, and in order to fit our students for the responsible positions to be held by them after leaving the college, it was ultimately found necessary to erect a new laboratory fitted up with the latest machinery. It was furthermore deemed advisable to have an equipment which should possess the characteristics of a power generation and distribution station modelled for the highest efficiency, and possessing that essential property of a laboratory—viz, flexibility. That this object has been obtained will be obvious to any old student who can contrive to pay a short visit to the new laboratories. Everything is up to date, and the Central Technical College can now boast of possessing one of the finest electrical laboratories of any college in Great Britain.

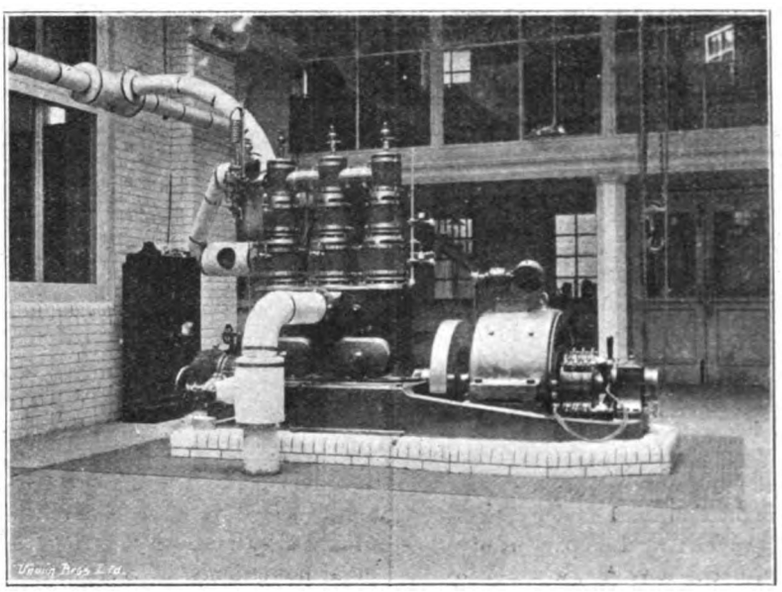

FIG. 1.—Willans Engine and Bruce-Peebles Generator.

Entering the well-lighted boiler-house, the engineer's eye is magnetically drawn to a neat electrical pump which supplies feed water to two Lancashire boilers. It is of the three-throw vertical plunger type made by Messrs. Blake and Knowles, and is connected by spur gearing to an enclosed direct-current motor fixed on the extended pump base. The set is as compact as could possibly be desired, and, in order that its performance may be tested, the pump is fitted with a Harding's improved counter, which registers the number of strokes made by the plungers. To serve as a spare, and as a substitute when the slight noise made by the pump would be objectionable, an injector is connected in parallel with it. In either case, the whole of the water fed into the boilers is previously measured in a Hayward Tyler meter, so that the boiler testing is greatly facilitated. On its way to the boilers the feed water passes through a surface heater, made by Messrs. G Weir and Co., of Glasgow, in which the exhaust steam from the engines is utilised for providing a hot feed. The steam passes from the boilers to the engines in the main laboratory through pipes which are very carefully and neatly lagged with mica covering.

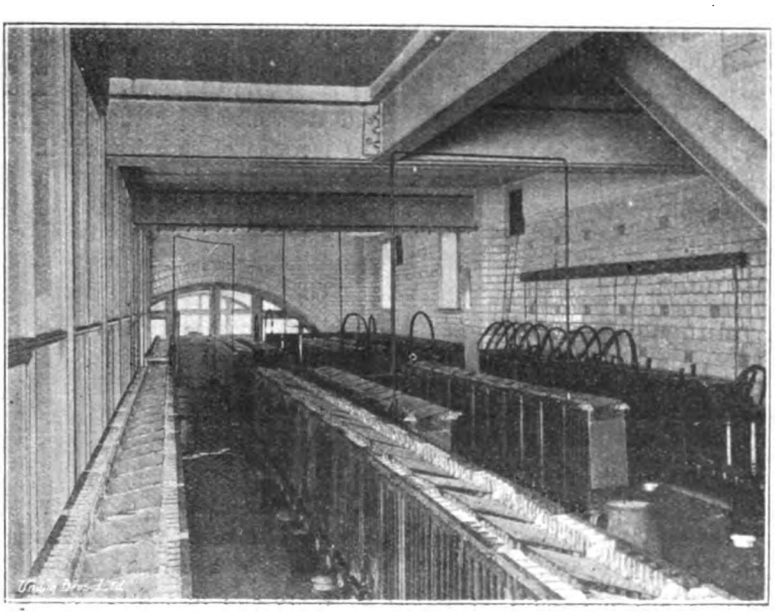

FIG. 2.—Accumulator House.

The piping (partly shown in Figs. 1 and 4), which is as short as possible, so that a minimum loss of heat and condensation occurs in the transmission, decidedly adds to the general appearance of the plant.

The laboratory itself is a spacious room 85ft. long and 53ft. wide, lined throughout with white glazed bricks, and so well provided with windows that, although it is on a basement floor, instruments can be read with the greatest ease in any part. The floor is so arranged that machines can be fixed anywhere, and leads run to or from them with

* Reprinted from the first issue of "The Central," which is the organ of the Central Technical College Old Students' Association.

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a minimum of trouble and expense. There are two engine sets, developing respectively 60 b.h.p. and 50 b.h.p., with a steam pressure of 100lb. per square inch. Fig. 1 illustrates the Willans single-acting three-crank compound engine running at 450 revolutions per minute. It is fitted with a steam separator as usual, and its speed is controlled within close limits by a centrifugal governor, which, by moving a loose collar on the shaft, actuates a lever, and thus throttles the steam when the speed rises too high. This engine is oiled by an excellent sight-feed lubricator made by Messrs. Dewrance, which has given the greatest satisfaction. Direct coupled to the engine is a Bruce Peebles compound-wound generator, giving out current up to 200 amperes at a practically constant voltage of 200, so that the arc and incandescent lamps may be connected to its terminals with little risk of damage. The commutation (partly E.M.F and partly resistance) is practically perfect, and even with the large and rapid variations of load no sparking can be seen at the carbon brushes. The winding and connections of the dynamo are such as enable it to be worked as a shunt generator for charging the accumulators and as a compound machine for supplying current to other circuits at one and the same time, thereby combining the advantages of a compound dynamo for variable load with the safety of a shunt machine in battery charging.

The storage cells are placed in a gallery above the Willans engine, and are shown clearly in Fig. 2. One battery, consisting of 100 Tudor nine-plate cells, is used solely for lighting purposes, whilst another similar battery, as well as a set of 15 Tudor and 15 E.P.S. 13-plate cells, are used for testing and experimental purposes. The capacity of each cell is about 350 ampere-hours, and may be discharged with a maximum current of 100 amperes and recharged with a maximum current of 60 amperes. All the connections in the accumulator-house are permanently burnt together, so that the resistance of the joints is diminished to its lowest value. Each cell is supported on insulators placed on wood painted with acid-proof varnish which is again supported on insulators, so that leakage has been reduced to a minimum. Every convenience in the way of distilled water supply, acid store, movable trolley, etc., is at hand. To obtain the distilled water conveniently and economically the discharge pipes from a steam trap draining the main steam-pipe and from the separator on the Willans engine empty into a raised tank just outside the battery gallery. The floor has been arranged to lead any liquid which may be spilt upon it down to the drains, whilst it is itself unacted upon by the acid; it, therefore, always presents a clean and dry appearance. The cells are all shielded from the direct action of the sun's rays, with the result that refilling is seldom necessary. All cables from the battery are led through Doulton earthenware conduits, and efficient ventilation has been provided.

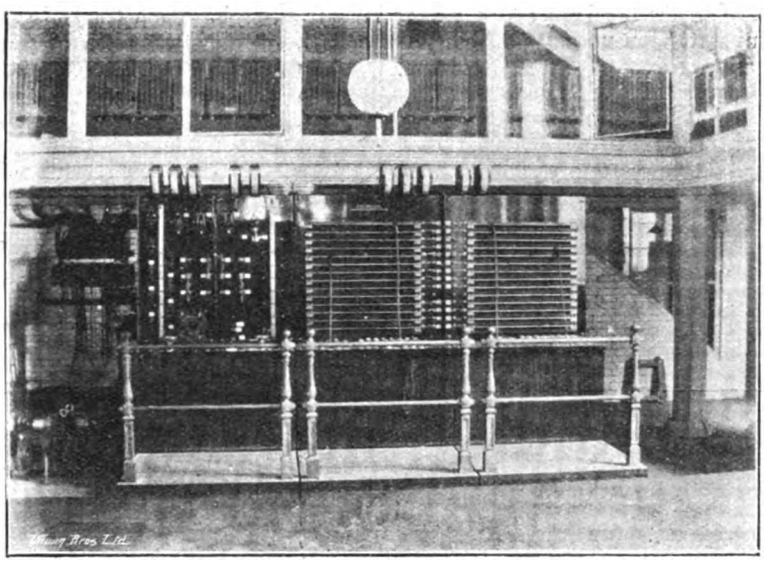

FIG. 3.—Main Switchboard.

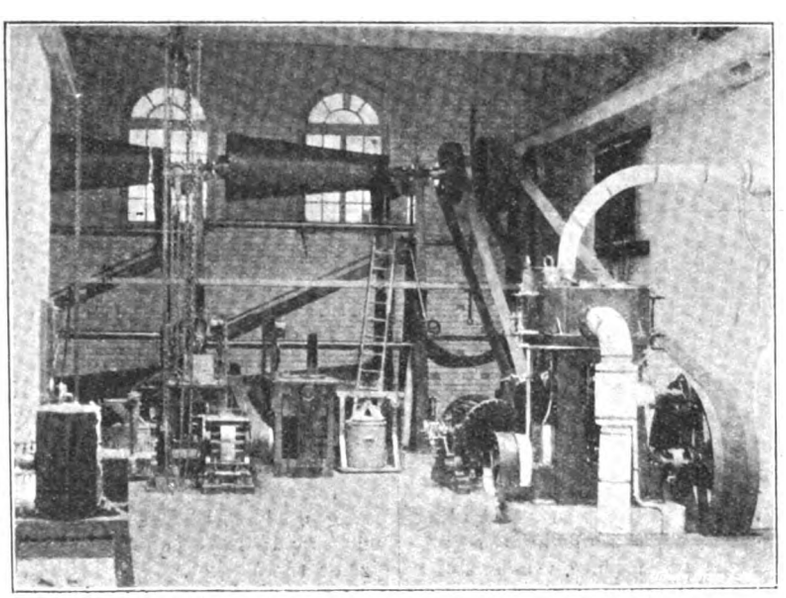

FIG. 4.—Allen Engine and Cone Shafting.

Fig. 3 illustrates the switchboard to which all the connections with the battery terminals, dynamos, and motors are brought. This board was constructed by Messrs. Reyrolle and Co., Limited, and is of exceptional design,

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because for experimental work flexibility is of the utmost importance, as almost every conceivable kind of connection has to be made. All the panels are of 1¼in. slate, enamelled back and front. There are four vertical panels—two each 4ft. wide for distributing the current, and two each 2ft. wide—and horizontal panels across the fronts of these. The distributing panels are fitted with a number of horizontal gunmetal bars, to which connections are made by means of plugs provided with phosphor-bronze spring contacts. The plugs are connected to flexible leads, and when out of use rest in holes provided for that purpose in the horizontal panels. Circuit breakers and fuses are provided in all the circuits to prevent any possibility of damage arising from excessive currents. Such "accidents" are sometimes known to occur. It is possible to connect any circuit to any dynamo, but impossible to connect two generators together without special arrangements. Both the experimental and the lighting battery can be charged either from the town mains or from the Bruce Peebles dynamo. In the latter case, by the use of a reversible booster having the town mains as constant voltage points, it is possible to charge the cells automatically at constant current and at the same time to have constant voltage at the terminals of the dynamo, so that the lighting is not interfered with. The platform, formed of glass blocks, is set in metal with insulating cement so that the danger to the operator is considerably lessened and the handrails although fastened to the framework, are insulated from it. The instruments are all of the Eversbed sector type.

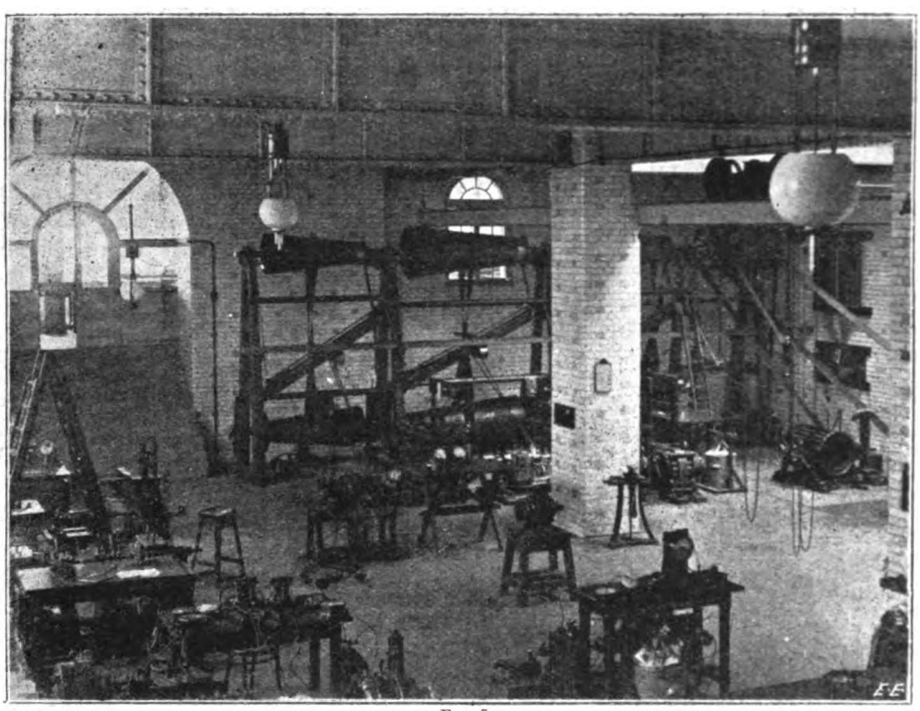

FIG. 5.

Fig. 4 illustrates the Allen double-acting compound engine running at 270 revolutions per minute and provided with drip lubrication. The steam-pipe is drained by means of a Geipel and Lange trap and the engine is governed in the same way as the Willans set. By means of a belt this engine drives a line of cone pulleys (Fig. 5), from which a number of machines, including a Ferranti alternator, Goolden dynamo, and Manchester machine, are operated at any speeds up to 1,500 revolutions per minute, thus enabling one in a very simple manner to determine all the important characteristics. A British Thomson-Houston arc lighting dynamo is also worked by belts from this engine, and supplies current to the Johnson and Phillips and the British Thomson-Houston lamps in the laboratory. Above the engine bay can be seen part of the overhead travelling crane, which runs on steel joists supported on I-iron fitted in the brickwork. Fitted to the crane is a Pickering block capable of lifting weights up to two tons.

In addition to the above equipment there are several other machines which deserve mention, but in such a limited space only a very brief description of the more important ones can be given. The alternating current machinery includes: (*a*) An 8-kw. Wenström rotary converter, provided with connections which enable experiments to be made on three, two, or single phase currents. It can be used (1) to convert alternating currents of any phase into direct current or *vice versâ*; (2) to generate, when operated by mechanical means, either alternating currents of any phase or direct current, or even to give out both currents at the same time and so operate as a double-current generator; (3) in addition to operation (1) it may act either as a direct-current or alternating-current motor at the same time. (*b*) A 5-kw. Ferranti transformer for making experiments on high-tension transmission. With the low-tension coils in parallel, the ratio of conversion may range from 100 volts to 5,000, 10,000, or 20,000 volts; and with the same coils in series, from 200 volts to the same voltages as in the first case. A 5-kw. Westinghouse transformer, converting from 2.000 or 1,000 volts to 100 or 50 volts, and Brush, Lowrie-Hall, and Swinburne transformers of similar ratios and capacity. (*c*) A 5-kw. Pyke and Harris inductor alternator having a very peaky wave-form. This machine is useful for making comparative tests with alternators giving a more sinusoidal wave-form, and for illustrating facts relating to the apparent variation in the capacity of condensers when operating with waves of different shapes. (*d*) Single-phase, two-phase, and three-phase induction motors, and a Gramme converter for single or polyphase currents.

The direct-current machinery includes (*a*) an 8-kw. E.C.C. motor-generator set, which may be used as a balancer on a three-wire distribution system, and also for efficiency tests by Hopkinson's or Kapp's electrical methods; (*b*) two of the latest sparkless Westinghouse motors (one 10 h.p and one 5 h.p.), and also one Edison and Swan enclosed motor driving a Swinburne alternator; (*c*) several small motors designed by Mr. Dahl (a student of the college), which, besides being absolutely sparkless, have an efficiency at least equal to any other motor of the same size on the market.

It may here be mentioned that intermediate connections from the experimental battery to the switchboard enable pressures of 50, 100, 150, and 200 volts to be readily obtained. The armatures of the various motors used for driving may, therefore, be run at quarter, half, three-quarter, or full speed without wasting power in series resistances. All intermediate speeds can be got by field regulation, for the machines may be separately excited at 200 volts.

In conclusion, we congratulate Prof. Ayrton and Messrs. Mather and Cramp on the excellent result they have attained, by which they will uphold the prestige of our college

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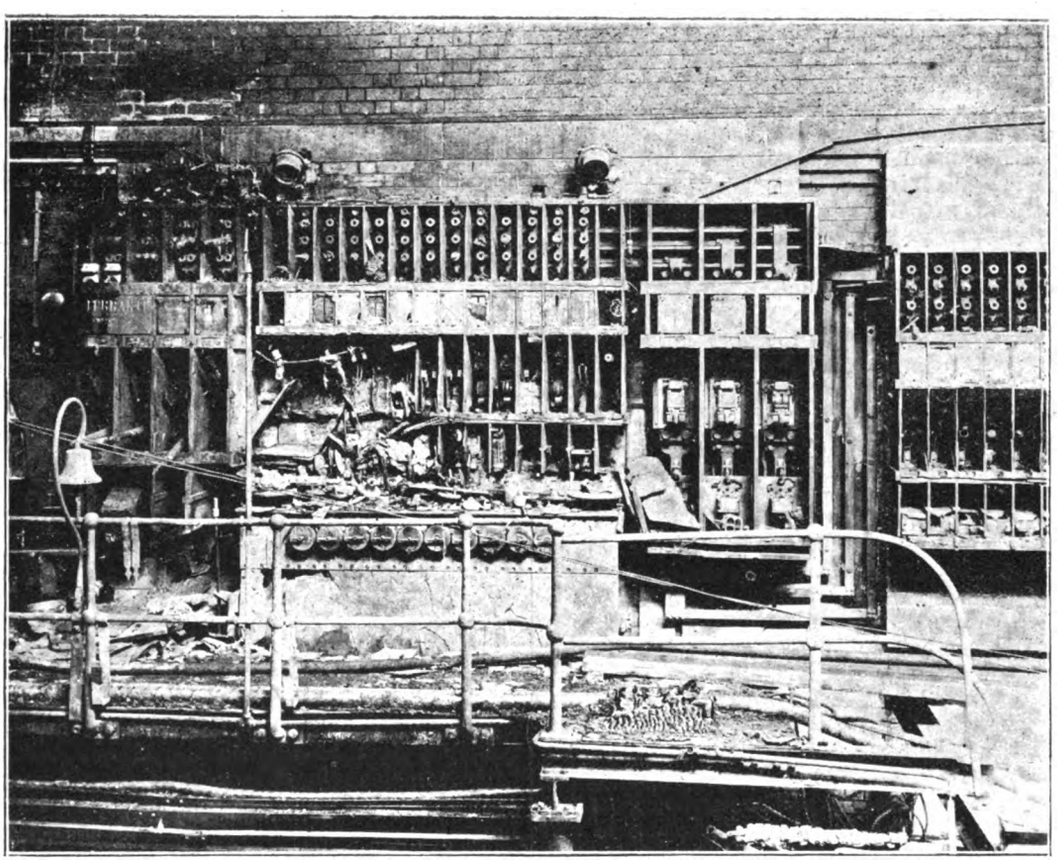
## THE BRISTOL FIRE.

The following is the official account of the fire at the Bristol electricity works, for which we are indebted to Mr. H. Faraday Proctor:

"A fire occurred at the Temple Back electricity works belonging to the Corporation of Bristol on Wednesday evening, Dec. 23, at 5.15 p.m., resulting in the total destruction of the 2,000-volt high-tension Ferranti switch-gear, and other damage, including the roof and windows of the engine-room. The exact spot at which the trouble commenced and the cause of the same cannot at present be ascertained. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank electricity works, and the whole of the 44 feeder panels were totally destroyed, as well as all the cables leading up to them from underground. Steps were immediately taken to shut off all current and shut down the boilers. The fire brigade were quickly on the scene, and the fire was soon got under control. The whole of the staff and employés immediately turned their attention to getting lighting on public thoroughfares in different districts, being supplied from feeder pillars at different parts of the city from the continuous-current supply system, were in operation at about 2.30 a.m. on Thursday morning also. Many other arc lighting circuits were able to be started up shortly afterwards, the continuous-current switchboards and machinery being damaged to a much lesser extent than was the case with the high-tension gear. Line resistances and other controlling gear, being in a very wet condition from the liberal application of the hose pipe, of course, caused some trouble, but the bulk of the lighting was kept going after the hour above mentioned. A temporary distributing switchboard was at once put in hand, and to this were joined the trunk feeders from the Avonbank electricity works, and the whole of the distributing feeders connecting the 60 or 70 sub-stations with the Temple Back works were joined up to this, joints having been made on all these cables in the street outside the works. This being done, all the feeders which were in proper condition were started up, the Clifton and Redland districts being switched off for this purpose, so that all might be put on together. The whole of the supply, both



View of Part of the Bristol Switchboard after the Fire.

the premises to facilitate the carrying out of temporary work which was necessary. The Bristol Tramways and Carriage Company, Limited, most kindly volunteered to start up their St. George's station, which had been out of use for some considerable time, and also to run cables and supplement the continuous-current supply if necessary. The Corporation availed themselves of the offer to the extent of some temporary arc lighting in the engine-room, and the tramway company supplied, erected, and connected five arc lamps in the engine-room, running cables from their Counterslip power station close at hand. By the time this work was done, however, the continuous-current supply of the Corporation was again in operation, the whole of the continuous-current power consumers having energy available at 2.30 a.m. on Thursday morning, thus enabling the different newspapers, all of whom use electricity for printing purposes, to get out their early editions.

"Trunk cables from the Avonbank electricity works were joined across to the Clifton and Redland feeders outside the works, thus enabling the alternating-current supply in these districts to be started up at about the same hour. The new five-ampere arc lamps (365 in number) for lighting alternating and continuous, was in full working order by about 8 p.m. on Thursday evening.

"Numberless telegrams and other messages offering assistance and expressing sympathy were received from all part of the kingdom. These have been too numerous to reply to during the extreme pressure of work, but gratitude is felt towards all those who thus expressed their feelings, and equally so to those who have only refrained from doing so in case they should take up the time of those engaged in rectifying the troubles. The engine-room roof and windows, which were burnt out, were protected as early as possible, the whole roof being covered with tarpaulins and the windows boarded up. Fortunately there has been little wet weather since the accident, and this has greatly assisted in the work that has been necessary.

"The whole of the staff and employés were kept hard at it during Wednesday night and until midnight on Thursday, and, in addition to those at present engaged in the works, some former assistants have most kindly come down to render assistance, which, owing to their knowledge of the details in the station, has proved most valuable. Fortunately, some of the machines at the Temple Back works were left

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in such a condition that, in spite of the great volume of water that was poured upon them, they were able to be started up after being dried out by passing current through them. The boiler-house and steam plant is all, so far as can be ascertained, in working order, none of such plant so far having given any trouble. The difficulty to be coped with now is the finding of a switchboard which will really be reliable under similar conditions on a supply system of 2,000 volts alternating.

"Up to Saturday no meeting of the Electrical Committee was summoned, as Alderman George Pearson, the chairman, expressed the view that it was better to give the officials an absolute free hand to deal with matters, rather than to take up their time by holding committee meetings, or by restricting their efforts in any other direction. This, of course, has greatly facilitated the expeditious reparation."

The photograph reproduced herewith was taken by Mr. Frank Holmes, of Bristol, who at Mr. Proctor's request also sent us two other photographs of other parts of the switchboard. The photograph shows the most damaged portion of the switchboard, but the whole of the board was gutted.

The report of Mr. Proctor to a special meeting of the Electrical Committee held on Tuesday was practically identical with the above. In answer to a question, it was then stated that there was now ample plant at the Avonbank station to supply the private lighting throughout the city and 25 per cent. to spare. Continuous current for power purposes is being obtained from the station at Temple Back, where the fire occurred.

The following additional notes are to hand from Messrs. Ferranti Limited, the makers of the switchboard: "The failure occurred on the single-phase alternating-current system at 2,000 volts, and it will be remembered (from previous articles in your columns) that there are two stations at Bristol, the old one at Temple Back and the new station at Avonbank, and that the whole of the distribution is from the switchgear at the old station, this switchgear being connected up by trunk mains to the new Avonbank switchgear. Both switchgears are of the Ferranti cellular type, the one at Temple Back being ordered from Messrs. Ferranti Limited nearly five years ago. At the time of the accident the load of about 3,000 kw. was being taken up by two 400-kw. machines at Temple Back and four 750-kw. machines at Avonbank. In such occurrences it is difficult to locate exactly the origin of the fault, but from the appearance of the switchgear it would seem that, for some reason yet to be discovered, one or both of the machine fuses at Temple Back blew. This action was apparently followed by a severe arc in the fuse panels, which burnt through the slate above it, melting the fuse contacts and the metallic connections between the fuses and the switches. It would appear from the *débris* that, although some minutes were taken to shut down the machines at Temple Back and Avonbank, the arc thus formed was confined to the machine panels. A serious conflagration, however, was started almost simultaneous with the forming of the arc, the flames igniting the linoleum floor and the insulation over the inner conductor of the cables connecting to the terminals under the bottom switch slate. The flames from this material were intense, and quickly spread over the entire switchgear and to the roof of the building.

"A close examination on Thursday revealed the fact that the damage to the power station and machinery was not so extensive as was at first thought. The fire was confined to the woodwork used in the structure, the insulation on the cables, and the flooring, although the water with which the fire was subdued impaired some portions of the plant. Practically the whole of the cable work in the station had to be cleared, and in order to get down to the sound portions of some of the cables it was necessary to dig up the road adjoining the electricity works.

"Although the Ferranti cellular switchgear is apparently at fault, in that the fuse (which is of an obsolete type) failed, yet the arc caused by this failure was confined to the switch and fuse panels of three or four machines, the 'bus bars (there being three inner 'bus bars in number) remaining intact, thus giving a practical demonstration of the utility of the cellular construction in limiting to a minimum the extent of the arc. While admitting that the remainder of the switchgear, including the circuit section, were placed out of commission, it must be taken into consideration that the damage was not caused by a direct electrical failure on the individual sections, but by the heat and smoke resulting from the combustion of materials which, although they were contiguous and near to the switchgear, did not form an inherent part of the actual cellular switchgear design."

## INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

*(Continued from page 966, Vol. XXXII.)*

### (10) Instrument Construction.

In the selecting of instruments for the working of an up-to-date telephone exchange, the consulting engineer finds himself in a very perplexing position, owing to the fact that there are not many eminent manufacturers who are telephone experts and have studied the perfecting or standardising of a good serviceable telephone instrument for exchange working. Another and more important point in connection with the selecting of instruments is to insist on a standard type and maintain this class throughout the whole system. It will not increase or improve the service to have some instruments capable of communicating to other towns (over the Post Office trunk lines) while others could only be used over very short distances. The consulting engineer in inviting tenders should select samples of instruments from the various manufacturers and subject them to a series of tests in the speaking, ringing, and interior working qualities of each part. The instruments' interior should show substantial and permanent work, the different circuits being well insulated from each other, the generator gearing silent, the shunt or cut-out of the generator and the automatic switch perfect in action, and the general appearance indicating superior workmanship and finish. In deciding the system to be adopted a descriptive specification should be drawn up setting forth all details with sketches of the various circuits. The most important part in a telephone instrument, and on which depends the reliability of the speaking and ringing circuit, is the cradle automatic switch, and it should be the first point to be tested and inspected, more especially with instruments on common battery exchanges, as the signals both in calling up and clearing depend entirely upon the action of the automatic switch. The cradle switch should be absolutely clear of the contact springs and not form any part of the circuit, all the contact springs being highly insulated on vulcanite blocks and of the best German silver, platinum pointed, to ensure perfect contact, and designed to give a good clear space for making and breaking the connection, the restoring springs being positive and durable in action and clear of electrical contact.

*Polarised Bells.*—These should be sensitive, easy, quick acting, durable, and reliable. The armature and cores of the best quality, soft, annealed iron, and the coils perfectly insulated and wound to a resistance of 200 ohms to each coil with the highest grade, silk-covered, copper wire. The armature should be provided with regulating screws, so that it may be conveniently adjusted to secure the best results on any resistance of line.

*Generator.*—This should be designed to give the best results and capable of ringing through 25,000 ohms, the armature cores being laminated and made up of very soft wrought iron mounted upon the shaft in a substantial manner, and thoroughly insulated with specially prepared tracing linen impregnated with highly insulating varnish. The winding should be done in a thorough manner to prevent leakage or short-circuiting, and with the best quality of silk-covered copper wire to a resistance of 500 ohms, the casing and pole-pieces being made from soft wrought iron permanently adjusted to the proper and uniform distances from the armature at all points and held in position by brass screws. The bearings should be of heavy brass castings and provided with oil-cups, the permanent magnets evenly cut and bent from bars of the best steel suitable for the purpose, strongly magnetised and tempered to obtain

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strength and permanency and also black varnished. The driving gear should be as large as practicable, evenly cut to ensure perfect and smooth running, and to be made from metal to give equal wearing qualities throughout. In order to prevent lightning discharge or other heavy currents damaging the armature, the generator should be provided with a reliable shunt, worked from the driving spindle, this shunt to be capable of shorting the armature when out of use. The spring for controlling the shunt should be made of the best steel, and form no part of the connection, suitable screw terminals being provided and mounted in a convenient position, so that the whole generator arrangements are easy of access in case of repair or inspection.

*Hand Micro-Telephone.*—That is, the transmitter and receiver made up in one, the transmitter being made of nickel-plated brass, into which is fitted a carbon cylinder for the reception of the carbon dust or granules, which are held in position by the diaphragm and a felt ring, the mouthpiece being made of celluloid. The diaphragm should be made of copper, the inside membrane being of carbon cemented to the cover in order to protect the carbon dust from dampness. The receiver is also of nickel-plated brass, the cover being

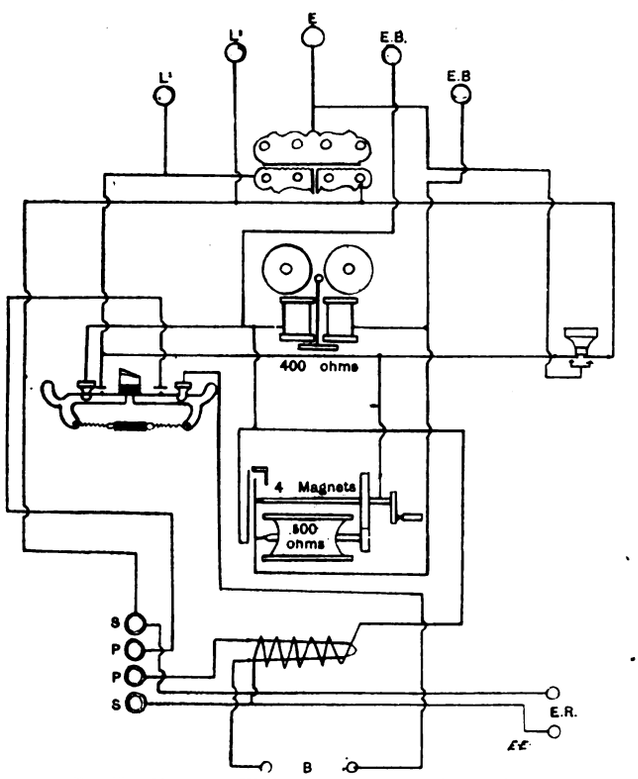


FIG. 55.—Diagram of Wall Instrument—Ring-through System.

of polished ebonite. In the brass casing should be fitted three ring-shaped steel magnets, inside which are fitted the two electromagnets, the cores being of soft wrought iron, the electromagnets being highly insulated with tracing linen impregnated with insulating varnish, and wound to a resistance of about 60 ohms per coil with silk-covered copper wire. The casing of the receiver should form no part of the electric circuit, but should be highly insulated, the handle being made of polished ebonite and bored true to receive the nickel-plated tubes at each end, for the fitting of the transmitter and receiver together by grooved screws, and the reception of the flexible silk cord for connection, this cord being accessible in the event of replacing. The induction coil should be of the bridged type, the primary winding wound to a resistance of one ohm, with silk-covered copper wire highly insulated from the core and secondary windings by tracing linen impregnated with varnish, the secondary windings being wound to a resistance of 70 ohms, with silk-covered copper wire covered outside with strong braided linen, the primary and secondary wires being brought out, bound in and soldered to screw terminals. The terminal screws for the connecting up of the lines, battery, extra receiver, and extension bell should be of brass, nickel plated, and protected from interference, the whole being mounted on polished wood back board, provided with writing desk and iron cover for the batteries. The instruments here described were made on the "ring through" system, and manufactured by the Ericsson-Bell Telephone Company for the Portsmouth Corporation, connections of which are shown in Figs. 55 and 56. Various forms of instruments are being placed upon the market, so that in the selecting, whether for common battery or magneto call, it will be found the best practice to maintain throughout the system a standard type.

*Fitting of Instruments.*—The fitting up of the instruments is best done by the department's own staff under the

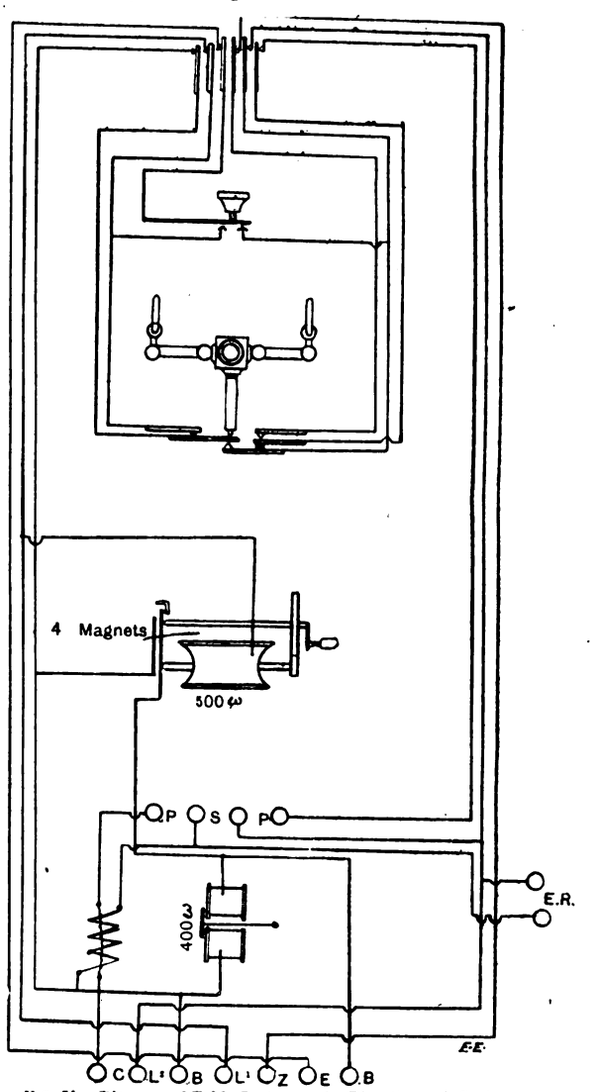


FIG. 56.—Diagram of Table Instrument—Ring-through System.

direct supervision of the management. As the work calls for special care and attention, it should be arranged to be carried out under a schedule of prices as follows:

*Fitting of Subscribers' Instruments.*

| | |
|---|---|
| Fitting and connecting up | at |
| ,, ,, lightning guards | at |
| ,, ,, extra bell | at |
| ,, ,, through switch | at |
| Charging and fitting batteries | at |
| Running and connecting up | at |
| Inside insulated wire | at |
| Running earth wire | at |

These prices should be checked each week with the pay sheets of the instrument staff, the amount of work done (if carefully watched) balancing with the amount paid out. The instrument fitters being organised and given written instructions, the work will proceed expeditiously, the foreman or chief fitter being able to check and examine from time to time and report on the class of work done. The written instructions necessary to provide to each fitter should be brief and to the point, in order that they can be easily understood and the same class of work maintained throughout. The instructions adopted in the construction of exchanges under the writer's supervision were as follows: the instruments being prepared, tested, and examined by the inspector placed in charge of the department, were

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handed to the fitters, along with the order to proceed with the work, also number plates, directories, and all instructions for fitting, the instrument, wire, and accessories being protected in carrying out by being placed in waterproof bags made for the purpose.

*Position of Instrument.*—This, as far as possible, was settled and arranged beforehand by a representative from the department, in order to avoid loss of time and waste of material.

*Plugging Walls.*—In some cases this was found necessary, but in order to make a better and more workmanlike job, polished wood straps, 10in. by 3in. by $\frac{5}{8}$in., were provided.

*Wiring.*—Sufficient care and attention is not generally given by inspectors and fitters to the wiring. All wiring should be neatly and carefully done, staples being used sparingly and only over one wire, driven in just sufficient to hold same; the earth wire being run apart, and as far as possible in an opposite direction from the line or insulated wires. On damp walls hardwood cleats should be used or lead in wire.

*Distinctive Colour of Wires.*—Wires should be connected up in a definite order, the red being known as the A, and connected to the left-hand terminal, the blue being the B, the earth of soft copper No. 18 gauge being connected to E, all wires where jointed being carefully soldered and insulated with pure rubber and waterproof tape.

*Connecting up Instruments.*—The wires should be stripped of the insulation the required distance only, and bound in under the terminals in the direction of the screw perfectly tight.

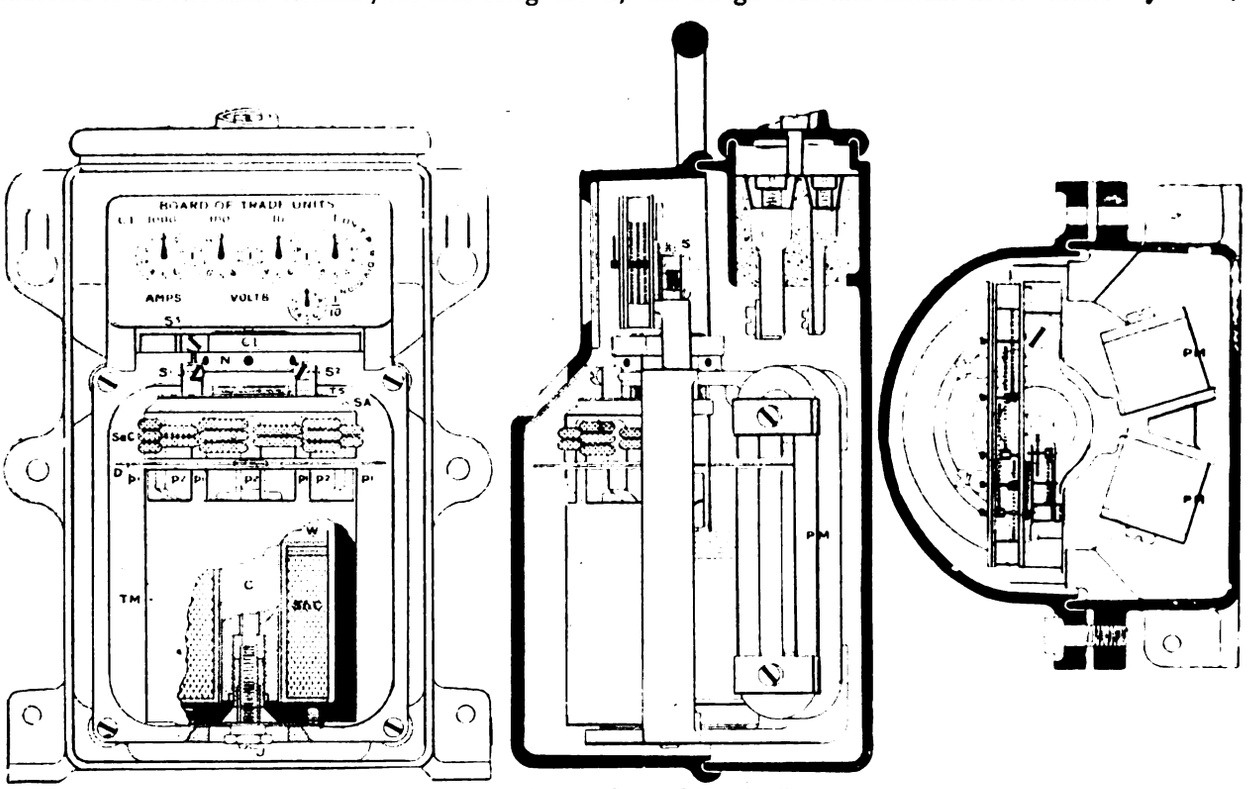
*Lightning Guards.*—Under no circumstances should instruments be fitted without a subscriber's lightning and high-tension guard, these being fitted up in a convenient and accessible position and connected to earth in a thoroughly safe manner.

*Battery.*—To each instrument two No. 2 Leclanché cells should be fitted. Where cells are used apart from the instrument they should be placed in a battery box, in such a position as to be easily accessible and yet out of the way of being interfered with. All work in connection with the fitting-up of small switchboards, instruments, lightning guards, and accessories, should on completion be carefully tested and the apparatus left in such a manner as to prevent anyone interfering with same. The number plate, directory, and all instruction cards should be fitted in a prominent position, and the subscriber instructed as to the working of the instrument. Where the subscribers have several extension lines it is customary to fit small switchboards, these switchboards being of a standard type and designed to work in conjunction with the same system as the central exchange, so that a perfect clearing out signal can be given on the extension switchboard simultaneous with the central.

*(To be continued.)*

## FERRANTI ALTERNATING-CURRENT INTEGRATING WATTMETER.

By the courtesy of Messrs. Ferranti Limited, 20, Cockspur-street, Pall-mall, London, S.W., we are enabled to give herewith an illustrated description of the Ferranti alternating-current integrating wattmeter, of which little has hitherto been published, although the instrument is already in extensive use. This meter has been devised with the object of providing an instrument which is at once reliable and accurate under all practical conditions of working, and can thus be relied upon to give satisfaction both to the supply authority and to the user of electricity. Its design combines certain novel features by which, it is claimed, very excellent results are obtained; not the least being the accuracy of the meter under all conditions likely to arise in practice, and the small losses with which it is operated.




The Ferranti Alternating-Current Integrating Wattmeter.

The construction is compact, strong, and portable, and such that the meter is not likely to suffer injury in transit; and, furthermore, the instrument can be very readily tested, as the speed of the disc in all meters is adjusted to be of fixed value at full load—viz., 40 revolutions per minute—and can thus be easily counted by the aid of a stop watch. The meter is an integrating watt-hour meter of the induction motor type, measuring accurately the energy consumed on an alternating-current circuit, whether the load is inductive or non-inductive; and while the accuracy of the meter is equal to that of many laboratory instruments, it is essentially a practical commercial instrument, the energy being recorded directly in Board of Trade units, and no multiplier or constant is necessary. The accompanying illustrations show clearly the construction of the meter, and indicate the extreme simplicity of its parts. The aluminium rotatable disc, D, mounted on the spindle, S, geared to the train of wheels, C T, actuating the index hands, serves the double purpose of an armature receiving the driving torque of the meter coils and also the retarding torque of the permanent magnets, P M. The shunt system consists of one shunt

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coil, Sh.C, placed round the core, C, of a special tubular electromagnet, T M. The core of this magnet has three outward radial poles, $P_2$, alternating with four inward radial poles, $P_1$, from the shell or tube of the shunt magnet, the plane of these poles being horizontal and parallel to the disc: this tubular magnet is placed below the disc.

It is well known that, in the case of the induction motor type of meter, it is necessary that the shunt circuit should be very inductive, and in this connection a special tubular magnet is found most suitable; no choking coils, secondary circuits, resistances, or compensating coils being required. The number of electrical connections is thus reduced to a minimum, and the possibility of trouble in this respect is removed. The series system consists of a slotted armature, S A, above the disc, the series coils, Se.C, being wound in these slots. A wave form of winding is used, somewhat similar to the winding adopted by Mr. Ferranti for his alternators in 1884, and it will be noted that the slots of the series armature are almost directly above the poles of the tubular magnet.

With regard to the principle of working, if the shunt circuit be sufficiently inductive, the eddy currents produced in the disc by the shunt field will be in phase with the impressed E.M.F. These eddy currents are acted on by the series field—which is in phase with the load current—giving a driving torque on the disc proportional to the E.M.F. of the circuit multiplied by the amperes and by the cosine of the angle of lag of the main current behind the E.M.F., this being the true watts supplied to the circuit through the meter. The retarding torque due to the permanent magnets is proportional to the speed, and the disc therefore revolves with a speed which is proportional to the watts. If the series and shunt magnetic systems could be made exactly symmetrical and placed relatively to one another in a symmetrical position—*i.e.*, the slots of the series magnet exactly above the shunt poles—then the disc would not revolve when the shunt coil alone is energised, and the meter would read low at the small loads owing to the friction of the train and spindle bearings. For the purpose of compensating for any dissymmetery in the magnetic system due to small irregularities in material, workmanship, and pivot friction, it is necessary to have some adjustment which gives a driving torque when no current passes through the series coil, this driving torque being insufficient in itself to cause rotation of the disc and train. It is an important feature in the Ferranti design that no additional windings or parts are necessary, provision being made to simply turn the series magnet about the axis of rotation of the disc to the necessary extent to effect the required compensation, for if the series magnet is displaced clockwise the disc will tend to revolve anti-clockwise; and if, on the other hand, the series magnet is put to the other side, the disc will tend to revolve clockwise. Hence it will be seen that it is possible to leave the series magnet slightly out of centre in the direction which gives a slight torque on the shunt alone, and this can be very accurately adjusted to compensate for pivot friction or for any dissymmetry in the magnetic circuit met with in manufacture.

The adjustment can be most accurately made, and the meter can be calibrated or adjusted by the simple action of slightly altering the relative positions of the shunt and series magnets, and this is done by means of the two screws, $S_1$ and $S_2$. The driving torque with the shunt alone, even with the maximum possible displacement of the series armature, is extremely small, and as it will be noted that the armature is fixed by a powerful clamp, Cl, and the two screws, $S_1$ and $S_2$, the possibility of the meter developing any tendency to creep on the shunt is very remote. The constant of the meter is also readily adjusted by lowering or raising the series armature by means of the nut, N, on the threaded spindle, T S, the effect of this being to strengthen or weaken the action of the coils, and after adjustment the series magnet is securely fixed by means of the strong clamp, Cl, and the screw, $S_3$.

The meter is claimed to be very accurate on all conditions of circuit, inductive or non-inductive, on overloads up to 50 per cent., and under variations of voltage to 50 per cent. above or below the normal, and it is also practically independent of variations in periodicity, wave form, or temperature. Every meter is calibrated before leaving Messrs. Ferranti's works at Hollinwood to the following limits of accuracy: 1½ per cent. from one-tenth to full load, and 2½ per cent. from one-twentieth to one-tenth load; the accuracy is not affected by short-circuit through a fuse of double the capacity of the meter. The starting current is very low; for example, a 10-ampere meter starts well with ·05 ampere, and can be relied upon to register with a 250-volt 8 c.p. lamp. Moreover, the losses in the meter are small, and the efficiency is consequently high. For example, in a 10-ampere, 200-volt, 100-period instrument, the losses in the shunt circuit will not be above 1·7 watts, and the series loss at full load will not exceed 0·8 watt, the shunt current being only ·015 ampere. The insulation of all meters is tested to withstand an alternating pressure of 1,000 alternating volts, applied between windings and case.

For convenience in testing, the meters are calibrated to run at a speed of 40 revolutions per minute at full load, the standard voltages for calibration being 100, 110, 120, 200, 220, and 240. For intermediate voltages the nearest standard is adopted, this making no difference in the accuracy of the meter. The terminal box is also specially designed to facilitate testing, the shunt being connected to a fourth terminal, which can readily be disconnected from the main terminal, allowing the shunts of several meters to be placed in parallel on the voltmeter leads, and avoiding unnecessary opening of the cases. Since the speed of the disc is directly proportional to the load, it is at all times easy to check the calibration of the meter on site. The meters are fitted with removable jewelled brass settings, J, which enables a defective jewel to be easily replaced by a new one at any time without altering the calibration of the meter, all parts being interchangeable.

The long experience which Messrs. Ferranti have had in this branch of the electrical industry serves as a guarantee for the soundness of the design of this meter, both mechanically and electrically.

## THE CARDIFF BREAKDOWN.

We have received the following communication from Mr. Arthur Ellis, borough electrical engineer, giving the cause of the breakdown at Cardiff on Christmas Eve:

SIR,—I beg to acknowledge receipt of your communication this morning with reference to *breakdown* in connection with our tramways system on *Christmas Eve*, and in reply may say that I have very much pleasure in giving you the following particulars, from which you will gather that a most dastardly outrage was committed, and one which might have had serious consequences, but which fortunately did not do any great amount of damage.

For some time past I have had a few men wiring the extension of our power station and also our new car depôts for electric lighting and other purposes. I have repeatedly complained about these men, and the progress which they have made with their work, and from time to time warned them that it would not be tolerated much longer. This matter came to a head on Thursday last, and ended in all these men being dismissed with a view to getting others who would make satisfactory progress.

One of the wiremen, a man named Frederick Parks, evidently got it into his head that we had no right to dismiss him, and, in consequence, struck upon the idea of taking his revenge, evidently upon myself, through the department generally, and what he did was briefly as follows: Being known to the watchman on duty for months past as having work to do in connection with the power station, he walked straight through the car depôt about 9 o'clock at night without seeing anyone but the watchman, who, on his part, thinking he was going to work, did not challenge him. By going through the car-shed he was able to get right up to the top end of the power station without being seen by anybody, as the car depôt was in semi-darkness, all the cars being on service. From the top of the car-shed he crossed over to the power station, and worked his way into the same, by what means I do not, of course, know up to the present. He, however, gained access to the chamber immediately underneath the Ferranti switchboard which

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we have installed, and inside this chamber regulating rheostats are fixed and stand upon a platform about 8ft. from the ground level. This chamber cannot be seen from the engine-room, as otherwise the man would have been seen by the engineers in charge. Having once gained access to this chamber, he took particular care not to turn the lights on in the same, knowing that if he did so he would immediately light a signal light on the switchboard gallery above, which would warn the engineers on duty that somebody was in the chamber working. He then proceeded to disconnect the cables from the field-regulating rheostats.

The first machine which he came to was one of 1,100 kw., which was not working at the time, but which was in readiness to be put on quickly in case of emergency, consequently nothing happened when he pulled the wires out of the terminals. Very different results were obtained with the second machine which he tampered with, as you will realise very readily. This machine was taking the whole of the tramways load of 105 cars, and consequently was fully loaded up at the time, and I do not think it is necessary for me to explain what happened.

Of course, two things happened. The whole of the load was thrown off the machinery and the tramways service stopped; secondly, this man received a shock severe enough to throw him off his feet, with the result that he fell from the platform upon which he working to the floor 8ft. below, his injuries sustained consisting chiefly of slight concussion caused by the fall. Fortunately, the switchboard attendant on duty above at the time, who suddenly saw the load go off the machine, reported to the engineer in charge that he had heard a peculiar thud underneath. The engineer immediately rushed downstairs into the chamber, where they found this man lying unconscious. Had the switchboard attendant not heard the fall it is quite evident and possible that they might have looked about for a very considerable time before finding out what was the matter. They then, to their great astonishment, after finding the man, discovered what he had been up to. The result, of course, was that the spare machine being disconnected also they were unable to get the car service under way again until they had coupled up the field wires to the rheostats. They then ran up the spare machine and got everything going, in my opinion, in marvellous time—viz., 20 minutes—because in this time they had to realise what happened, attend to the man, couple up rheostats, and get the machine under way, and all the traction feeders put in again.

The man's idea, in my opinion, was evidently to get there and wreck the station if he possibly could, or in any way to stop it altogether for that night, and not only that, but to put the town in darkness like Bristol was the previous evening

There is one matter in connection with this which I think most fortunate—almost a God-send—because one can hardly realise the panic that is created when business premises and streets are thrown into entire darkness on a night like Christmas Eve, with thousands of people about. But the circumstances are these, that about 5.30 to 6 o'clock I got in communication with the power station to ascertain what sort of a load they had on at that time, and also as to what machines they had taking the load. I was told, in reply, that the two large sets of 1,100 kw. each were working, one taking the tramways load and the other the electric lighting load. I then gave instructions for the electric lighting load to be transferred over from the large set to the four 300-kw. sets, as I realised that if anything happened to one of the sets the other three would be able to take up the load comfortably; consequently we should ensure continuous supply for that evening, and the other machine, which this man disconnected first, was the machine from which the lighting load was transferred.

I happened to be in town at the time and saw something was wrong, and immediately went to the power station, and I saw the man and eventually I gave him in charge, after which he was taken by the police ambulance to the infirmary, where he is now and has been since, and during the time he has been in the infirmary he has been under the supervision of the police, and when he is discharged from that institution he will be brought before the magistrates and charged under the Electric Lighting Act, 1882, 45 and 46 Vict., Chapter 56, Section 22. If you will refer to this particular Act, you will see that the penalty is five years' penal servitude or two years' hard labour—and this is as little as the man deserves.

Our staff have worked nobly during the holidays putting the machine right, because the fact of throwing the load off suddenly, as this man did, was to burn out one of our large field coils, and these are somewhat difficult to get at and put in order again. (Signed) ARTHUR ELLIS,

Borough Electrical Engineer and Manager.

N.B.—An interruption in an electric supply system due to wilful damage is happily rare in this country, and we trust that the results of the prosecution of this first offender will be such as to emphasise the serious nature of the offence, which was aggravated by the time selected for the same.—ED. *E. E.*

## THE "CALLENDER-WARD" FUSE BOX.

Through the courtesy of the Callender Cable and Construction Company, of Hamilton House, Victoria-embankment, E.C, we have had the opportunity of examining and photographing one of their new type of house service fuse

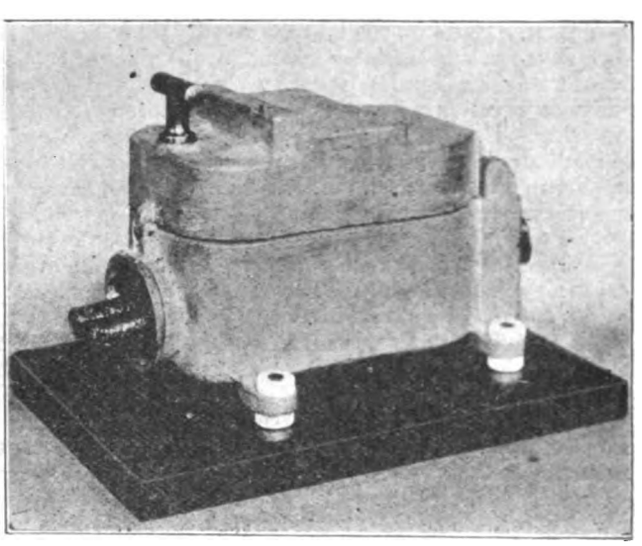

FIG. 1.—Exterior View of the Callender-Ward House Service Fuse Box.

boxes, which are just being placed on the market. The photographs we have had taken show respectively (Fig. 1) the fuse box closed and ready for sealing, (Fig. 2) the fuse box open, and (Fig. 3) the fuse carrier and neutral-wire connector removed from the lid of the box. The design of this new service box will be of interest to all central-station engineers. The example we illustrate is intended for a three-wire system, and contains a solid link connection for the neutral main and a fuse only for the outer conductor. This is in accordance with the recently-made regulations of the Board of Trade and with the old accepted custom of central-station engineers, who, although installing a double-pole fuse box, have used a copper link in the neutral on three-wire systems. The illustrations show such a box made for two single rubber conductors coming out to house wiring and a twin branch off the main. It will be seen that the box is not only a fuse box, but a combined switching arrangement with fuse gear. Thus, by opening the lid the current is switched off from the installation, and, shutting the lid, closes the switch contacts.

On examination of the illustrations, it will be seen that the neutral-wire solid link connection is carried up the centre of the porcelain bridge which carries the fuse for the outer, and is attached to the lid, so that when the lid is opened the fuse and solid link contacts are brought up with it. By this means, where it is necessary to renew the fuse, there is no occasion for touching any of the live conductors. The solid link and fuse caps attached to the bridge porcelain fixed on the lid are removable from

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the lid when it is necessary to renew or withdraw a fuse. When put in position on the lid the fuse is enclosed in a chamber (showed removed in Fig. 3), which is made of a non-hygroscopic and non-inflammable material, such as pressed asbestos slate or porcelain. It will also be seen that the fuse chamber is ventilated at the top and bottom with a view to providing plenty of ventilation, so that when the fuse blows the volatilised metal will mix with the air, and there will not be so much tendency for the arc to be maintained as is the case where

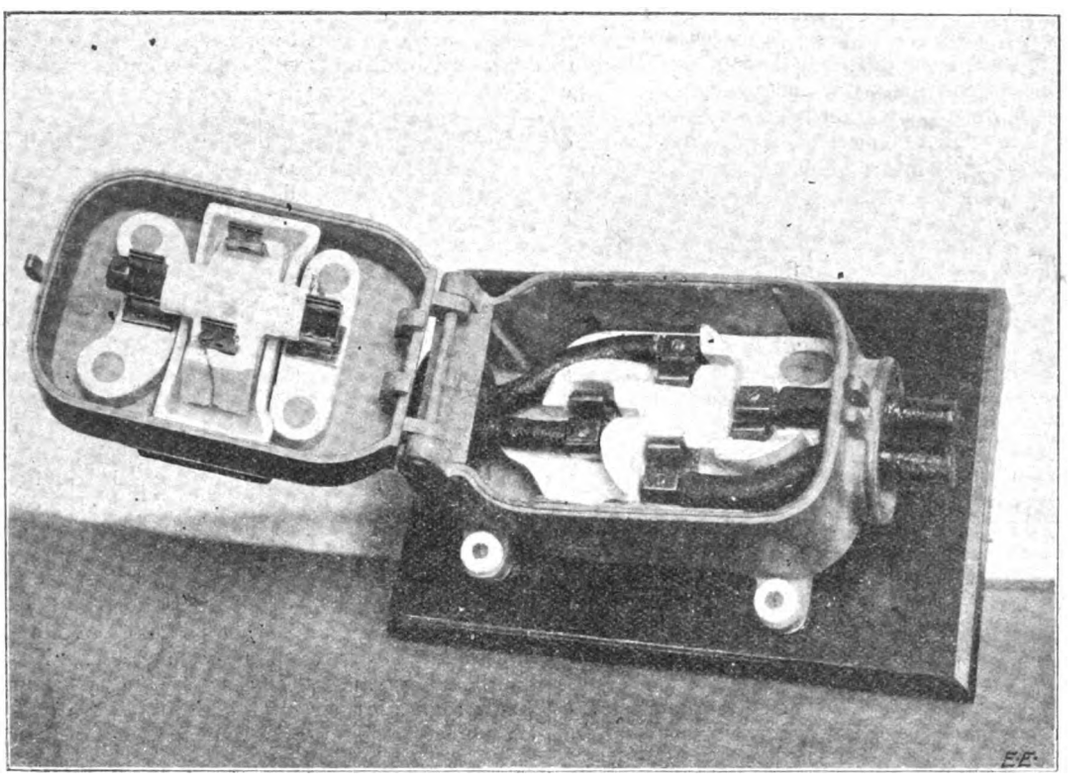

FIG. 2.—View of the Callender-Ward Fuse Box Open, showing Fuse and Neutral-Wire Connection in the Lid.

the metal gas cannot mix freely with the air, thus maintaining the arc between the fuse terminals or sides of the box. Arcing cannot take place on to the sides of the box, owing to the insulating material in which all the live conductors are surrounded. The box has been designed so that when fixed in a vertical position, or lying on its base, the fuses are always horizontal. By fixing the fuse in a horizontal position when it blows, the arc will not be maintained to such a serious extent as would be the case if the fuse were vertical, for the reason that with the tin strip

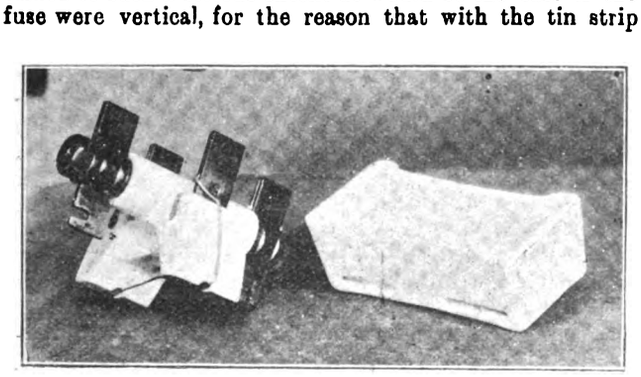

FIG. 3.—The Fuse Carrier and Neutral Connector removed, with Insulating Fuse Chamber on the right.

horizontal, as soon as the metal reaches the melting point, a piece drops out and forms a gap between the remaining portions of the fuse, so that the arc as it rises has nothing to sustain it. On the other hand, if the fuse were fixed vertically, when the fuse metal melted, the tendency for the arc to rise keeps the metal melting, and so the top portion of the metal melts and drops towards the bottom, thereby helping to maintain the arc. This box is also made as a double-pole fuse box by means of doing away with the solid neutral link and arranging for two fuses across the porcelain bridge with a porcelain separator between them.

The details of construction leave nothing to be desired. The boxes are now made of malleable iron, and the porcelain supports for the live metals are secured to the same by sulphur cement. The details of hinge end of the box are such that the sulphur filling round the T headed screws in the base can be put in with the box shut. In this way perfect alignment between the fuse carrier on the lid and the base contacts is secured. Those of our readers who require further commercial details respecting this new type of service fuse box should obtain from Messrs. Callender's Cable and Construction Company their new catalogue of feeder pillars and joint-boxes.

## THE ELECTRIFICATION OF THE LIVERPOOL, SOUTHPORT, AND CROSSENS SECTION OF THE LANCASHIRE AND YORKSHIRE RAILWAY.

It will be remembered that little more than 12 months ago it was announced that the Lancashire and Yorkshire Railway Company intended to electrify the portion of their line between Liverpool and Southport, and although at that time much of the detail of the work had to be decided, a start was made early last year upon the work, which has steadily and quietly progressed. The original scheme has since been extended, and a service at certain times of day will be given to the stations as far as Crossens on the north side of Southport on the old West Lancashire line, so that the residents in these districts will eventually be able to go to and return from Liverpool and district without change of carriage.

The amount of track to be electrified amounts in all to about 23 miles of double line, nearly all of which has been completed. All the high-tension alternating cables have been laid. The sub station buildings are all completed, and progress is being made with the erection of machinery in the same. The rolling-stock is all in an advanced state, and is being fitted up with the electrical equipment. The power-house building is complete, and every effort is being made to get the machinery ready for operation early in the New Year. A promising sign of the approaching completion of the work was noticeable this week, when an entirely satisfactory experimental run was made with one of the new four-car trains between Southport and Formby, the high-tension alternating current being obtained from the power-house at Formby, and transformed into direct

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current at Birkdale sub-station to supply the current for the train.

A general description of the electrification will be acceptable at this stage, but we hope to give more electrical details later. Briefly, the trains generally are composed of two first and two third class cars, the third-class cars of which are equipped with four motors of 150 h p. each, making a total of 1,200 h.p per train. To operate these motors current is obtained from a live rail alongside the running tracks, which is fed with direct current at about 600 volts from four sub-stations, three of which are situated at Birkdale, Seaforth, and Sandhills respectively, and another in the main power-house building at Formby. These sub-stations are provided to transform and convert the high-tension alternating current from the main power station at 7,500 volts into direct current.

The power station, adjoining the railway, on the banks of the River Alt, at Formby, is a building 290ft. long by 130ft. wide, and consists of an independent steel structure, the steel stanchions of which, in addition to carrying the roof, support travelling cranes over the engine-room, the spaces between the stanchions being filled with brickwork. It has two spans, one containing 16 Lancashire boilers, 8ft. 6in. in diameter by 32ft. long, for a working pressure of 160lb. per square inch, together with superheaters, feed pumps, induced-draught plant, etc.; the other and larger span contains four horizontal cross-compound condensing engines of 1,500 kw. capacity, also one subsidiary vertical compound condensing engine of 750 kw. capacity, capable of taking large overload for short periods. The generators in connection with these engines are of the three-phase type, with a periodicity of 25 and a voltage of 7,500. The engine-room also contains steam-driven exciters, sub-station plant, and a main switchboard.

Three-core, paper-insulated, metallic-sheathed cables convey the high-tension current to the sub-stations, and are laid on the solid system at a suitable depth along the company's permanent way. The sub-station equipments, similar in character, consist of static transformers, which transform the three-phase alternating current of 7,500 volts to low-tension alternating current, from which it is converted in rotary converters to direct current at 600 volts. The rotary converters are nominally of 600 kw. capacity, four being provided in each sub-station, and three static transformers, cooled by means of air blast, are provided in connection with each rotary. The connections from these sub-stations to the third rail are made by insulated copper cables run underground in troughing.

The permanent-way equipment consists generally of a live third rail of Vignoles section, supported at intervals of 10ft. on insulators, the centre of the rail being exactly 3ft. 11½in. from the centre line of the track, and the top of the rail 3in. above the surface of the track rails, these being dimensions agreed upon between all the railway companies. This third rail is of special steel, and, of course, of ample section, weighing 70lb. to the yard, in order to convey the full amount of current required to the trains, when between two sub-stations, without causing any appreciable loss in voltage, the different lengths of this rail being bonded with copper bonds to maintain the conductivity; it is carried by special insulators, and generally placed in the six-foot way, but occasionally brought to the outside of the track, to suit special conditions. At all level crossings, of course, gaps in this rail have been provided of such a length that there can be no risk whatever to the public, and where these gaps do occur the third rails are bonded with cable underground. Timber guarding is being provided at all the busy places on the line to prevent the possibility of any person coming in contact with the third rail, though even if they did the consequences would be unpleasant but not serious. In order to ensure an excellent return circuit, an exactly similar rail to the third rail, supported on wooden blocks, has been placed in the four-foot way, bonded, of course, to each running rail; this method of return interfering least with the running tracks and permitting the easy removal of any running rail at any time.

The electric cars for this service naturally concern the public most and are all new. They are 60ft. long and 10ft. wide, being the widest carriages in this country. This width was adopted because it was found before any operations were begun that it was possible on the Southport line, as distinguished from other parts of the main line, to have wider stock, some slight alterations to the permanent way and some trifling ones to the platforms along this length alone being necessary. The carriages have centre passages throughout, with vestibules to allow passage from one carriage to the next. The motor vehicles are at the end, and third-class, and, as previously described, are equipped with two 150-h.p. motors on each bogie. The outer end has a small compartment for the motorman, containing all the apparatus for controlling the train, and near this is a luggage compartment, the remainder of the vehicle being devoted to passengers. Most of the seats are crosswise, to seat three on one side of the passage and two on the other, but at the ends they are fixed lengthwise, to allow more room for passengers entering or leaving the cars. The cross seats are reversible, so that passengers may sit as they choose. The seats are all covered with rattan, a very clean and healthy kind of cane seating. The interior of the cars is fitted with oak, giving a very light appearance. The trailers or first-class cars have seats arranged after the same design, but only two on each side of the passage. They are upholstered in epingle, the interior decoration being mahogany, with light wood panelling, and the roof covered with millboard. Special attention has been given to the electric lighting and heating of these vehicles, and the public will doubtless find their comfort has been amply provided for in this very important particular. A four-car train will carry 270 passengers, the third-class seating 69 and the first-class 66 people.

Perhaps it is well to mention that in order to run a satisfactory suburban service it is necessary that the delay at stations should be reduced to the smallest possible amount, and this will entail alterations in the method of dealing with baggage, as it is not to be expected that the electric trains can carry heavy luggage. Notice boards will be hung on the platforms showing passengers where to stand to await their class, and in order to ensure quick loading and unloading of passengers, strict regulations will be made that every passenger is to enter the carriage at the end door and leave by the front door, thus ensuring a continuous circulation.

In view of the alarm caused within recent months by fires on electric trains, it will be interesting to note that the company have taken all possible precaution against any such an occurrence. The motor compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with uralite, a well-known fireproof material, the floor also being fireproof. In addition to the cable troughs, in which the cables are placed for conveying current to the motors, and equipment, being lined with uralite, the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect, though the danger on surface lines is practically nil. The passengers will be able to feel that they are just as comfortable and as safe as in any steam worked train.

The vacuum brake used on the trains is, with some slight differences, the same as that used all over the Lancashire and Yorkshire Railway. It is fitted with quick-acting valves, and, as will be seen, an exhauster must be provided in place of the steam ejector on the locomotive. This is the first case of the use of the vacuum brake upon electrically-worked trains.

The electrical equipment consists of four 150-h.p. motors on each motorcar, with a controller capable of controlling all the motors on the train, together with the necessary switches, gauges, and circuit breakers in each motor compartment. Under the floor of the car are placed the resistances and reversers for the electrical control. On each side of the bogie are cast-steel shoes, or slippers, which pick up the current from the live rail. The current is returned through the wheels to the running rails, and thence to the centre rail, and then on to the power-house. Between the carriages connections are provided for operating the rear motors from the front end.

When the service starts there will be a service of stopping trains in both directions between Liverpool and Hall-road

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with not more than 10 minutes' interval. Every second train will go on as a stopping train to, or come from, Southport, thus forming a service to Southport every 20 minutes. In addition to this, however, there will be an hourly express in each direction between Liverpool and Southport, and at certain times the trains arriving at Southport from Liverpool will go on to Crossens. The stopping trains between Liverpool and Hall-road and those between Liverpool and Southport will be run in less time than at present, but it is not intended that the expresses to Southport shall do the journey in less time than the fastest steam trains now running. Enquiry has elicited the fact that the company have no intention of making any changes in the charges for season tickets, the public obtaining their advantages in a more rapid and more frequent service.

The whole of the work, with the exception of the rolling-stock, which is being made at the Horwich and Newton Heath works of the railway company, is being carried out by Messrs. Dick, Kerr, and Co., Limited, of London and Preston, who are now fast completing at their Preston works the main and subsidiary generators, the sub-station equipment, the control equipments of the trains, and other electrical plant.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### STEAM TURBO GENERATING PLANT.

SIR,—As a small contribution to the controversy on the above subject, I am sending you a diagram I have prepared showing the performance of various engines, plotted on a superheat basis. These include:

(*a*) 1,000 kw. steam-turbine at Newcastle, as given in Mr. Hunter's paper before the Institution of Mechanical Engineers (refer *Engineering*, Aug. 1, 1902); 145lb. steam, 26 5in. vacuum, works test nine-tenths full load, being presumably the tests quoted by Mr. Wilkinson in his paper, as the best figures agree with those given by him in comparison with the Belliss engine at Leeds.

(*b*) I have indicated by a spot the consumption of the Belliss 1,400-kw. engine at Leeds, as per their letter in your recent issue; steam pressure, 180lb.; vacuum, 25·6in. Tests on site.

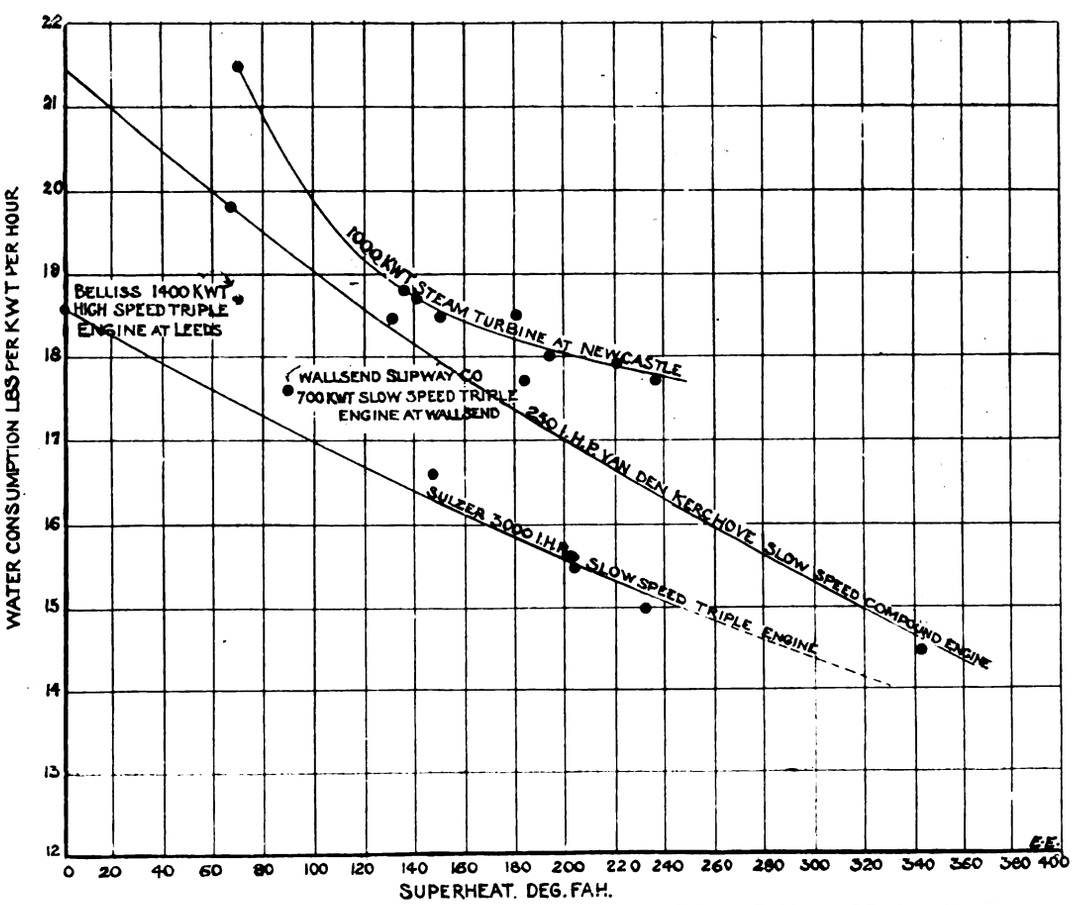
(*c*) Ditto, Wallsend Slipway engine at Newcastle (refer Mr. Minshall's paper, *Proc.*, Inst.C.E., vol. cli., p. 200); steam, 192lb.; vacuum, 25 6in. Test on site.

(*d*) Line showing performance of 3,000-h.p. Sulzer engine, as published in the *Engineer* of May 25, 1900; steam, 200lb. condensing.

(*e*) Ditto, Van den Kerchove 250-h.p. engine (refer *American Electrician*, June, 1903); 130lb. steam, 27·7in. vacuum.

It will be noted that the turbine lies well away above any of the others, and that the gain due to superheating with the turbine is at a very low rate after about 140deg. superheat, whereas the improvement with the reciprocating engines is well maintained. Is the turbine, after all, nearer its limit of economical performance than the reciprocating engine?—Yours, etc.,

A STUDENT.


WATER CONSUMPTION LBS PER KWT PER HOUR
SUPERHEAT. DEG. FAH.
BELLISS 1400 KWT HIGH SPEED TRIPLE ENGINE AT LEEDS
1000 KWT STEAM TURBINE AT NEWCASTLE
WALLSEND SLIPWAY CO 700 KWT SLOW SPEED TRIPLE ENGINE AT WALLSEND
250 I.H.P VAN DEN KERCHOVE SLOW SPEED COMPOUND ENGINE
SULZER 3000 I.H.P SLOW SPEED TRIPLE ENGINE
C.E.

Curves showing Variations of Steam Consumption with Superheat with both Steam Turbines and Reciprocating Engines.

## FORTHCOMING EVENTS.

TUESDAY, JAN. 5.

**London Electrical Contractors' Association.**—At 8 p.m., Frascati's Restaurant, ordinary meeting. Paper: "The Necessity for the Standardisation of Wiring Rules," by Mr. M. B. Johnson.

THURSDAY, JAN. 7.

**Rontgen Society.**—At 8.30 p.m., ordinary meeting. Paper: "The Revelations of Radium," by Dr. G. B. Batten.

**Rugby Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "The Design and Construction of the Electric Tramway Car," by Mr. R. H. Simpson.

SATURDAY, JAN. 9.

**Glasgow Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "The Manufacture of Weldless Chains," by Mr. Alex. G. Strathern.

**West Hartlepool Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Boiler Feed-Water," by Mr. J. W. Patterton.

**Law Courts.**—The electric light will shortly be installed outside the Royal Courts of Justice in the Strand.

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THE
# ELECTRICAL ENGINEER.

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## MUNICIPAL INSURANCE.

Quite a number of municipal authorities have long been enamoured of the idea of a municipal combination to insure their buildings and plant in case of fire. We long ago pointed out that those who advocated such a system little understood the business of fire insurance. The companies which have laboured in this field have accumulated stores of experience, the extent of which enables them fairly well to average the risk upon any one class of undertaking. But the knowing the probable risk and the preparing for it are two different things, and we very much doubt if any single office in any civilised country so administers its business as to obtain the correct premiums for particular risks. There may be a hundred classes tabulated, while the office has only a dozen or a score different rates of premium. This means that the classes are averaged. A further consideration will be found in the extent of business transacted by a large company compared with the limited amount that could be brought under the hands of a municipal combine. If, for example, a company finds by its experience one loss in a particular class in a thousand insurances of that class—say, Class Town Halls—it is far better to have a full thousand insurances on the books than only five hundred, and probably it would be easier for a company to get the thousand than the combine the five hundred. We may be sure, too, that in averaging the classes the factor of safety is duly considered and kept high. Further still, individual companies fight shy of large risks, and reinsure all round, so getting another averaging up. Altogether, a company can manage to protect itself to the utmost, while similar protection would be difficult, if not impossible, for a municipal combine. Quite lately municipalities have incurred fire losses, the most recent being at Teddington and Bristol. Those who have been so eager to institute the combination had better think further over the matter—find out what funds would have existed to have met these losses if the system had been commenced even five years ago. We still incline to the opinion that such risks are too large, too few, and the premium income based upon what is paid now far too small to warrant a fresh departure of the kind indicated.

## VADE ET FAC SIMILITER.

It is not long since that a large order was in the market for a particular kind of machinery. The agents of firms making that class of goods were persistent in their efforts to book the order, none more so than the representatives of certain foreign firms. A careful investigation of designs and results rather pointed to a foreign make, when the question of breakdowns arose. This proved the crucial point, and negotiations with the makers abroad broke down. Enquiries around have made us conclude that in this direction, as in many others, too little attention is often paid to what is going to happen after plant is installed. There is no great anxiety to hasten by an English firm of makers called in during an emergency to repair a foreign make of tool or machine, and especially so when the English firm happens to be a competing maker. A good many business men also prefer to order something that has stood time tests rather than to order something that is new, although the latter may be shown to be more efficient, and, therefore, probably more economical. An example which will not tread upon the toes of anybody may be cited. There are gas-engines and gas-engines. A goodly number of patents have been made, engines built and installed, but the advantages obtained were not enough to really oust other

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machines. Hence the building of the newer designs stopped, and many users found themselves in the difficulty of having to go to competitors for repairs. Thus it is essential that in determining what machines shall be installed, much more consideration than is usually the case should be given to the hereafter. If the new departure has come to stay, one trouble may be eliminated, but there are others, such as repairs, which may be troublesome. Is not the complaint of some of our manufacturers justified, in saying that all engineers do not consider the whole of the conditions, and too often accept something because of an immediate gain, which in the long run will prove costly in maintaining? The best man is he who balances initial cost and maintenance cost, and over the working year obtains the best average economy combined with efficiency.

## POWER.

When it began to be realised that a dynamo was a reversible machine, there could be no two opinions about the extensive use of electrical energy for power purposes. The development may not have been so rapid as some people desired, but when all the attendant circumstances are taken into account, it is little less than marvellous what great strides have taken place in a few years. It is no longer necessary to argue for the use of electricity on tramways. Other forms of traction are rapidly becoming things of the past, and the electrification of railways has commenced. In our opinion, the advance in this latter direction will within a few years be without parallel in the history of any new departure. Its advantages are enormous, its defects few. The time is well within sight when almost all local trains will be worked electrically. Perhaps the long-distance trains may be actuated with steam for a while, but even their electrical conversion is sure. Although we have had upon more than one occasion to animadvert upon the position of trams, we have always recognised their utility and the value of electrification. We do not object to tramways as tramways, only to their being put into positions where a large public is detrimentally affected. Tramways are business concerns, and ought to be treated so, and not as a semi-public matter, wherein a part of the public is called upon to suffer for the benefit of another part. We have always held that the present method of treating tramways was inflicting an unfair competition against local steam lines. There is one point which might be incidentally mentioned here. A part of the public is not so enamoured of the value of trams as a means of getting rid of traffic troubles as some of the thick and thin supporters, otherwise the Birmingham authorities would not have been asked to delay the opening of certain lines for fear of interference with the crowds going to and from a football match. We must, however, return to our subject—power—and venture upon a prediction. Lighting stations will give place to power stations, and the load factor will practically cease from troubling and be at rest. The station plant will be kept running under the most economical conditions, and greater demands will be supplied by improved methods of storage. Lighting supplies will be subsidiary to power. There is even now little difficulty in devising an economical scheme, given certain conditions, but apparatus is not yet perfect enough to do all that is required. Still, the requirements can be stated, and the means for fulfilling those requirements will come.

**Electrical Contractors' Association.**—The first annual dinner of the Tees side and District Electrical Contractors' Association was held last week at the Royal Hotel, West Hartlepool. Mr. Watson, of Middlesbrough, presided. An excellent musical performance followed.

## REVIEWS.

### Glover's Tear-off Calendar.

It was last year that Messrs W. T. Glover and Co. first issued from Trafford Park, Manchester, a calendar with leaflets to tear off for each day of the year On these leaflets were printed interesting extracts from the remarks of electrical engineers on electrical and general subjects. The interest in the calendar was considerable, owing to the happy choice of these extracts. The same idea has been adopted by the firm this year, and improved upon. The first improvement lies in the reproduction of the photographs of prominent electrical engineers, so that birthday wishes may be forwarded to them on the correct day. It is worthy of note in this respect that Mr. J. C. Robinson gets before his contemporaries by being born on Jan. 1. The extracts this year from the Institution *Proceedings* and from the *Journal* of the Incorporated Municipal Electrical Association are exceedingly well chosen, and the few words placed over each extract show that the compiler is by no means wanting in humour. As an example of this we give the three following extracts as they appear on the daily leaflets.

TUBAL CAIN IN CHARGE.

It was agreed that the engineering side of the management preponderated. When the trams are started the following subordinates to the engineer will be appointed: an assistant engineer, who will have charge of the car-sheds, repairs to the road, and maintenance of cars; a traffic manager, who will have complete charge of the staff on the cars, and who will look after the running of the same to schedule times. The financial department will also come under this manager's care. He thought that the solution of the difficulty was a good one, and that the engineer should have the complete control, and not be subordinate to a non-technical man.—Mr. J. F. C. Snell (M.E.A. 1900, p. 76).

THE CAP FITS.

There can be no doubt that orders have gone to at least one of our rivals because of what I term his arts in advertising. These are not confined to the orthodox announcement in a trade journal, nor to the apparently inspired leaderettes in the daily Press and the monthly magazine, but to his assiduous and ofttimes daring approach to possible users by careful and attractively penned letters, and by the ingenious ways—I was going to say bluff—of his representatives. I think we underdo advertisement as much as this particular rival overdoes it, and suggest our manufacturers give more heed to the subject. The moral I wish to point is that the British manufacturer has hitherto been too modest in advertising, and that the time has arrived when the excellence of his productions and his stereotyped form of trade journal announcements shall not be his only means of communicating his existence to the world.—Mr. Harold Dickinson (vol. 32, p. 570).

AFTER A BIRTHDAY, PERHAPS.

There are without doubt some curious instances of irregularities due to absence of mind or fatigue. It is not at all uncommon to see a man feel the bearings and fill the oil-cups of a standing machine, but when it comes to the switchboard attendant signalling "raise speed" on a particular engine, the driver adjusting the governor of a standing engine, and the attendant signalling back "all right," the subject becomes distinctly interesting. Then there is the man with the laboratory training, who taps every instrument, including the clock and the almanac, before taking a reading.—Mr. J. R. Blaikie (M.E.A., 1898, p. 43).

Messrs. W. T. Glover and Co. are to be congratulated on this production, which threatens to be a serious rival to a much-advertised encyclopædia.

**Ramsgate and District Electric Supply Co.**—This company has been registered with a capital of £30,000, the objects being to carry on the business of electrical, mechanical, and chemical engineers electricians, practical engineers, and contractors, manufacturers of electrical apparatus, producers of light, heat, sound, and power by electricity, galvanism, or magnetism, etc.

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## THE FARADAY SOCIETY.

The second ordinary meeting of the Faraday Society was held on Dec. 8 in the library of the Institution of Electrical Engineers, Prof. A. K. Huntington presiding.

Dr. LEHFELDT gave a short *résumé* of his paper on "The Total and Free Energy of the Lead Accumulator.* The most convenient form in which to express the concentration of acid in the accumulator, for the present purpose, is by the molecular function, Z, of $H_2SO_4$. The heat of the reaction (in equivalents)

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O$$

may then be put in the form

$$\chi - \frac{dQ}{dZ}$$

where $\chi$ is the heat of reaction between the pure materials (in absence of water) and Q is the heat of formation of the mixture $Z.H_2SO_4.(1-Z)H_2O$. Numerical values of this are calculated from the experimental data already in existence for the range $Z = 0$ to $Z = 0{\cdot}25$, and the results shown by a curve. The free energy can be put in a similar form. A curve is drawn for it based on E.M.F. measurements, and the latter are compared with the vapour pressures, $p$, of dilute $H_2SO_4$ by the thermodynamic relation that takes the form

$$\log p = \frac{F}{RT}\{f\,E\,.\,dx - Ex\}$$

(F = faraday; R = gas constant; E = E.M.F.; T = absolute temperature).

Dr. OGG sent in a short note in which he tested the numbers derived from Thomsen's formula, and compared them with those derived from Pickering's experiments. The former all lie below the latter, probably because the Thomsen formula does not absolutely represent the heat of mixture of $H_2SO_4$ and $H_2O$.

Dr. LOWRY made some remarks on the basis of the sulphate theory, observing that sulphating is usually looked upon as a "disease."

Dr. LEHFELDT, in his reply, said that the adoption of the sulphate theory was justified by the fact that measurements of the changes of weight in the Pb, $PbO_2$, $PbSO_4$, and $H_2SO_4$ agreed tolerably closely with those deduced from the equation given in the paper. Sulphating, however, was not the same as the formation of sulphate during discharge, where only a film is allowed to form, and is immediately broken down by the current.

Mr. J. A. SUTHERLAND, F.I.C., F.C.S., read a paper entitled "Bitumen in Insulating Compositions" (Part I.). The author points out that little or no reliable data have been published as to the use of bitumen for electrical purposes. The chief source of bitumen is Trinidad Lake, where there is estimated to be a quantity of 9,000,000 tons, which appears to be renewed to the extent of 20,000 tons annually. Upwards of 150,000 tons are exported yearly. Bitumen is also found in Venezuela, California, and on the shores of the Dead Sea; it occurs in some limestone (asphalt) as an impregnation, about 10 to 15 per cent. being present, but it does not pay to extract it from this source. Its physical and chemical properties and constitution, which are fully dealt with in the paper, prove it to be infinitely superior to gas or coal tar for insulation and durability. Care should be exercised in refining; the temperature should be regulated, or the results will be injurious both for paving and electrical purposes. It is used in cable insulation, and very extensively for joint-boxes and troughs for "solid laid" cables. No specification is, however, in use, and the object of this paper is to invite discussion and the views of electrical engineers to assist the author in the completion of his experiments, and to enable him to draw up a satisfactory definition of bitumen, so that users may secure the best results from its valuable non-hygroscopic and insulating qualities.

Mr. GASTER referred to Roumanian sources of asphalt. He had succeeded in freeing pitch from its carbon, which could then be used for arc carbons and electrodes, but the pitch still retained too much oxygen to be a satisfactory substitute for bitumen.

Dr. STEINHART strongly supported the author in his remarks regarding the desirability of arriving at some standard tests for bitumen. Physical as well as chemical and electrical tests were required.

Mr. E KILBURN SCOTT said that some firms declare that refined pitch is as satisfactory as bitumen. Leakage troubles, especially where cables are laid in round curves, are often caused by the creeping of the cable—which can be prevented by the use of wooden bridges—and is not at all the fault of the filling-in materials.

Papers by Mr. Cowper-Coles and Dr. Perkin were held over, on account of the lateness of the hour, until the next meeting.

* The complete paper was given in our issue of Nov. 14, p. 794.

## NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

### Report of Educational Committee.

#### I.—EXPLANATORY.

The committee is, in the first place, of opinion that youths intending to qualify as artisans should receive while at school the best training possible, including, when practicable, some instruction in elementary science; that more attention than at present should be given in schools to the inculcation of habits of order, perseverance, and good conduct; and that the development of these studies and habits should be encouraged in the workshop by a system of rewards offered by employers. Hence the regulations proposed hereafter for ordinary apprentices.

The committee, in the second place, believes that industrial conditions in this country now call for some change in the methods of selecting and training those destined to work in the higher branches of engineering and shipbuilding. The committee feels that if we are to maintain our position in those industries in which science now plays so important a part, more vigorous efforts than hitherto must be made to secure the highest and most suitable education and training for adequate numbers of selected youths. As it is obvious that the attitude of employers will largely determine whether these youths can be induced to equip themselves for competition with similar young men of other nationalities, the committee has ventured to put its recommendations as to pupils in the form of regulations suitable for use in works. It is earnestly hoped that in the interests of all concerned—both employers and employed—these regulations will be generally adopted.

The object of the increased pay attached, in the regulations for pupils, to educational qualifications is intended to serve as an immediate inducement for youths to voluntarily undertake the severe discipline, self-denial, and hard mental work entailed by systematic study in the higher branches of their profession.

As regards probable numbers of pupils, it is estimated that the object aimed at would be attained if each firm were to take, say, an average of two fresh pupils each year (large works taking more, and small works fewer), making for a six years' pupilage, three of which will be spent at college, a total number of six pupils in the works and office at any one time, the total extra cost in wages being estimated at something like £240 per annum, on an average, for each firm.

To obviate confusion and misapprehension, the regulations are presented under two heads: first, those dealing with ordinary apprentices; and second, those dealing with pupils.

The term "apprentice" is to be understood to refer to those who enter the works to learn one or other of the trades or handicrafts therein practised, who serve the usual five years' apprenticeship in the works, who may or may not attend evening science classes, but who do not attend a systematic university college day course of instruction during their apprenticeship, and whose object is to qualify as tradesmen, mechanics, or artisans.

The term "pupil" is, on the other hand, understood to refer exclusively to those who enter works, not with the sole view of becoming expert in any handicraft, but with

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the view of ultimately rising into the higher branches of the profession of engineering or shipbuilding—*e.g.*, draughtsmen, managers, superintendents, inspectors, consulting experts, employers, etc.—who may or may not attend evening science classes, but who either have already attended, or will attend, a systematic course of instruction at university college day classes.

II.—REGULATIONS.

*Regulations for Apprentices.*

In starting apprentices, preference will be given to those who bring the best certificates of conduct and character and the highest school-leaving certificates. The age of starting should be from 15 to 16 years.

At the end of September in each year each apprentice will be awarded marks as follows: for each approved examination passed during the year, 20 marks; for timekeeping, a maximum of 40 marks; for good conduct, perseverance, and progress in the workshops, a maximum of 40 marks.

Marks for timekeeping will be deducted at the rate of one mark for every three hours lost, but no deduction will be made for special leave, or for sickness if certified by a doctor.

Conduct marks will be awarded quarterly by the chief foremen of departments on the following scale: very good, 40 marks; good, 30 marks; fair, 20 marks; moderate, 10 marks.

An apprentice obtaining 60 marks will have the sum of 6d. added to his weekly rate of pay for the ensuing year, and for marks in excess of 60 his rate will be proportionately increased. For example, an apprentice who in any one year passed in two science subjects at an evening science school will be entitled to 40 marks, for very good timekeeping 40 marks, and for general good conduct, perseverance, and progress in the workshops a maximum of 40 marks—total for the year, 120 marks. This will entitle him to an increase of 1s. per week on his rate of pay, say, from Oct. 1 for one year, but payments under this scheme will cease on the termination of apprenticeship or on dismissal.

Should an apprentice obtain, say, 30 marks for timekeeping and 40 for good conduct, perseverance, and progress, or a total of 70 marks, his rate of pay would be increased 7d. per week, and so on.

No payment under this scheme will be made to apprentices obtaining less than 60 marks, and apprentices who fail to obtain any marks for timekeeping, good conduct, perseverance, and progress will be subject to dismissal.

Apprentices commencing their apprenticeship between Oct. 1 and March 31 will be entitled to half rates for their first year.

Promotion in the workshops will depend upon marks obtained. Should an apprentice during the first three years of his time have shown marked ability at the evening classes, and obtained maximum marks for timekeeping, perseverance, and progress in the workshops, he may, at the discretion of his employer, be allowed to spend his fourth or fifth year at college day classes, the fees for which will be paid by his employer.

At least one vacancy per annum in the drawing office will be filled by an apprentice obtaining the highest marks under the above scheme.

*Regulations for Pupils.*

*Scheme A.*—Youths who have passed through a three or four years' engineering day course at an university college, and who have obtained therefrom either an approved certificate, or a pass degree in engineering science, or in naval architecture, may be admitted into the works as pupils. They will serve a three years' pupilage, and for their first year the scale of pay will be that of an ordinary apprentice of the *third* year. The scale of pay for their last two years will be that of ordinary apprentices of the fourth and fifth years, plus 3s. and 5s. per week respectively. Those who hold a degree with honours may be admitted on the same conditions as the above, but the scale of pay for the last two years will be increased by 4s. and 7s. per week, instead of 3s. and 5s.

*Scheme B.*—Youths who desire to combine workshop experience with college study, and who hold no certificate or degree from an university college, may be admitted to the works as pupils, on the production of evidence that they have received a sufficient preparatory education A certificate showing they have passed the matriculation examination required for graduation in engineering science at a science college of university rank, or an equivalent certificate, will be accepted as evidence of this. They must give an undertaking that they will attend for at least three academical years the degree course of study at an university college during the currency of their pupilage, which will extend over a period of six years, including the time spent at college. Their pay will be that of ordinary apprentices in the corresponding years, plus 4s. per week in years subsequent to their first year's college training. (See appendix for suggested division of time.)

*Scheme C.*—Youths who, having entered the works as apprentices, succeed during their apprenticeship in passing the matriculation or equivalent examination prescribed under Scheme B, will for the remainder of their time be treated as pupils under Scheme B, in respect of leave to attend college day classes, promotion, and rates of pay. The time served, including that spent at college, will be a minimum of six years. It is understood that in every case the advancement of an apprentice to pupil rank is at the option of his employer, and subsequent promotion will depend solely upon merit and the requirements of the business. In selecting under Scheme C, other things being equal, preference will be given to the sons of workmen and other employés of the firm. Promotion in general, and admission to the drawing office in particular, will depend absolutely upon merit and conduct in all cases. This clause refers to Schemes A, B, and C.

*Premium Pupils.*

In the case of pupils who pay a premium, it is recommended that so far as college training is concerned they should be asked and encouraged to conform to the regulations under either Schemes A and B, whichever is more suitable to the circumstances of the individual case.

(Signed) JOHN TWEEDY, President.
JOHN DUCKITT, Secretary.

APPENDIX.

The time of pupils under Scheme B may be divided in any of the following ways, according to circumstances:

*First Alternative.*

| | Months. |
|---|---|
| Works | 12 |
| College | 9 |
| Works | 15 |
| College | 9 |
| Works | 15 |
| College | 9 |
| Works | 3 |
| Total | 72 |

*Second Alternative.*

| | Months. |
|---|---|
| Works | 12 |
| College | 9 |
| Works | 15 |
| College | *21 |
| Works | 15 |
| Total | 72 |

*Third Alternative.*

| | Months. |
|---|---|
| College | 9 |
| Works | 15 |
| College | 9 |
| Works | 15 |
| College | 9 |
| Works | 15 |
| Total | 72 |

*Fourth Alternative.*

| | Months. |
|---|---|
| College | 9 |
| Works | 15 |
| College | *21 |
| Works | 27 |
| Total | 72 |

* Including three months' holiday in summer.

## TRADE NOTICES AND NOVELTIES.

### The "E.V." Arc Lamp.

We have received from the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., an advance sheet describing their "E.V." pattern enclosed arc lamp for direct currents. This lamp is an improvement upon the firm's well-known "H.V." and "D.V." enclosed arc lamps. In it they have attained the desirable object of making the lamp very small, and at the same time maintaining from 100 to 120 burning hours. They have also eliminated the network and ash-tray, and claim to have secured that perfectly white and brilliant light which is so desirable in all arc lamps, whether of the open or enclosed type. The mechanism of the "E.V." arc lamp is exceedingly simple, consisting of an iron-clad double-wound solenoid containing a moving core, which grips the upper

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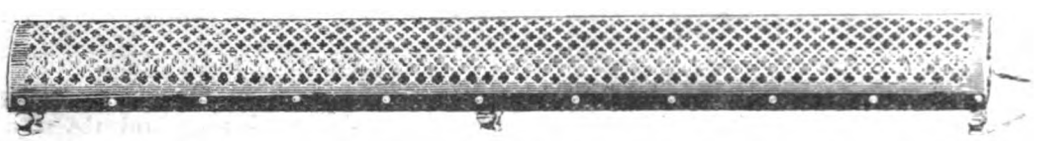
carbon. The lower carbon, which in practical working is the unburnt remainder of the upper one, is secured by a screw. Every part is standard and interchangeable. The lamp is suitable for parallel or series running, and can be used in connection with compensating resistances for high voltages or in long series for street illumination, etc.

## An Electric Radiator for Shop Windows.

We illustrate herewith an improved form of electric radiator which has been introduced by the Allgemeine Elektricitäts-Gesellschaft, Berlin, for employment in shop windows to prevent the condensation of moisture on same, and the consequent formation of ice and rime in frosty weather. The improvement consists mainly in the better arrangement of the resistance wires in the heater. A thin brass tube serves for the body of the heater, and upon this tube the necessary resistance wires, embedded in fireproof insulation, are carried. This arrangement at once removes all possibility of accidental short-circuits between the wires, and makes a good mechanical job. A perforated iron or brass cover is used to protect the heater, as shown. The maximum degree of heat which can be imparted to the cover by radiation from the heating element amounts to about 200 deg. C., so that no danger of fire exists through the contact of materials with the apparatus. Any length of radiator



An Electric Radiator for Shop Windows.

from about 18in. to 10ft. can be supplied. We may remind our readers here that the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., are the selling agents for the Allgemeine Elektricitäts-Gesellschaft in this country.

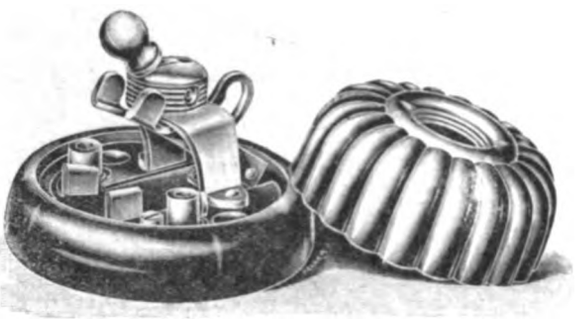
## A New Insulation Testing Set.

The accompanying illustration shows the very latest thing in insulation testing sets—viz., that of Messrs. Everett, Edgcumbe, and Co., 151-152, Great Saffron-hill, Holborn-circus, London, E.C. The chief advantages claimed for this set are that it is direct reading, has an extremely open scale (about 12in. long), so that accurate readings are possible, the indications are absolutely independent of the testing voltage, and are unaffected by the strongest magnetic fields, so that it can be used close to dynamos or motors; lastly, it is extremely compact and light. The set works on the Wheatstone bridge principle, but is so constructed that the insulation is read off directly on the dial, no plugs or switches being employed. For ordinary insulation testing, the set can be used to read from 1,000 ohms to 20 or 50 megohms, while for mains testing an additional range can be added, so that measurements up to, say, 200 megohms can be made. For the latter purpose, the set is particularly handy, as the ordinary generator can be used with it instead of the usual cumbersome and messy portable battery; moreover, extreme accuracy is attainable, and no calculation is necessary, to say nothing of the fact that there are no plugs to get lost or magnets to be adjusted. So successful has been the insulation set that Messrs. Everett, Edgcumbe, and Co. have adapted it to copper resistance measurements; in fact, a complete set can be obtained 8½in. by 6½in. by 6in., by means of which resistances of from one-tenth of an ohm up to 200 megohms can be measured without any alteration of connections, or, in fact, any manipulation whatever. Either a generator or a battery can be used with this set, or, of course, current from the supply mains. For the copper resistances, a few Leclanché cells only are required.

Messrs. Everett, Edgcumbe, and Co.'s New Insulation-Testing Set.

## An Improved Tumbler Switch.

We are indebted to the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., for the following particulars of an improved form of tumbler switch which they are now putting on the market. The makers claim that this switch marks a distinct advance, both in design and construction, over previous patterns of its class. The special feature about the switch

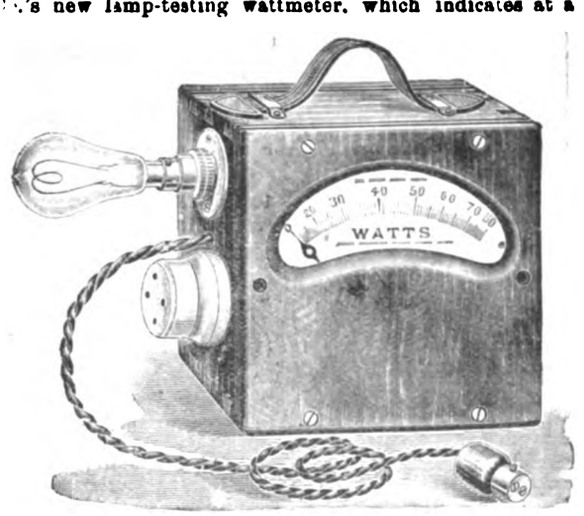


An Improved Tumbler Switch.

(see the accompanying illustration) is the increased length of break. When in the "off" position, the two contact pieces have a break of practically ½in., and owing to the spring being right at the back of the bridge instead of in the middle, as is usual in this class of switch, both these contacts have practically the same clearance from every other metal piece in the switch mechanism. Particular attention is also drawn to the link motion. This is on the bottom side of handle, which is of the General Electric Company well-known lever type, with the addition of a link underneath. This link is so arranged that it gives to the tongue piece positive action when switching off. As regards the mechanical construction of the switch, it is extremely simple, yet thoroughly reliable, and with the above special features the action is remarkably smooth. Special precaution has been taken against breakage of the tongue piece, which in the firm's older types is made up of brass-bound fibre. In the new switch the tongue piece is of one solid metal stamping, and thus a difficulty often experienced with former patterns is successfully overcome. Another improvement which is adopted in all the newer forms of the firm's tumbler switches is the provision of conical holes in the base through which to thread the insulated leads. For the rest the switch is mounted on the usual black or white china base, and the cover is of the fluted brass pattern.

## Lamp-Testing Wattmeter.

The illustration herewith shows Messrs. Everett, Edgcumbe, and Co.'s new lamp-testing wattmeter, which indicates at a glance the actual watts consumed by a lamp. This firm's lamp-testing ammeter is so well known, that no special description of the wattmeter is required. Suffice it to say that it is only necessary to insert the adaptor in any fitting, when on placing a lamp in the holder of the instrument, it will light up and the pointer will indicate the power consumed. Being a true wattmeter, all variations in the voltage of supply are accurately taken into account, which was, of course, not the case with the lamp-testing ammeter. The instrument is accurate with a direct or alternating current of any frequency, and, moreover, can be used to measure the power consumed by any other




Messrs. Everett, Edgcumbe, and Co.'s New Lamp-Testing Wattmeter.

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apparatus, such as small fan motors, for example. The range which is found to be most generally useful is from 0 to 130 watts, but any other range can be supplied if required.

### "Protected" Rail Bonds.

A leaflet received from the Forest City Electric Company, 3, Gore-street, Piccadilly, Manchester, illustrates a few tram-rail joints that have been bonded with "protected" rail bonds of the firm's design and manufacture. The following four points of superiority are claimed for these bonds: (1) being short, they cost less and offer less resistance to the passage of the electric current; (2) they are fixed in the bond holes by sheer pressure, the copper being expanded by a double screw compressor to absolutely and evenly fill the hole in the rail; (3) they are between the fishplate and the web of the rail, and are thus protected from actual contact with the earth and from mechanical damage; (4) being built up of parallel strands of flat wire or ribbon of copper, their extreme flexibility ensures long life.

### Patent Rail Joint.

Pamphlet No. 160, recently issued by Messrs. Estler Bros., 25, Laurence Pountney-lane, Cannon-street, E.C., describes the "Imperial" rail joint (Scheinig and Hoffmann's patent) for use on electric tramways. This joint, of which a section is shown in Fig. 1 herewith, consists of the soleplate, A, block, B, key, C, and a zinc contact strip. The soleplate, A, is made of cast steel, and forms a substantial base for the rail joint. One side of this plate has a groove to fit the base of the rail, and the other is shaped to fit the key. The block, B, is made of

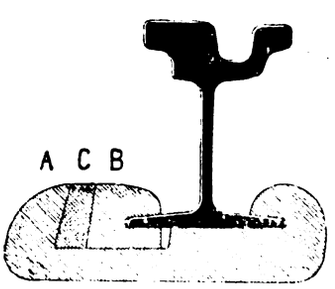


FIG. 1.

similar material, and has on one side a groove cut or milled in it to fit over the rail base, and on the other a flat face to suit the key. The key, C, is of mild steel, and has the cross-section, shown, with parallel sides longitudinally. This key is driven into position, so that the soleplate and block are firmly wedged against the flange of the rail. Further, the cross-section of the key causes the soleplate to rest flat on the bottom of the rail flange. This is achieved by making the sides of the key at special angles to each other.

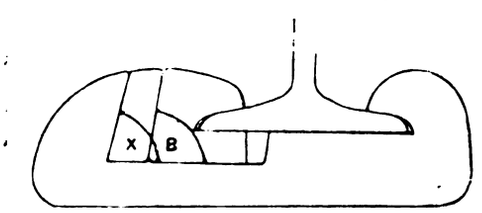


FIG. 2.

Fig. 2 shows that the angle B is smaller than a right angle, and the angle X smaller than the angle B. The relation between these angles determines the amount of pressure between the rails and the soleplate. The grooves in the soleplate and block are so dimensioned that the rails are firmly gripped, the more so as the soleplate is put in position in a red-hot condition. The length of the soleplate, as well as its other dimensions, depends on the type of rail used and the amount of traffic. The weight of a complete joint varies in accordance with the rail used, from 17lb. to 54lb. The results obtained with this joint on the Continent seem to have been highly satisfactory. Full instructions for making the joints are included in the pamphlet under notice.

### Catalogues, Calendars, etc., Received.

THE BRUSH ELECTRICAL ENGINEERING COMPANY have sent us a copy of their waistcoat-pocket diary for 1904. This annual reminder from the Brush Company is strictly to standard, and universally appreciated. Only five pages is there any mention of the various manufactures of the company, which now include motorcars as an addition to their electrical plant. As a result, the diary is much more useful than it would have been if a condensed catalogue were included.

THE BRITISH ELECTRIC TRANSFORMER COMPANY, LIMITED, HAYES, MIDDLESEX, have hit upon a very effective plan to keep their memory green during 1904. It takes the shape of a morocco-bound, padded, gilt-edged *edition-de-luxe* of Whittaker's Almanack, interspersed with a number of plates showing their Berry transformers in various stages of completion and in a number of important stations, the list of which alone occupies the whole of four pages.

THE HOWARD CONDUIT COMPANY, LIMITED, TRAFFORD PARK, MANCHESTER.—A postcard with a view of laying troughing is employed by this firm as a Christmas greeting.

COPPER RAIL BONDS.—Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., have sent us a copy of their new catalogue dealing with the several types of copper rail bonds which they have supplied in enormous quantities to various tramway undertakings all over the world. Numerous illustrations are included.

CARBON RESISTANCES.—Sheet No. 82 issued by Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., describes this firm's standard type of carbon resistance box for test-room work, meter testing, etc. The nominal carrying capacity of the box is 200 amperes, a drop of six volts being obtainable with this current, but the box will carry a much larger current for short periods. On a six-volt circuit the current can be controlled from one ampere up to full load by varying the pressure on the carbons and the arrangement of the connections. The outside dimensions of the box are 25½in. by 7in. by 5½in. deep.

ELECTRICAL WATER PURIFIER.—A pamphlet which we recently received from Mr. A. P. Young, 37, Walbrook, London, E.C., describes a patent apparatus for the purification of liquids by electrolysis. The principle involved is the enforced passage of the impure liquid in close contact with a series of alternately positive and negative metallic electrodes, by which the impurities are attacked and dissociated from the pure liquid and immediately separated from it by gravitation. The rate of dissolution of the electrodes is stated to be very low, and the current required for the process small. It is claimed that when applied to boiler plants this mechanical electro-purifier will (1) effectively purify and soften impure or hard water; (2) effectually prevent any scaling in boilers or tubes; (3) reduce coal consumption from 10 per cent. to 20 per cent.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.—In the shape of an aluminium ash-tray embossed with the Royal Ediswan incandescent lamp, the Edison and Swan United Electric Light Company remind their friends that they are alive to the advantage of keeping themselves prominently before the public.

COX-WALKERS, North-Eastern Electric Works, Darlington.—This firm contract for complete installations for light and power, and make a speciality of switchboards. Their latest advertising medium shows photographs of switchboards supplied to the Royal Masonic Schools and the Kesteven County Asylum.

ELECTRICAL POWER STORAGE COMPANY, 4, Great Winchester-street, E.C.—This company again issue their combination calendar, blotting-pad, and notebook, which is a splendid advertising medium, as no desk is big enough to hide it altogether wherever it is in use.

COALBROOKDALE COMPANY, LIMITED, 141, Queen Victoria-street, London, E.C.—We have received a leaflet illustrating and describing their Speedon hot-water radiator, the water of which is heated by electricity from below, and a positive hot-water circulation is set up through every tube. The appliance may be seen in operation at the above address.

DORMAN AND SMITH, Ordsal Electrical Works, Manchester, and Charing Cross-road, London.—We have received a pocket price-list and notebook combination giving details of the firm's manufactures, such as contact breakers, switches, fittings, etc.

W. N. BRUNTON AND SON, Wire Mills, Musselburgh.—The firm's latest price list illustrates their special galvanised arc lamp rope. This rope is of a new construction, which renders it both durable and flexible, and therefore useful for arc lamps, mast arms, or other uses subjecting them to exposure and moisture. Amongst other specialties we note various classes of sash cord.

THE POWER PLANT COMPANY, LIMITED, 20, New Bridge-street, London, E.C.—The latest leaflets describe portable two-stage one-cylinder compressors; the "Globa" or patent worm gear with roller wheel; and a new electrical hand drilling machine, with three speeds, for drilling holes up to ⅝in. diameter in iron and steel. This machine only weighs 18lb.

CALENDARS.—The United States Metallic Packing Company, Soho Works, Bradford, issue a wall calendar, which shows the dates in remarkably bold figures of several inches in size, and which also gives the firm's telegraph addresses and telephone numbers. Calendars have also been received from the Campbell Gas-Engine Company, Halifax; the Saxon Portland Cement Company, Limited, Cambridge; James Hendry, maker of laminated leather belting for plane, lathe, and all kinds of heavy belting, 252, Main-street, Bridgeton, Glasgow; the Hunslet Engine Company, Leeds, designers of locomotive pump engines; Knight and Talbot, Limited, engineers and founders, Brookley Ironworks, London, S.E.; May-Oatway Fire Appliances, Limited, Glasgow; Willesden Paper and Canvas Works, Limited, Willesden Junction.

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## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

649. I have a Ferraris three phase watt-hour meter for unbalanced circuits constructed for 2,000 volts, 50 cycles, and a capacity of 250 kw. I require to use it on a 60-cycle system. Will the error be variable or constant, and what alterations are necessary to allow it to read accurately at the latter frequency?—J. G.

650. In the tandem or concatenation control of two similar induction motors on a traction system, the secondary of one motor is fed into the primary of the other. Explain clearly why the resulting speed will be equal to half the synchronous speed of the motors in parallel.—M. C.

### ANSWERS.

*Question No.* 641.—Show clearly how to calculate from the indicator card the water used per stroke per indicated horse-power in condensing and non-condensing engines.

*Best Answer to No.* 641 (*awarded* 10*s.*).—There seems to be something a little wrong with the wording of the above question. It is possible to determine from the indicator diagram of an engine the amount of steam used per hour per indicative horse-power, or (time of one stroke) per indicated horse-power if the speed is given, or, again, per foot-pound of work done, but there can be no such quantity as that of the water used per *stroke* per indicated horse-power, since horse-power is a rate of working, and not a quantity. Presumably, however, the first of the above calculations is the one required. The consumption of steam per indicated horse-power per hour may easily be calculated from the card given, by means of certain measurements taken from it, and although the amount as shown on the diagram always varies considerably from the real quantity of steam used, being, in fact, always less, yet deductions of considerable value may often be drawn from such calculations, though rather of a qualitative than of a quantitative nature.

We will first show the method used to calculate the consumption per indicated horse-power per hour, and will then discuss the value and uses of the figures thus obtained. In the first place, all that is necessary is the card and a knowledge of the scale of pressures on it, or, in other words, the spring used in the indicator. It is unnecessary to know either the length of stroke of the engine, the cylinder area, or the speed. To take first the case of a simple engine, suppose that the pressure in the diagram under consideration is just before release, say at ·95 of the stroke, 20lb. absolute. Then its volume, neglecting clearance, is ·95 V, where V is cylinder volume, and if this be taken in cubic feet, and the weight of steam per cubic foot at that pressure (got by referring to the table of properties of saturated steam, given in most engineering pocket-books) be called W, then weight of steam in the cylinder, as shown on the diagram, will be ·95 V W pounds. Now, if there be no compression, the whole of this will be discharged per stroke, with the exception of the small amount in the clearance spaces, but if the exhaust closes before the end of the stroke a portion of it will be trapped, and the weight of this must be found and deducted from the weight in the cylinder at the end of expansion. This weight may be found by taking a point on the compression curve and finding volume, and weight due to the pressure, and calculating as before.

The above method neglects clearance, but to take this into account it is only necessary to add the clearance volume to each of the above volumes. However, it is very desirable to take the point on the compression curve on the same level—that is to say, at the same pressure as that on the expansion curve—as it is then only necessary to take into account the volume represented by the distance between these points and the ratio of that volume to the total volume, the distance being that during which steam is discharged.

Let this ratio = $r$;

and let L = length of stroke;

P = mean effective pressure on piston;

A = area of piston in square inches, and $\therefore \frac{A}{144}$ = area in square feet;

W = weight of a cubic foot of steam at the pressure due to the point on curve chosen;

N = number of strokes per minute.

$\therefore$ Weight of steam discharged per stroke $= \frac{A}{144} \times r\,L\,W$,

and weight discharged per hour $= \frac{A}{144} \times r\,L\,W \times 60\,N$

$= \cdot 416\,A\,r\,L\,W\,N.$

The indicated horse-power $= \frac{P.L.A.N.}{33,000}$.

$\therefore$ Steam per indicated horse-power per hour

$$= \cdot 416\,A\,r\,L\,W\,N \div \frac{P.L.A.N}{33,000}$$

$$= \frac{\cdot 416\,A\,r\,L\,W\,N \times 33,000}{P.L.A.N.}$$

$$= \frac{416 \times 33,000 \times r\,W}{P}$$

$$= 13,750\,\frac{r\,W}{P}$$

By the above it will be seen that the only data required to ascertain the steam consumption per indicated horse-power per hour are $r$, the ratio, as explained above; W, the weight of steam per cubic foot at the point on the curve chosen; and P, the mean effective pressure acting on the piston. Thus is proved the old rule that in any engine the maximum efficiency is obtained when the mean effective pressure is highest relatively to the terminal pressure.

In the case of a diagram in which the terminal pressure is high, or the pressure of compression low, so that points at the same level cannot be selected on both curves, the above method must be modified by calculating $r$ from the separate volumes of steam at the end of expansion and of compression, the difference of which is to the total volume as $r$. The amount of steam as shown by calculation at the end of expansion is always (except in the case of a leaky piston) more than that at the beginning, owing to re-evaporation of part of the water by transference of heat from the walls of the cylinder. For this reason the point chosen for calculation should always be as near the end of expansion as possible.

In the case of compound engines P must be the mean effective pressure for all the cylinders referred to the one under consideration. Thus, if R be the ratio of the cylinders, P the mean effective pressure in the high-pressure cylinder, and $p$ the mean effective pressure in the low-pressure cylinder, the weight of steam per indicated horse-power per hour taking the high-pressure diagrams

$$= 13,750\,\frac{r\,W}{P + r\,p}$$

taking the low-pressure

$$= 13,750\,\frac{r\,W}{p + \frac{P}{R}}.$$

We may now calculate a case from practice. The following diagrams (Fig. 1) are a reproduction of the high-pressure and low-pressure cards of one of a pair of 2,500-h.p. vertical Corliss cross-compound engines under the writer's charge. The cards were taken at rather over half load, and represent fair average practice.

We will first show the method of obtaining the water consumption from the high-pressure card, and then show the difference of the results from the low-pressure card.

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The mean effective pressure for the top end high-pressure side is 35·1lb.

Value of $r$ = ·86.

The terminal pressure is 28lb. absolute, for which W = ·0696lb.

The mean effective pressure for low-pressure top end is 5·73lb.

The cylinder ratio is 4 (high-pressure = 36in, low-pressure = 72in). $\therefore P + rp = 58{\cdot}02$lb.

$\therefore$ Steam per indicated horse-power per hour (top end)

$$= 13{,}750 \frac{{\cdot}86 \times {\cdot}0696}{58{\cdot}02}$$

$$= 14{\cdot}4\text{lb.}$$

For bottom end, $r$ = ·88; W = ·696; $P + rp = 60{\cdot}34$.

$\therefore$ Steam per indicated horse-power per hour (bottom end)

$$= 13{,}750 \frac{{\cdot}88 \times {\cdot}0696}{60{\cdot}34}$$

$$= 14\text{lb. (nearly).}$$

$\therefore$ Average steam consumption as calculated from the high-pressure card is 14·2lb. per horse-power per hour.

Taking the low-pressure cards:

Top end, $r$ = ·88.

Terminal pressure = 7·5, for which W = ·0202.

$$p + \frac{P}{r} = 14{\cdot}53.$$

$\therefore$ Steam consumption $= 13{,}750 \frac{{\cdot}88 \times {\cdot}0202}{14{\cdot}53} = 16{\cdot}8$lb. per hour

For bottom end, $r$ = ·85; W = ·0202; $p + \frac{P}{r} = 15{\cdot}1$.

$\therefore$ Steam consumption $= 13{,}750 \frac{{\cdot}85 \times {\cdot}0202}{15{\cdot}1} = 15{\cdot}6$lb. per hour

So that the average consumption shown by low-pressure diagrams is 16·2lb. per indicated horse-power per hour, or 2lb. more than that shown by the high-pressure. As a matter of fact, this is probably the more correct figure, the actual consumption at half load being about 18lb. per indicated horse-power hour.

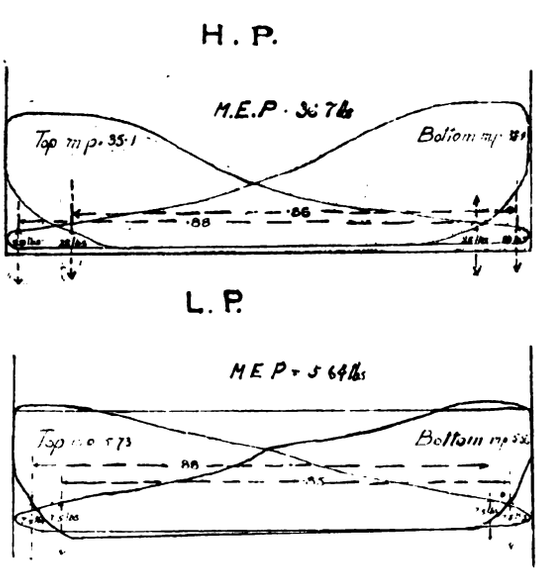
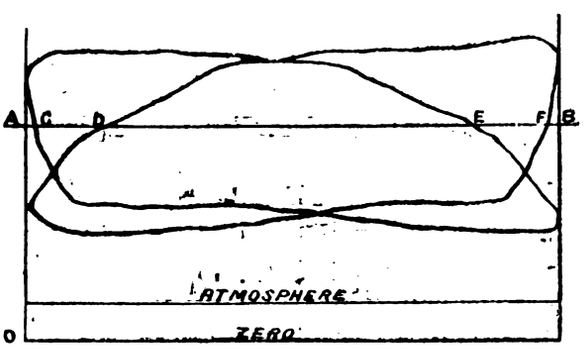



FIG. 1

To discuss now the uses of the figures thus obtained, it will be easily seen that as an actual measurement of the steam used they are a failure. The steam, as shown by the above method, may be anything from 50 to 90 per cent. of the actual consumption, varying with type of engine, point of cut-off, lagging and jacketing of cylinders, etc. For a simple engine it may be taken to vary from 60 per cent. with very early cut-off to 88 per cent. with late cut-off, while with a compound it will probably be from 75 to 90 per cent., with cut-off varying from 10 to 60 per cent. The figures, however, are very valuable for the deductions which may be drawn from them as to the efficiency of the valve setting and the comparative value of different cards. Also, by taking a number of cards at different points of cut-off, it may be shown which is the most economical load at which to run the engine; and a very common error—namely, that to cut off early is necessarily economical, without taking into consideration the increased condensation that takes places with early cut-off—may be exposed. When taking these tests, however, it must not be forgotten that the frictional loss will remain about the same, and so as the load gets lighter will assume a greater relative importance.

To conclude, it may be as well to state that conclusions must not be rashly drawn without the calculations and measurements being carefully checked, as a small error of measurement will quite destroy the value of the figures. It is a good plan where possible to take two sets of cards with different indicators and compare the results, and great difference will often be found, due to some apparently small and overlooked detail, such as the precaution of having the indicator clean in every part.—R S. B.

*Answer to No.* 641 (*awarded 7s. 6d*).—The method here described of calculating the weight of water used per stroke per indicated horse-power may be applied equally well to condensing and non-condensing engines. Referring to the figure, the diagrams for both ends of the high-pressure




cylinder of a compound condensing engine are shown. The method consists essentially in finding the volume of steam in the cylinder after the valve has closed, and from that getting the weight by means of a table of properties of saturated steam. Obviously this will not give us a perfectly exact result, for even if the diagram were accurate to begin with, we have no means of allowing for the steam which is initially condensed, or leaks past the piston. We must, therefore, find the volume at a point as soon after cut-off as possible before the steam has to any extent condensed through doing work. For the same reason the high-pressure diagram must always be taken when dealing with a compound engine.

As the clearance volume of the cylinder does not require to be filled at each stroke with fresh steam we have not to take any account of it, so that in speaking of the volume of the cylinder we mean, throughout this description, the volume swept through by the piston—that is, the area of the cylinder in square feet multiplied by the length of stroke in feet. We shall call this V.

Taking the diagrams, draw a line, A B, horizontally across, taking care that it cuts the expansion curves of both ends below the points of cut-off and above the compression corners and release. Now, A B represents to some scale V, while to the same scale A C represents the cushion steam already in the cylinder before admission, and A E the total volume after cut-off, so that C E represents the volume of steam which has been admitted, all at an absolute pressure, O A. Similarly F D represents the volume admitted at the other end. To get the volume per stroke, take the average of these—that is $\frac{CE+FD}{2}$. The ratio of this to A B is the ratio of the steam per stroke to the total volume, V, so that the actual volume admitted per stroke $= \frac{CE+FD}{2AB} \times V$ at absolute pressure, O A, and looking up a steam table, we find the weight of a cubic foot of steam at that pressure. Calling it W, we have the weight of steam per stroke $= \frac{CE+FD}{2AB} \times V W$ pounds, and the weight of steam or water used per stroke per indicated horse-power $= \frac{CE+FD}{2AB} \times \frac{VW}{I.H.P.}$. C E, F D,

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and A B may be measured on any scale, provided that the same scale is used for all the measurements.—D R.

*Answer to No.* 641 (*awarded 7s. 6d.*).—I presume this question is intended to be read "water in the form of steam used per stroke per indicated horse-power"—in other words, calculate the steam consumption. The following example clearly shows how this may be done. Fig. 1 is

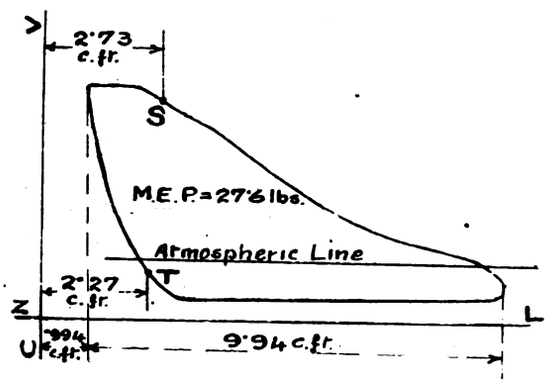



FIG. 1.

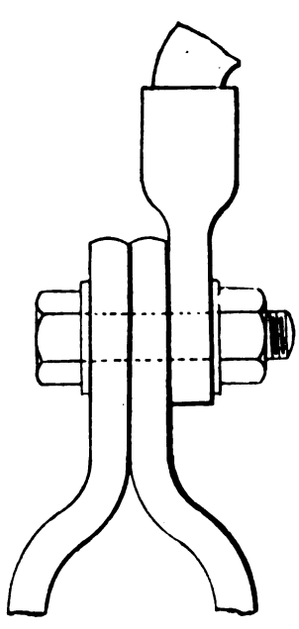
a diagram taken from the low-pressure cylinder of a condensing engine, working at the time the card was taken under full load. Diameter of cylinder, 27in.; stroke, 30in.; clearance volume (this includes the volume of the steam passage), 10 per cent. of volume swept through by piston; number of revolutions per minute, 120; steam pressure (in cylinder), 60lb. absolute; pressure in condenser, 5lb. absolute. Work out the indicated horse-power; this is equal to $\frac{27\cdot6\times2\cdot5\times572\cdot5\times240}{33{,}000}=287\cdot3$ i.h.p. About the diagram draw the absolute zero line, Z L, and a line, C V, to represent the clearance volume. The volume swept through by the piston $=\frac{572\cdot5\times30}{1{,}728}=9\cdot94$ cubic feet, therefore the clearance volume = ·994 cubic foot. The diagram is 2¾in. long, therefore 1in. length represents a volume of $\frac{9\cdot94}{2\cdot75}$ = 2·71 cubic feet. Choose a point, S, on the expansion curve near to but *beyond* the point of cut-off. (It is very difficult to fix upon the point at which cut-off actually takes place, and as we wish to measure the quantity of steam admitted to the cylinder, etc., it is necessary that a point should be chosen when cut-off has really taken place.) When the piston is at the point S, the volume of steam in the cylinder and clearance space is found by measuring from S to the clearance volume line, C V, to be 2·73 cubic feet, and the pressure found by measuring from S to the line Z L to be 56½lb. absolute. The weight of a cubic foot of steam at 56½lb. absolute is found, by referring to tables on the properties of steam, to be ·1343lb., therefore the weight of steam in the cylinder and clearance space = ·1343 × 2·73 = ·3666lb. Choose a point, T, low down on the compression curve, but make sure that at the point chosen the cylinder is closed to exhaust. By measuring from T to the line C V it is found that when the piston is at point T there are 2·27 cubic feet of steam in the cylinder and clearance space, also by measuring from T to Z L the steam pressure is found to be 12lb. absolute. The weight of a cubic foot of steam at 12lb. absolute = ·0313lb., therefore the weight of steam in the cylinder and clearance space = ·0313 × 2·27 = ·0710lb. Now it is evident that the weight of steam consumed during the stroke is the difference between the weight admitted and the weight of steam still in the cylinder. This is equal to ·3666 − ·0710 = ·2956lb., but this is the weight consumed by the total horse-power—viz, 287·3 h.p.—during the stroke, hence the weight of steam consumed per stroke per indicated horse-power $=\frac{\cdot2956}{287\cdot3}=\cdot001028$lb. The above diagram was taken during a recent test. The *measured* quantity of water consumed per indicated horse-power per hour was 16·1lb.; this is equal to $\frac{16\cdot1}{14{,}400}=\cdot001118$lb. per indicated horse-power per stroke.

The difference between the measured consumption and that calculated, and which is equal to ·000118 − ·001028 = ·000090lb. per indicated horse-power per stroke, is accounted for by the steam being saturated, the boilers having been forced slightly to cope with the demand upon them. As will be noted on the expansion curve, part of the water has been evaporated under a reduced pressure. As the quantities of steam dealt with are so very small, the measurements taken must be very exact in order to get anything like an accurate result. The clearance volume should be ascertained by filling the port, and the clearance between the piston (when at the end of its stroke) and the cylinder cover with water. It will be noticed that in the working of the above example, the atmospheric line has only been used for fixing the zero pressure line. Therefore, diagrams from a non-condensing engine can be worked in exactly the same manner; the pressures to be absolute pressures, and the volumes to include the clearance volume. E. G. T.

*Question No.* 642.—A battery of Tudor accumulators is connected in sections to the cell board by single-strand conductors No. 6 S.W.G., covered with hemp braiding. These conductors are burned into the leaden lugs of the accumulators, and are bare for about 1in above them. Much trouble has been experienced through a very active corrosion which takes place in some cases even under the braiding. The bare parts have been scraped and repainted with 'asphaltic black," but after a few weeks corrosion has again broken out. How can this be remedied?

*Answer to No.* 642 (*awarded 7s. 6d.*).—This trouble is of very common occurrence in the battery-room, and particular care should be taken to guard against it, as it often is the cause of an "earth."

The corrosion is mostly due to the action of the acid vapours which rise from the battery when being charged. This vapour fills the battery-room and rests on everything, and, of course, the regulating wires get their share, hence the result complained of by "A. B. D." Common oil of vitriol is frequently the cause of excessive corrosion, and particular attention should be given to see that you are using the best brimstone acid. Common acid often contains arsenic, nitrous and nitric acid, and other impurities. Nitrous and nitric acids when under electrolytic action give off noxious fumes of oxides of nitrogen, which are very corrosive. To prevent this vapour or spray from rising, spray arresters are used. These are plates of glass fixed across the top of each cell, thus arresting the vapour as it rises from the acid. It is obvious that if arresters are used, they will prevent a considerable amount of damage.



The ordinary hemp braiding insulation is not at all suitable for conductors in a battery-room; it is practically useless after it has been subjected to the action of the acid for a short period, and affords no insulation whatever. Lead-covered, vulcanised-rubber cables are the best for this class of work The lead covering should be coated with acid-proof paint. Burning the conductor into the lug of the plate should be avoided where possible, as it is very

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inconvenient, especially if you desired to alter your regulating wires to get better regulation.

The best method of connecting the conductor to the lug is by means of a brass bolt and nut. The end of the conductor should be bared and sweated into a copper or brass thimble, then the lug and thimble is bolted together as shown by sketch. Of course, the lug and thimble must be thoroughly cleaned and bolted firmly together to make a perfect connection. Loose and dirty connections cause local heating, and therefore loss of energy. After bolting the lug and thimble together, cover all the bare parts with a good coat of vaseline—that is, the parts which are liable to be attacked by the acid. However, if "A. B. D." still keeps his present arrangement, the corrosion may be stopped by the following method: Clean the corroded parts thoroughly with file carding, care to be taken that the dirt does not fall into the cell, and then cover the cleaned parts with a thick coat of vaseline The insulation should be stripped off if corrosion has taken place under it, as it is not protecting the conductor in the least. After stripping the wire should be cleaned with file carding as stated, and afterwards lapped with "Manson" tape, covering this with acid-proof paint.—H. H. R.

*Answer to No.* 642 (*awarded 7s. 6d.*).—This corrosion is most likely caused by electrolysis, and may arise from two distinct defects. Firstly, it is quite possible that the joint is not good electrically for the amount of current it has to carry. If so, it would probably get a little warm when the current is passing, and this would be an indication, but the joint may not be bad enough for that and yet be bad enough to make a sufficient difference of potential between the copper and the lead to set up electrolysis, because, although the resistance in ohms would be small, the current in amperes would be fairly large, and the E.M F. produced by these is equal to the current multiplied by the resistance, or C R = E.M.F., so that if the resistance of the joint is only ·2 ohm and the current not more than 20 amperes, the difference of potential between the copper conductor and the leaden lug would be four volts, which is more than enough to corrode the copper. The acid necessary for this corrosive action is, of course, supplied by the rising and bursting gas bubbles in the cells when charging splashing on to the lugs and end of the copper wire The hemp braid covering would assist the action by soaking up the acid solution, and the "asphaltic black" would be covered with a conducting film which would easily allow the current to pass from the copper under the braid to the leaden lug, and so would act as a shunt to the bad joint. The conducting film would be composed of dust from the room and the acid solution from the cells.

Secondly, the cause of the trouble may be a leak in perhaps several places, such as from the battery through the insulators on which it stands into the floor, and also through the insulation of the conductor. This would be favoured by a damp situation and by the splashing of the cells during charging, for the spray thus thrown up falls on to the outside of the cells, and so makes a good conducting film: therefore, the leaden lugs should not be allowed to touch the material of the cells even if this is glass. Leaks may quite easily allow a considerable current to pass continuously, and, therefore, a good deal of mischief might be done, but in order that electrolysis may do harm to the copper conductor it is necessary that the electricity should leave it by passing from it through an acid solution. This condition is easily fulfilled in many battery-rooms, for they are often both damp and dusty, and, worse still, the atmosphere is invariably acid—at least, I have found it so on a good many occasions when I have analysed it. The damp, the dust, and the acid would settle on everything, including the covering of the copper conductor, and so the electricity leaves the copper by passing through the acidified "insulating" (?) hemp covering, which it has practically destroyed. If the conductor is laid on earthenware insulators they must be kept clean and dry, or their insulation will be greatly reduced by the above-mentioned acid and damp.

Now for the remedy. Firstly, thoroughly ventilate the battery-room, then clean and dry it and everything in it as far as possible. Then search carefully for any leaks and stop them all, whether under the battery cells or on the conductors. If the insulation of the conductors is faulty, put them on earthenware insulators, and if deciding to put in new conductors, have them covered with fairly good insulation, and when fixing them, varnish them thoroughly. Now, with regard to putting the conductors on to the lugs, I do not consider that "burning" or melting them on is the best way to do it. I have had batteries under my care for 20 years, and have never once had the least trouble with my joints. I always clean the end of the wire (or cable), and also the leaden lug; then I smear them with vaseline, and having done the same to a brass binding screw, I clamp them tightly together; then with my finger I put a good thick coating or covering of vaseline over the whole joint, taking care to fill up the cracks. It is as well (but not necessary) to go round these joints once a year to see if any fresh vaseline is wanted. If by any chance a screw gets loose, the joint gets warm and melts the vaseline, which is instantly missed at the daily inspection of the battery, when the necessary tightening and re-covering with vaseline is done before the joint gets bad enough to cause any trouble. The binding screws are cheap, easily put on, and easily taken off, so that a new cell is easily put in the place of an old one; and they may be used throughout the battery to bind the leaden lugs together, all that is necessary being to clean the two lugs and bend them to suit each other. Then put the binding screw in just as before and apply the final covering of vaseline, which experience shows is proof against the acid solution. I am sure that this covering of vaseline is far superior to any asphalt, guttapercha, or similar material for this purpose. If all the above hints are carefully attended to, all the trouble complained of in the question will disappear. The corrosion cannot be caused by any purely local galvanic action, because the result of this in the case of lead, tin, and the usual metals used in soldering would be to protect the copper.—F. G. A.

*Answer to No.* 642 (*awarded* 5*s.*).—Where bare copper is used as a connection to accumulators, corrosion usually takes place at the joint between the copper cable and the lead terminal plate of the cell, due to the galvanic action set up between the two different metals in the presence of moisture, resulting generally in the destruction of the copper cable. In the various text-books various remedies are suggested, two of the more common are vaseline and paraffin wax. Vaseline smeared over the troublesome part will keep the moisture from depositing, and where brass nuts are used vaseline is generally the preventative used, and will keep the nuts, etc., in perfect order for two or three years at least. Paraffin wax is melted in a pot, and painted on the joint with a brush.

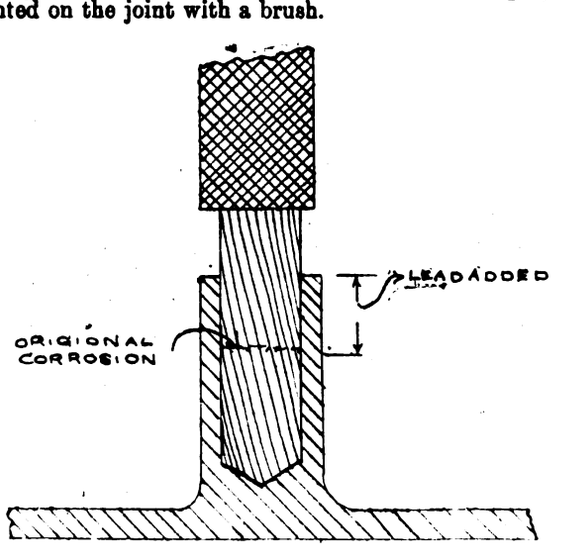


FIG. 1.

About a year ago we had some trouble due to corrosion at the connecting socket between the lead of the cells and the cables. The remedy adopted, although a simple one, seems to work very well. The cable and the top part of the socket were thoroughly scraped and cleaned, and in order to ensure a good connection between the cable and the lead above the point of corrosion another inch was burned on to the lead socket, and the whole cable and socket was painted

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over with anti-sulphuric paint. These connections have given no trouble since although the cable is bare, except for the paint, for about 1in. above the socket. I examined some of them the other day, and they seemed to be perfectly free from corrosion (Fig. 1). If a more substantial job than this is wanted, which I should say would only require to be adopted in extreme cases, a wooden box made in two halves can be put over the exposed parts, as shown in Fig. 2. This box would be fitted closely round the socket and cable, and if a thoroughly good job is wanted, two dovetails at the top and two at the bottom can be arranged so as to draw the box closely together and make a tight joint. The bottom dovetails would be such that the wooden pin securing the halves would drive in from the sides. At the top of the box are two holes for filling the interior with bitumen after the box has been fitted.

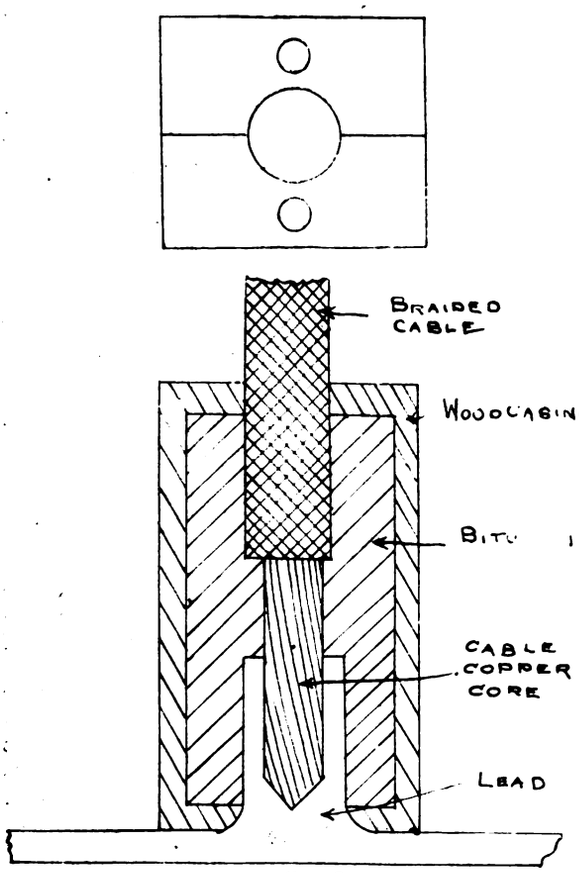


FIG. 2.

I should say that the anti-sulphuric paint, which has done very well in our case, is worth a trial, and would be all that is necessary for the braided part of the cable. The paint used by us was supplied by the India Rubber, Gutta Percha, and Telegraph Works, Limited. If the bare parts still give trouble after this, then they should be covered in, as indicated in Fig. 2.—McG.

*Answer to No.* 642 (*awarded* 5*s.*).—The use of hemp-covered cables in a battery-room is bad practice. The braiding absorbs the moisture present in the air after battery charging, and as this moisture is dilute acid, chemical action upon the copper and braiding is unavoidable. The writer has had experience with braided cable in a battery-room, and found that the braiding soon became rotten and fell off the cable, showing that the copper underneath was green and badly corroded. A coat of paint over the braiding was tried, but without success. The paint seemed to crack and allow moisture to enter, with the same unsatisfactory results as before. Lead-covered cable is undoubtedly the best for use in battery-rooms. It is absolutely unaffected by the acid, and gives no trouble. Where the lead covering stops and the cable enters the battery lug is the place where corrosion may take place, unless care is exercised. The top of the lug, the insulation exposed, and two or three inches of the lead covering should receive three coats of anti-sulphuric acid enamel, taking care to allow each layer to thoroughly dry before apply the next. If "A. B. D." objects to putting in lead-covered cables on account of the extra expense the next best thing is to do as follows: Scrape all the braiding off the conductors and carefully clean any parts that are corroded. Refix the conductors on insulators, and give them three coats of anti-sulphuric acid enamel whilst in position, so that the cables need not be moved afterwards, thus cracking the enamel. The conductors being now bare, it will be easy to see where any corrosion is taking place. It is advisable to fix the conductors as rigidly as possible, as if they are accidently bent, any coating of enamel or paint would crack and allow moisture to enter. As the conductors in question are solid and not stranded, "A. B. D." should get satisfactory results if he adopts the last treatment described.—W. A. T.

# COMPANIES' MEETINGS AND REPORTS.

## BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The directors in their annual report for the year ending July 31, 1903, state that the profit and loss account to that date shows a profit of £107,609. 7s. 6d. This includes about £60,000 special discounts allowed by the American companies on orders executed at Pittsburg. It was felt by the American companies that these discounts should be made in view of the fact that the Manchester factory could turn out only about one-third of the electrical apparatus needed for its orders, and had, therefore, to purchase the balance from the Pittsburg factories. An interim dividend at the rate of 6 per cent. per annum upon the preference shares has been paid. After providing for debenture and loan interest, and the further items set out in the profit and loss account, a balance remains of £47,106. 8s. 1d. Out of this sum the directors recommend the payment of a final dividend at the rate of 6 per cent. per annum on the preference shares, absorbing £45,961. 13s., carrying the balance of £1,144. 15s. 1d. to reserve. This being the first year during which the Company's works have been equipped, it has not been thought necessary to make any provision for depreciation of buildings and machinery. The total authorised share capital of the Company has now been issued. Under the provisions of the articles of association the directors have created a further £450,000 4 per cent. debenture stock to rank *pari passu* with the £787,600 previously created; £50,000 of this further debenture stock has already been issued. In order to make provision for maintaining a sufficient supply of stock at the Company's works and for other purposes to meet the requirements of the increasing business of the Company, the directors will propose to the meeting that an additional 100,000 6 per cent. preference shares of £5 each, ranking *pari passu* with those already existing, shall be created. Arrangements have been made under which the subscription to these shares will be assured. The works at Trafford Park, Manchester, are now employing over 5,000 hands, and the orders received during the year ending July 31, 1903, amounted to £1,657,114. Among other important contracts obtained during the past year by the Company are those with the Admiralty, the Midland Railway Company, the Metropolitan Railway Company, the North-Eastern Railway Company, the Underground Electric Railways Company of London, Buenos Ayres Western Railway Company, Buenos Ayres Great Southern Railway Company, De Beers Consolidated Mines, London County Council, and the Corporations of Aberdeen, Bath, Bournemouth, Glasgow, Hackney, Ipswich, Liverpool, Salford, and Dunedin (N.Z.), and the Savoy Hotel Company.

## SOUTH STAFFORDSHIRE TRAMWAYS.

The annual meeting of the shareholders in this Company was held at Winchester House on Wednesday, Mr. W. Somers L. Schuster presiding. Previously to the general meeting an extraordinary meeting was held, at which it was resolved that the general meeting should be held in December instead of in March.

The **Chairman**, in presenting and moving the adoption of the report and balance-sheet, said he wished to call the shareholders' attention to the fact that their debenture debt had been entirely paid off; and, secondly, that the Company was paying this year very nearly double the dividend to preference shareholders which was paid last year. The directors had been in constant negotiations with the various authorities through whose lands the Company's lines ran. In the Walsall section six miles six furlongs of line had been sold to the Corporation of Walsall for £18,500. Nine miles six furlongs had been sold to West Bromwich for £32,000. The money derived from these sales had been used in paying off the debentures. The directors were even now in negotiation with Handsworth for the sale of one mile one furlong of line, and they were also negotiating with Wednesbury. In fact, although the Company was apparently doing small business, he knew of none which gave more trouble to the directors. Negotiations kept them constantly busy both day and night. They had had an offer from Dudley which the directors had refused, and they might have to fight Dudley on the shareholders' behalf. In the case of West Bromwich, the directors had by dint of working at the authority got £32,000, although £23,000 only had at first been offered. He hoped in the same way that they would do better with Dudley. With regard to the Company's relations with the British Electric Traction Company and the South Staffordshire Tramways Lessee Company, there were a great many points in common, but on a great many other points they were at issue.

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Although his Company were prepared to live on amicable terms with these people, if they were pushed they meant to fight. Before taking any definite steps the shareholders would be called together.

**Mr. S. R. Blundstone** seconded the motion, which was carried without discussion.

## PERSONAL.

Mr. P. N. Hooper has been appoined borough electrical engineer and works manager to the Poplar Borough Council at a salary of £400 per annum.

The second annual supper and smoking concert of the staff of Messrs. R. G. Nicholson and Co., electrical engineers, of Manchester, came off successfully last week at the Atlantic Restaurant, Cross-street, Manchester. Mr. R. G. Nicholson presided, and there was a large attendance.

We are informed by Mr. Thos. Browett that he has resigned his position as joint managing director of Browett, Lindley, and Co., Limited, Patricroft, and no longer holds a seat on the Board. For the present his address will be 6, Old Queen-street, Westminster.

Mr. G. R. Blackburn, A.M.I.C.E., A.M.I.E.E., and hon. secretary of the Leeds branch of the Institution of Electrical Engineers, has now entire control (under the general manager) of all engineering and technical work in connection with the Bradford tramways.

To Sir Francis Mowatt, who is retiring from the post of permanent secretary at the Treasury, it was, it will be remembered, mainly due that the money was found for the establishment of a physical laboratory for standardising and testing purposes.

## APPOINTMENTS VACANT.

**Clerk of the Works,** St. George's Union, London. Applications by Jan. 11. See advertisement in last issue.

**Assistant Electrical Engineer,** Bengal-Nagpur Railway Company, Limited. Jan. 15. See advertisement in last issue.

**Installation Foreman Canvasser,** Woolwich Borough Council. £104 per annum and 3d. per equivalent 8-c.p. connected. See advertisement.

**Chief Assistant Electrical Engineer,** Supply Company near London. Apply, 429 *Electrical Engineer* Office. See advertisement.

**Electrical Mechanics,** Devonport Dockyard. Commencing wages, 34s. a week. See advertisement.

**Assistant Jointer,** Electricity Works, Tynemouth. See advertisement.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cuba.**—The Insular Railway Company will shortly require material for installing an electric tramway in Marianas.

**Warsaw.**—The Municipality are open to receive tenders for electric tramways. Particulars may be obtained on application.

**Rome.**—The Admiralty require tenders for electric lampe, estimated at £6,000, by Jan. 23. Foreign competitors are invited.

**Madrid.**—The Public Works Department require tenders for installation and working of electric tramways from Mondariz to Porrino by Feb. 12, 1904.

**Barcelona.**—The Harbour Works Commissioners require tenders for installation of electric light and power by Feb. 15. Particulars may be obtained from the Commissioners.

**Kettering.**—The Urban District Council invite tenders for the supply and delivery of electricity meters. Particulars from Mr. John Bond, clerk. Tenders by Jan. 9.

**Avila.**—Tenders will be received by the Municipal Council (Ayunta miento Constitucional) for installation and working of electric lighting until Jan. 22, 1904.

**Fire-Alarm Wiring.**—The Scottish Office of the May-Oatway Fire Appliances, Limited, invite tenders for wiring for various buildings. Tenders by Jan. 6. See advertisement.

**Fire-Alarm Wiring.**—The Scottish Office of the May-Otway Fire Appliances, Limited, invite tenders for wiring buildings. Tenders by Jan. 2. See advertisement in last issue.

**Peteringa (Croatia).**—The Municipality require tenders for installation and working of electric lighting; 6 to 8 arc and 160 to 180 incandescent lamps are required for the street-lighting.

**St. George's (Hanover-square).**—The Guardians invite tenders for electric wiring and mains at their workhouse in Fulham-road, West Brompton, S.W. Tenders by Jan. 13. See advertisement in last issue.

**Greenwich.**—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

**Irvine (Scotland).**—The Corporation invite tenders for providing, erecting, and laying down the whole plant and apparatus necessary for electric light installation. Particulars from Mr. Jas. Dickie, town clerk.

**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Hackney.**—The Council invite tenders for feeding and distributing mains. Specifications from Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by Jan. 4, 1904. See advertisement in former issue.

**Camberwell.**—The Borough Council invite tenders for the maintenance of electric bells and private telephones. Forms of tender from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Tenders by 5.30 p.m. on Jan. 18

**Sydney (N.S.W.).**—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W. Tenders by Jan. 12.

**Bo'ness (Scotland).**—The Town Council invite tenders for the electric lighting of their new town hall and Carnegie Library. Plans, etc., may be obtained from Mr. Liddle, electrical engineer, 28 Rutland-street, Edinburgh on deposit of £1. 1s. Tenders by Jan. 7.

**Manchester.**—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes (Contract No. 9), with other appurtenant works. Specifications, etc., from City Surveyor's Office, Town Hall. Tenders by 10 a.m. on Jan. 11.

**Pontypridd.**—The Urban District Council invite tenders for Section D (pipework) and Section T (supply of meters). Specifications, etc., from Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on Friday, Jan. 15, 1904. See advertisement.

**Wallasey.**—The Urban District Council invite tenders for the supply and delivery of about 7,100 yards concentric armoured cables, together with joint boxes and section boxes. Specifications from Mr. J. A. Crowther, Electric Supply Works, Sea View-road, Liscard. Tenders by Jan. 16.

**Christchurch (New Zealand).**—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement in former issue.

**Northampton.**—The Corporation invite tenders for the purchase of about 550 tons of second-hand steel girder tramrails, about 14 tons of steel fishplates, and about 2½ tons of wrought-iron tiebars, bolts, and nuts. Particulars from Mr. A. Fidler, A.M.I.C.E., borough engineer, Guildhall, Northampton. Tenders by Jan. 8.

**Copenhagen.**—The Corporation invite tenders for the delivery of two centrifugal pumps, direct driven by electromotors as salt-water circulating pumps. Specifications, etc., from Elektrisk Station, Gothersgade 30 Copenhagen K. Tenders to Kjobenhavns Belysningvæsen, Vestre Boulevard 22, Kopenhagen B, by 12 noon on Jan. 5.

**Enniscorthy (Ireland).**—The District Lunatic Asylum Committee invite tenders for the following works: generator and motor-generator converter; motor and motor pumps; accumulators; main switchboards; overhead conductors and telephone; gearing and shafting; wiring asylum. Specifications, etc., at the Asylum Office. Tenders by Jan. 20.

**Glasgow.**—The Corporation invite tenders for providing and erecting at their generating stations in the city two 3,000-kw. 6,500-volt three-phase turbo-alternators and condensing plant, one 2,200-h.p. engine coupled to a double-current generator and transformers, and six 500-kw. motor generators or rotary converters. Specifications from Mr. W. A. Chamen, 75, Waterloo-street. Tenders by Jan. 11.

**Erith.**—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings, and steam feed pump; steam, exhaust, feed, air and circulating, blow-off, and drain pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam-engine of 500 kw. capacity; extensions to main switchboard and cable connections. Tenders by Jan 18. See advertisement in last issue.

## RESULTS OF TENDERS.

**Falkirk.**—The Town Council have contracted with Messrs. Venner and Co. for a supply of electric meters for the year 1904.

**Erith.**—The Council have accepted the tender of Mr G. A. Moore, 13 and 14, Bexley-road, Belvedere, for wiring and fitting of premises.

**Bradford.**—The Guardians have accepted the tender of Mr. G. A. Steinthall 41, Piccadilly, for electrical engineering work at the Hospital Pavilion, Horton-lane, at £288.

**Pietermaritzburg.**—The tender of R. W. Blackwell and Co., City-road, has been accepted for overhead equipment of proposed tramways, for supply of 306 trolley wire, insulators, etc.

**Great Western Railway.**—The contract for engines, three-phase generators, condensing and auxiliary plant, aggregating about 10 000 h.p. for the company's new electricity generating station at Park Royal, has been secured by the Electric Construction Company.

**London, W.C.**—The following tenders have been received for erection of the electrical standardising, testing, and training institute at Southampton-row:

| | |
|---|---|
| Howard and Co. | £15,487 |
| H. Lovatt | 15,400 |
| F. G. Minter | 15,000 |
| Dowe Bros. | 14,875 |
| Jerrard and Sons | 14,747 |
| Colls and Sons | 14,580 |
| C. F. Kearley | 14,549 |
| Gough and Co. | 14,544 |
| Lawrence and Sons | 14,386 |
| Patman and Fotheringham | 14,373 |
| Holloway Bros. | 14,300 |
| J. Carmichael | 14,260 |
| Perry and Co. | 14,155 |

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# BUSINESS NOTES.

## TRACTION.

**Branksome.**—There is an agitation in favour of tramways in this district, which is contiguous both to Poole and Bournemouth.

**Cleckheaton.**—The Yorkshire (Woollen District) Electric Traction Company propose to construct a tramway in the direction of the Moor.

**Barton Regis.**—At the last meeting of the Rural District Council it was stated that the tramways company are promoting a Bill respecting the suggested tramway extension.

**Competition at Bradford.**—In consequence of the electric tramway competition, fares have been considerably reduced on the Great Northern Railway Company's line between Bradford and Shipley.

**Melbourne Tramway and Omnibus Co.**—The directors of the Melbourne Tramway and Omnibus Company, Limited, have declared a dividend at the rate of 10 per cent. per annum for the half-year to 31st ult.

**Nottingham.**—A delay of about half an hour occurred on the electric tramway system on Tuesday owing to the trolley wire snapping The broken wire was replaced by a new length after the cars had ceased running for the night.

**Swedish Railways.**—It is stated that the Administrative Board have decided, after an exhaustive enquiry on the Continent and the United States to recommend the Government to adopt electric traction on the Swedish State railways.

**South London.**—The electrification of the tramway from Camberwell-green to Peckham and New Cross is now complete, and awaits the official inspection of the Board of Trade. It will probably be opened for traffic within the next week or so.

**Harrogate.**—A special meeting of the Town Council has decided to apply in the next session of Parliament for an Act to empower the Corporation to construct a temporary tramroad, telephonic communication, and other works in connection with their waterworks.

**Stepney.**—The Borough Council have approved the reconstruction of the following tramways proposed by the London County Council: (*a*) the tramway along the Commercial-road, Leman-street, and Dock-street; (*b*) the tramways along Whitechapel High-street, Commercial-road, Commercial-road East, and East India Dock-road.

**Hereford.**—A scheme is afoot for the laying down of a light railway, 2ft. 6in gauge, in Southern Herefordshire from Llangarren through St. Weonards, Llanwarne, Much Dewchurch, to Hereford It is desired that sidings should be as frequent as possible, so that every large farm on the route will be able to have its own siding.

**Bristol.**—The Hanham Parish Council have approved the proposed extension of the tramways from Hanham-street to Longwell Green. The Bristol Rural District Council have appointed a committee to consider a proposal of the tramway company to extend the tramways to Long Ashton. The local Parish Council is not in favour of the extension.

**Newcastle.**—About 30 men employed at the Byker tramway sheds went out on strike on Monday morning. One of their fellow-workmen, a cleaner, it is stated, had a dispute with the manager, and in consequence ceased work. The others in sympathy refused to work until the matter was settled. Other men were engaged, and all the vacancies were filled up during the morning.

**Lancaster.**—A discussion took place at the last Town Council meeting on a recommendation of the Tramways Committee to construct another route from the Castle Station by Market-street, King-street, Common Garden-street, and Brook-street, to Dalton-square, the present terminus, at a cost of £8,041. An amendment against the scheme was defeated, and the proposals of the committee were passed.

**Paris.**—A "motor train," made up of a 50-h.p. automobile, three trailers for passengers, and two trucks filled with ballast, has been making a tour through the principal streets of the city. The principle of the automobile train is that a shaft, with universal joints, runs from one end of the train to the other, and enables the driver of the tractor vehicle to guide the whole, all the wagons following the leading vehicle with ease.

**Middlesbrough.**—A special meeting of the Streets Committee was held last week to consider the proposed extensions of the Imperial Tramways, in respect of which a Bill will be promoted in the next session of Parliament. After some discussion it was decided to hold a further meeting in the early part of the New Year, the borough engineer and the town clerk in the meantime to draw up reports relating to the subject.

**Islington.**—At to-night's meeting of the Borough Council a proposal will be brought forward that the London County Council be asked whether they would be prepared to take the electricity required for running the tramcars under their control from the metropolitan borough councils who are also electric lighting undertakers, provided the latter are prepared to supply such electricity under suitable conditions and at reasonable rates.

**Johnstone.**—The tramway has been completed in High-street for the electric cars. Nothing has yet been done with the section from Church-street to the boundary of the burgh, and, as Mr. Murphy does not intend to proceed with this work at present, the Town Council have made representations to the promoter to finish the work as scheduled, as if not carried out it would be a great inconvenience to a thickly-populated part of the town.

**Barrhead.**—The Town Council have unanimously approved of the application by the Glasgow Corporation for power to extend their tramway system to Barrhead. The Barrhead authority wished it to be stipulated that the line would be commenced immediately parliamentary sanction is obtained, but the Glasgow Tramway Committee undertake to lay the line only within the period allowed by Parliament. The period asked for is five years.

**Dumbartonshire.**—At a meeting of the Eastern District Committee of Dumbarton County Council, the Electric Supply Corporation notified their intention of applying for power to construct a tramway between Clydebank and Dumbarton. Glasgow Corporation also announced their intention to apply for an order for the extension of their system to Bearsden and Milngavie It was agreed to await the decision of the County Road Board before dealing with the matter.

**Leeds.**—The Tramways Committee have definitely decided to adopt the "split turn" arrangement of working hours for the motormen and conductors, and considerable dissatisfaction exists among the men in consequence. The threat has been made that should the system be enforced the employés will go out on strike *en bloc*. It should be added that the system in question is working satisfactorily on some municipally-owned tramway systems at the present time.

**Manchester.**—Progress is being made with the suburban scheme set out in the Manchester Southern Tramways Act of 1903, and the Tramways Committee are authorised to deal with its provisions so far as they affect the city. The Act, it may be stated, was passed with the consent of the Corporation. The scheme provides for tramway communication with Barton, Davyhulme, Urmston, Stretford, Sale, Northenden, Stockport, and Altrincham.

**Lytham and St. Annes.**—The electric tram service between Lytham, St. Annes, and South Shore is gaining in popularity, due to the introduction of cheap winter fares. The cars do the journey with remarkable punctuality. Last season the company earned £13,300. With the full complement of cars running next season, a larger measure of success is anticipated. The company are hoping to make arrangements for a through service to Blackpool and Fleetwood without changing cars.

**Rowley.**—A conference has taken place between a sub-committee of the District Council and the representatives of the Birmingham and Midland Tramway Company with reference to the construction of the proposed tramway from Old Hill to Blackheath. The company promised to send in a formal tender to the Council, so that they should have an opportunity of considering the price before giving them a contract for the work. The Board of Trade have sanctioned a loan of £21,500 for the tramways.

**Central London Railway.**—Traffic on the Central London Railway was deranged on Sunday by two accidents. The first occurred at the Bank Station at 3.30 in the afternoon, as a train was being shunted, and, in consequence, the traffic had to be worked between the British Museum Station and Shepherd's Bush during the operations at the Bank. The other accident occurred at 5 45 at the British Museum through the same cause, necessitating traffic being worked between Marble Arch and Shepherd's Bush only.

**Rhos.**—A special meeting of the Parish Council has considered the action of the electric tramway company in not extending their line from Johnstown to Rhos. The company wrote stating that owing to a claim which had been made to the absolute ownership of the road over which the tramway was to pass—a claim which they disputed—it was not the intention of the company immediately to construct the portion of line alluded to. It was resolved to refer the matter to the Board of Trade and to the District Council.

**Gloucester.**—The City Council have placed an order for 10 additional cars with the Brush Electrical Engineering Company. Messrs. Dick, Kerr, and Co will supply the electrical equipment for these, as well as for the cars already under construction by the former. The Tramways Committee, having considered the question of using jarrah or karri blocks for all wood paving required for the light railways, have decided that jarrah wood blocks be used wherever wood blocks are specified as required, the additional cost being estimated at £652. 18s. 6d.

**West Ham.**—Last week the first trial trip was made on the Corporation's electric tramway system, the route covered being Plaistow-road and Church-street, stopping at Plaistow railway bridge. The journey was satisfactorily made, the only difficulty met with being in the yard of the car-shed at West Ham-lane, where there are several awkward curves. Fifty cars have been ordered, and some have already been delivered or are awaiting transit. It is expected that a service for West Ham-lane, Stratford, and Canning Town will commence running in February.

**Burnley.**—An inquest has been held in which the question of tramcar guards was raised. It was stated by the tramway manager that the victim—a boy of four years—was drawn in at the side of the car, his body being found behind the lifeguard, but not under the bogie, and that it was impossible to prevent such accidents, the movement of the bogie forbidding the use of nets. The boy being wedged under the car, jacks had to be used to extricate the body, and it was stated that the Burnley Corporation was one among very few that provided jacks on cars.

**Halifax.**—The Tramways Committee have considered a letter from the Greetland District Council asking the Corporation to take into early consideration the continuation of the tramways to Greetland. The committee instructed the town clerk to reply that the parliamentary powers authorising the construction of the tramways in the Greetland district had now expired, and could not be revived until next autumn. It is probable that the municipality may next autumn apply to Parliament for powers of various kinds, and included in these may be one or two tramway extensions, Greetland among the number.

**Birmingham.**—The Tramways Committee of the City Council held a sitting last week, when representatives attended on behalf of the Aston Town Council for the purpose of talking over certain matters with the committee respecting the arrangements for running the tramcars after the close of the year. Colonel Yorke and Mr. Trotter on

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Tuesday officially inspected the new electric tramway between the city and Aston. This is the first length of the municipal system to be electrically equipped. The Tramways Committee subsequently met and decided to open the route on Jan. 4, instead of on Jan. 1, as originally arranged.

**Bootle.**—At the last meeting of the Rural District Council some discussion took place on the proposed tramway up the Duddon Valley, which the Barrow Corporation propose to make permanent, and objection was taken by some of the members to the level crossing on the Duddon Bridge-road. They objected to the line being laid down across the road permanently, and it was accordingly resolved, and a sub-committee was formed to approach the Ulverston Rural District Council, in whose district the level crossing is, to see if something could not be done in the way of opposition to the making of this crossing permanent.

**Lewisham.**—At the last meeting of the Borough Council the Special Tramways Committee recommended the Council to offer to the London County Council a contribution of one-third of the estimated cost of the street widenings in the borough in connection with the following four schemes: New Cross-road to Lee Green; Greenwich to Catford; Lordship-lane to Forest Hill, and Lewisham High-road to Forest Hill; and that the resolution of the Council of Sept. 23 be altered or varied accordingly. As the recommendation involved an expenditure upon capital account of a sum exceeding £1,000, consideration thereof stood over until the next meeting of the Council.

**Leicester.**—The construction of the electric tramways is making rapid progress. Seventeen miles of single track have been completed by the direct labour of the Corporation workmen, under the control of the borough engineer, and the necessary paving work in connection with the track and side paving has absorbed 1½ million hardwood blocks, 3½ million granite setts, and 4½ acres of land have been leased from the Corporation estate as a site for the main car depôt. Contracts amounting in the aggregate to a little over £190,000 have been let for the power station, car-sheds, electric installation, etc., which, without exception, are all in most advanced stages, and the permanent-way work (done by direct labour) is also well advanced.

**Mid-Yorkshire.**—Messrs. J. G. White and Co., the firm who constructed the Mid-Yorkshire tramways in the Shipley district, and who are the chief owners, have sent a communication to the Tramway Committee of the Bradford Corporation, offering to enter into negotiations for the running of the cars over the existing track by the Bradford authorities. The powers obtained by the promoters provide for extensions to Keighley and to Ilkley, with branch lines to Baildon and Frizinghall, the latter by the Valley-road route. Messrs. White and Co. propose to carry the lines forward to Bingley and Baildon, and possibly to Frizinghall, and to include these portions in the suggested lease. The matter has not yet been considered by the Tramways Committee.

**Newport (Mon.).**—The Electricity and Tramways Committee have decided to recommend the Council to proceed with the scheme for running electric cars over the Stow-hill route. The recommendation is that a single track be laid instead of the double line, which has been sanctioned by Parliament. By the adoption of the single line sufficient space will be left for uninterrupted vehicular traffic. Electric motor-cars or 'buses have been advocated instead of the tramcars, but it was found from enquiries made in other towns that the tramcar was likely to prove the more satisfactory method of meeting the requirements of the district. Should the Council sanction the Stow-hill scheme, it will be proceeded with early in the New Year, and it is hoped to get the line equipped by Midsummer.

**Additional Traffic Returns.**—Anglo-Argentine, £420 decrease; Barcelona Ensanche y Gracia, £131 increase; Barcelona, £103 decrease; Brisbane, £11 decrease (month of November, £10,544, increase £253), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £125 increase (month of November, £14,142, increase £444); Calcutta, £55? increase; Cape Town (month of November), receipts £16,785, expenditure £8 673; Isle of Thanet Electric, £78 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of November), receipts £47,350, expenses £27,600; Perth Electric, £255 increase; Port Elizabeth (month of November), receipts £4,073, expenditure £2,989.

**Poplar.**—At the last meeting of the Borough Council the General Purposes Committee reported that the London County Council proposed to adopt for the existing tramways running along East India Dock-road and the proposed extension to the Iron Bridge a conduit system of electrical traction precisely similar to that adopted for certain of the Council's tramways south of the Thames. They had applied to the Board of Trade for approval of the system of electrical traction. The borough surveyor had examined the plans submitted by the London County Council, and was satisfied that the interests of the borough were sufficiently safeguarded. The system proposed to be adopted was that already approved by the Council, and the committee recommended that the plans be adopted, which was agreed to.

**Greenwich.**—At the last meeting of the Borough Council the General Purposes Committee reported that they had had under consideration further letters from the clerk to the London County Council stating that the time had now arrived for his Council to decide whether they would proceed with their Bill for the session of 1904 for the proposed tramway from Deptford to the Royal Herbert Hospital, Shooter's-hill *via* Blackheath, and for a double line from Greenwich to Catford, and asking whether this Council could see its way to make the necessary contribution of one third of the net cost of the incidental street widenings. The Greenwich Council had already signified consent to the tramways, but had refused to make the contribution, and the Council decided that they were unable to vary their resolutions in the matter.

**Tramways in Denmark.**—The British Consul in Copenhagen eulogises the tramway system of the Danish capital in his report. The overhead trolley is now in general use, and storage batteries have been entirely done away with. One can travel any distance from one to five or six miles for 1d., and transfer tickets enabling passengers to change cars are supplied. The working expenses are about 7½d. per mile. The tramways belong to a company, which holds a 40 years' lease from 1898 from the municipality, the latter having the right to buy the lines in 1908. This company has a capital of £889,000, and employs 793 conductors and drivers, with about 127 hands in the various sheds, track cleaners, etc., besides day labourers. There are 184 motorcars and 75 trailers, in addition to 26 horse cars and 17 omnibuses. The length of the tracks, double lines, is about 19 miles and about eight miles single lines. The cars up to the present have been built in Germany and Denmark, also the electric plant, but the consul sees no reason why British firms should not compete for these supplies, which run into many thousands of pounds.

**Bolton.**—The question of lifeguards was discussed at an inquest held on the body of a woman who was knocked down and run over by a Corporation tramcar on Christmas Eve. A juror asked what kind of a lifeguard was attached to the car, and was informed, "An old pilot board." The foreman said he had heard of cases where a child had been picked up by the guard and saved. The Coroner: Yes, the catcher. We have had two or three of these cases. The Foreman: We cannot understand how it is this guard should have had no effect in protecting the woman. Mr. Alderman Miles, the chairman of the Corporation Tramways Committee, who was present at the enquiry, said they had three or four kinds of lifeguards under trial now, and they had been testing lifeguards for some considerable time. The moment the committee could get hold of one which they considered of real utility they would adopt it, but he was informed the committee felt there was no such guard as they would deem really capable of assisting materially in saving life. The jury returned a verdict of accidental death, and added that no one was to blame.

**Walsall.**—The Corporation tramways were formally inaugurated yesterday, though the lease to the South Staffordshire Tramways (Lessee) Company did not expire until midnight, and to-day the cars will run under municipal auspices. The only drawback to the change of management is a break in the through connection between Walsall and the adjoining Black Country towns of Wednesbury and Darlaston. The Corporation terminus is at a point where the Darlaston road branches off from the Wednesbury road, and beyond this the tramway company run their cars to and from each of the towns named. As a matter of fact, a somewhat extensive residential district within the borough, but beyond the point indicated, is not served at all by the Corporation cars, this perhaps being the weakest point in the Corporation scheme. It is, however, urged that the arrangement which has been made will prove to be most convenient to the public generally, as it will allow of the Corporation cars and the lessee company's cars from Wednesbury and Darlaston meeting at one terminus, and it is understood that the Corporation will run their cars in such a manner that the inconvenience of changing from one line to the other will be minimised as much as possible.

**Stourbridge.**—At the last meeting of the District Council the Clerk read a letter from the Dudley, Stourbridge, and District Electric Traction Company referring to a question of doubling the track along the route from Coalbournbrook to the Ridge on the Kinver line. The Council had deferred giving their consent to the proposed new double line until definite assurances had been given by the company on certain points. The secretary now wrote that the company would undertake, in the event of their proposals being approved, and subject to powers being obtained for the whole route from Mr. Foley and adjoining local authorities, to give a through service of cars between Stourbridge and Kinver on completion of the work, such service to form part of the ordinary Kinver service. They would also carry passengers riding *via* Enville-street to the Ridge Top for 1d., and that the last-named point should be the stage for all ordinary cars working on the Enville-street section. The company also stated they were prepared to comply with certain requirements of the surveyor. They realised the urgent need of some improvement to enable the public to gain free and quick access to Kinver, and it was owing to this that they submitted the proposed improvements. The communication was referred to the Railway Committee of the Council.

**Electric Railways in the United States.**—Fifteen years ago the total length of electric railways in operation in the United States was 86 miles, on which 172 cars were used. The census report of June 30 last year showed 22,589 miles of electric road using 67,199 cars, and requiring 1,298,133 h.p. for their operation. These roads carried during the preceding 12 months nearly 6,000,000,000 passengers. The total gross earnings were £48,316,939, the operating expenses being £27,802,400, leaving net earnings of £20,514 539. The social influence of this industry is further indicated by the number of hands to which it gave employment on the various roads. The 138,183 employés reported earned £16,927,255, or an average of about £123 each per annum. In the 12 months following the date of this report nearly 3 500 additional miles of railroad were laid, bringing up the total length of railways in the country to nearly 26,000 miles. The early electric cars were for the most part old horse cars, mounted on improved trucks, and carrying 20-h.p. electric motors, capable of making at the outside, a speed of 12 miles an hour. Now the electric car can make its 40 miles and more an hour, if need be, and some of the electric roads are putting on sleeping-cars nearly 60ft. long, each equipped with 600 h.p. in electric motors. Some of these cars have 10 compartments, with upper and lower berths, that fold up during the day, and are so adjusted that the car can be converted into a parlour car, having 20 chairs for the day service.

**Glasgow.**—In coming to their decision not to alter the present ½d. stations on the tramway system, the sub-committee of the Town Council were mainly influenced by a memorandum prepared by the

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general manager. In the course of this document Mr. Young points out that the ½d. stage forms the unit on which all other stages are based, and these must be measured from the centre outwards. Overlapping ½d. stages are unworkable. It is desirable that ½d. stations should be placed, as far as practicable, at important junctions. This is generally effected by the present stages of about half a mile. The proposed extension of the ½d. stage would remove the stations from many important gathering points If new stations were placed at a comparatively short distance from these stations, the conductors could not collect all the fares before reaching the new station. This would apply noticeably to stages where the percentage of ½d. fares taken by artisans at the meal hours is very great. It is pointed out that only one in five of the "workmen" using the early morning cars is a ½d. passenger. Seventy-two per cent. are 1d. passengers. If the ½d. stage were lengthened to three-quarters of a mile, it is estimated that 12 per cent. of the 1d. passengers would avail themseves of it, causing a loss of £26,000 a year. The extension would no doubt aggravate the difficulty experienced from ½d. passengers crushing out higher "fares" at the rush hours in the evening. Mr. Young further points out that we shall probably experience a period of bad trade, during which the revenue is certain to be adversely affected. This year the department are being called upon to meet largely increased expenditure, the increase for local taxes alone being over £25 000.

**Sheffield.**—One of our northern contemp raries has been dilating on the excellence of the tramway service in the city and the huge proportions which it has assumed since the introduction of electric traction. Looking back over the past year, the removal of Mr. A. L. C. Fell, who has done splendid work as general manager of the undertaking, to a similar position under the London County Council, and the appointment of Mr. A. R Fearnley, of Birkenhead, to the vacancy thus created, are the most important changes that have taken place. It is estimated that 61,178,618 passenger have been carried over the system during the year, made up of over 11 millions paying ½d. fares and nearly 50 millions 1d. fares. The number of car miles run works out at about 5,513,543, or nearly a million more than last year. The number of car routes now open is 16, an increase of two during the year. There are 57 miles 6 furlongs 6·5 chains single track open for service, being an increase of nearly eight miles on the year, and the number of cars in possession of the Corporation is 218. This number will shortly be increased by an additional 25. The average number of ordinary cars running daily throughout the year has been 119, compared with 115 in 1902, and the special cars number 40, against 27. The employés in the department number 1,379, or nearly 100 more than a year ago. Important additions have been made at the Kelham Island power station, including the erection of a new generator and engine and new boilers with mechanical stokers. There have been other improvements, all tending to bring the plant up to date. The ventilation in the basement of the Kelham Island works, which was a source of great annoyance to the men, has also been improved. One of the most important schemes in connection with the tramway department is the extension of the Queen's-road car-sheds. The new building, when complete, will run 378 t. along the Queen's-road, and, with the existing sheds, will provide accommodation for 130 cars. The present sheds give sufficient space for 85 cars. There will be sufficient room for 17 cars to be under repair at one time, and the plans, which have been prepared in the office of the city surveyor, provide for a smithy, machine-rooms, joinery department, caretaker's house, and offices. The new extensions will occupy all the available land, and with the sheds now in occupation will cover an area of about 8,000 square yards. The cost of these extensions will amount to about £20,000. A controversial point during the year has been the question of advertising on the cars. The committee were some time in arriving at a decision, but eventually the vote went in favour of the advertisements, and the general opinion is that they are not so ugly as was at first anticipated. The solution of the dry-seat problem remains to be satisfactorily settled. But in order to keep passengers on the upper deck free from the attacks of inclement weather, the committee have erected coverings on many of the cars, and, although the beauty of the vehicles is not increased thereby, the improvement has been much appreciated. The year closes with some minor regulations as to parcels which passengers are allowed to carry inside the cars.

## LIGHTING AND GENERAL.

**Malton.**—The Northern Counties Electricity Supply Company will commence operations with the laying of cables, etc., early in the New Year.

**Foreign Contracts.**—Messrs. Rowland Carr and Co. report receipt of a further large repeat order for troughing and roadway frames and covers for Oporto.

**Agency.**—The Union Cable Company, Limited, have appointed Messrs. Palmer and Taylor, 50, Wellington-street, Glasgow, sole representatives for Scotland for electric cables and wires. Messrs. Palmer and Taylor will hold a considerable stock of cables.

**Lundberg Switch Litigation.**—A reference to the case Tucker *v.* Lundberg will be found in our advertisement columns. Our readers will be pleased to hear that this case has been dismissed for want of prosecution, and that Mr. A. P. Lundberg was awarded costs.

**Edmundson's Electricity Co.**—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares of this company, payable on Jan. 15, 1904, for the half-year ended Sept. 30, 1903.

**Beckenham.**—A letter from the Kent House and District Improvement Association requesting the Council to give early attention to the electric lighting of Beckenham-road from Clock House Bridge to Kent House-road, is before the Electric Lighting Committee of the Urban District Council,

**Manchester.**—At a recent meeting of the Electricity Committee, it was stated that for the four weeks ended Dec. 19 the total output was 3,606,372 units, an increase of 1,067,004 units over the corresponding period of 1902.

**Gillingham.**—The Parish Council have decided to request the company who have the electric lighting provisional order to make a canvass of the town with a view to the formation of a company by them, or locally, with the option of purchase by the Council.

**Leek.**—The Urban District Council have agreed that, in addition to the flat rate of 6d. per unit already decided upon, there should be an alternative maximum demand rate of 7d. and 3d. An application for a large supply of electricity for power is under consideration.

**The Savoy.**—Exactly 22 years ago last Tuesday, that was on Dec. 29, 1881, Mr. Doyly-Carte, then running Gilbert and Sullivan operas for all he was worth, installed the electric light at the Savoy. This was the first electric light installation in a London theatre.

**Erith.**—The Council have decided to undertake forthwith the wiring and fitting of consumers' premises, the cost to be paid by the Council to the contractor, and repaid to the Council by the owner or occupier of the premises by quarterly instalments over a period of three or five years.

**Bray.**—Tenders are to be invited for an 80-gallon cistern. The electrical engineer's last report stated that the plant was running fairly satisfactory, but every effort should be made to have new plant installed without delay. Mr. Hammond is to be written to to urge on the work as soon as possible.

**Exeter Cathedral.**—Mr. H. A. Willey is providing an installation of electric light for the cathedral. Part of the lights were in use for the first time on Christmas Day. Mr. T. Hammond, A.I.E.E., is the consulting engineer; and Mr. Munro, city electrical engineer, is engaged in the carrying out of the scheme.

**Sunbury.**—The District Council have approved an agreement with Messrs. Edmundson's, Limited. The company will supply current to private consumers at 7d. per unit for the first hour, and 3d. for each following hour, and will charge for public lighting at 2½d. per unit per hour, or £2. 17s. 6d. per lamp per annum, the light to be 25 c.p. per lamp.

**Tynemouth.** — The searchlight presented to the Tynemouth Volunteer Life Brigade by Mr. Roland Philipson, of Tynemouth, will be formally presented by the donor at a special drill on Saturday evening, when Mrs. Philipson will switch on the light. The proceedings will be presided over by Sir W. H. Stephenson, ex-mayor of Newcastle.

**Dalkey.**—A London syndicate who appears to be anxious to invest large sums of money in Irish enterprise, particularly in electric lighting, has communicated with the Urban District Council. The clerk has been instructed to ask for a statement of definite terms as to what would be the cost of public lighting in the township, and at what rate private consume s would be charged.

**Wolverhampton.**—Some large electrical orders have reached the works engaged in this industry, and will occupy several months to execute. At the Electric Construction Corporation's factory, Bushbury, an important contract has come from the Admiralty and also another one from a leading home railway company, while owners of other works and public bodies are ordering for installation purposes.

**Wood Green.**—At the meeting of the Urban District Council on Wednesday, the electric light was discussed at great length. Councillor Leake moved that a previous resolution to apply to the Local Government Board for sanction to borrow £43,000 for the purpose of generating and distributing electricity be rescinded. The proposer favoured a company undertaking the scheme. The motion was lost, only three supporting it.

**Wrexham.**—The Town Council will apply for sanction to borrow £5,300 for electric lighting purposes. They have also agreed that in future the charges for current be fixed at a uniform price of 4½d. per unit for current supplied as from Jan. 1, with a discount of 2½ per cent. if paid within a month, but that in the case of the few consumers who take 1,500 units or upwards in any one quarter the charge should remain at 4½d. A satisfactory report on the units of electricity generated during the month as compared with last year has been presented.

**Christmas Excursion.**—By arrangement with the Great Central Railway a large number of employés of the Manchester works of the British Westinghouse Company visiting London for Christmas had, we are informed, an unusually pleasant and speedy journey on Christmas Eve. The railway company ran a special train, without stopping, from Manchester Central to Marylebone—206 miles—in just over four hours. The services of the catering department, under the supervision of Mr. Barton, the Sheffield district superintendent, were eminently appreciated.

**Hunslet.**—A representative from the Yorkshire Electric Power Company attended the last meeting of the Rural District Council, and entered into an explanation of the terms on which electricity could be supplied to the Council. He stated that the price for public lighting would be 2d. per unit, or about an average of 30s. per lamp per annum The company would lay cables to sub-stations in central positions, and the Council would have to lay their own cables from these. The charge for individual users would be from ½d. to 1½d. per unit. They would be in a position to commence the supply in December, 1904.

**Stock Exchange.**—The Stock Exchange Committee have ordered Blackheath and Greenwich District Electric Light Company, Limited, 50,000 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 150,001 to 200,000, to be quoted in the official list. The committee have been asked to allow the following securities to be quoted in the official list: Consolidated Electrical Company, Limited, 109,251 ordinary shares of £1 each, Nos. 1 to 109,251; Kalgoorlie Electric Power and Lighting Corporation, Limited, 150,000 cumulative 6 per cent. preferred shares of £1 each, fully paid, Nos. 1 to 150,000.

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**Barnstaple.**—The municipal electricity undertaking has scarcely been in working order for a year, but its success has already exceeded the most sanguine anticipations. The first 12 months' working will show a good profit, the Town Council being enabled to pay £700 interest upon capital, whilst having a large sum in hand towards the redemption. There appears to be a good demand for current for motor purposes.

**Bispham.**—On the minutes of the Lighting Committee coming up for confirmation it was suggested that as the Blackpool Corporation would not extend the gas-mains into the village, they should approach the tramway company with a view to getting overhead cables taken into the village. The place could be very well lit by putting electric lamps on the present posts. This could be done as cheap as by gas, and possibly cheaper.

**Ferranti Limited.**—From Jan. 1 the sales administration of the company's meter department will be conducted at Donington House, Norfolk-street, by Mr. F. Barnes Spencer, M.I.E.E., as representing this branch of the company's manufactures. Both the continuous and alternating current types of meter are now entirely standardised for all sizes, and are manufactured throughout at the company's works, Hollinwood, Lancashire.

**Annual Concert.**—The annual concert given by the employés of the Robertson Electric Lamp Works took place at the Brook Green Works on Dec. 19, in the dining hall of the factory. A company of over 800 assembled, and the concert was a great success in every way. The chair was taken by the manager, Mr. Wilson, and several of the directors, including the chairman (Mr. Hirst), honoured the company with their presence. An excellent programme of 26 numbers was carried through completely.

**Londonderry.**—The electrical engineer (Mr. Macrory), in a report adopted at the last meeting of the Private Lighting Committee of the Corporation, showed the progress of the cable work. He also reported that the first boiler had arrived and was being placed; that a price had been obtained from the Western Electric Company for the extra large fuse-box boards; and that he had received complaints regarding the reinstatement of pavements from the city surveyor, and had handed them to the cable contractor.

**Johannesburg.**—On Tuesday, Dec. 1, a serious fire occurred at the Johannesburg electric light station. We gather from the descriptions published in the Johannesburg papers that the fire commenced at the switchboard, and was spread by the insulation of the connecting cables. It occurred in the oldest portion of the works, in which single-phase alternators were used. Eight of these machines were partially destroyed, but the new three-phase plant was not injured. In consequence of this the supply could be resumed quickly.

**Accident.**—A few days ago a young man named Joseph Firth, employed by the Phœnix Dynamo Company, Limited, of Bradford, was engaged at the Bolton-road electricity works of the Bradford Corporation when he met with a somewhat serious accident. Some alterations in the electrical fittings are being carried out, and Firth, it appears, was at work behind a "live" switchboard when by a short-circuit he received a spark of between 2in. and 3in. in length full in the face. His face and the top of his head were somewhat severely burned.

**Electrical Exhibition.**—In a recent dispatch to the Foreign Office, H.M. Consul-General at Warsaw reports that sanction has been obtained for an electrical exhibition to be held at Warsaw from May to September, 1904. The exhibition will include a special section for new inventions in this direction: foreign exhibitors are invited to take part. It is understood that permission is to be granted for the admission of exhibits free of duty. All communications respecting the exhibition should be addressed to the Committee, Philharmonia-building, Moniuszki-street, Warsaw.

**The Distribution of Electricity in Canton Waadt.**—The electricity works erected by the Compagnie Vaudoise des Forces Motrices des Lacs de Joux et de l'Orbe for the supply of electricity to 190 parishes in Canton Waadt were recently inaugurated. The power-house is situated near Vallorbe, and utilises a 781ft. fall of water from Lake Joux, from which a total of over 10,000 h.p. is available. The current generated is transmitted at a pressure of 13,000 volts, the generators being wound to yield this voltage direct. The Maschinenfabrik Oerlikon have supplied the electrical equipment.

**Progress in Norway.**—A supply of electricity for lighting and power purposes has recently been inaugurated in Drammen, Norway. The supply is obtained from a power-house situated at Gravfos Fall, about 23½ miles distant from the town. This power-house is designed for an output of 5,400 h.p., furnished by six turbo-generator units of 900 h.p. each. The electrical energy is transmitted at a pressure of 25,000 volts to a transformer sub-station in Drammen, where it is reduced for distribution. The Maschinenfabrik Oerlikon supplied the whole of the electrical plant used in connection with the above scheme.

**Beeston Telephone Works.**—About two years ago the National Telephone Company became the owners of this factory, which covers a considerable area, and from Dec. 1 the British Ericsson Company, a branch of the Stockholm telephone makers, took over the whole concern. Notwithstanding the recent fire about 250 hands are now in employment at the works, and work is to be found for 20 more immediately. The company have their own electric light installation. The central portion of the building, where the fire was confined, has not yet been touched, but the company hope to begin building immediately after Christmas.

**Gloucester.**—The electrical engineer (Mr. W. J. Bache) reported to the Electricity Supply Committee on Dec. 16 that three small arc lamps had been erected in Lower Westgate-street, and that they had been lighted since the 12th ult., and found satisfactory. Mr. Bache reported as to the progress made by the contractors with the extension of the generating station, and the town clerk was instructed to write Mr. Hammond and the architect as to the importance of completing the works at the generating station within the time allowed for completing the works under the various contracts. We learn that, compared with this time last year, there is an increase in private consumption of about 20 per cent.

**Annual Dinner.**—The first annual dinner of the staff and employés of the Salford Corporation electricity department was held at the Horseshoe Hotel on the 16th ult. Mr. Councillor Hodgson (deputy-chairman of the Electricity Committee), Mr Charles D. Taite (borough electrical engineer—in the chair), and 108 members of the staff attended. A most enjoyable smoking concert followed. During the course of a speech Mr. Taite gave the following particulars of units sold: 1896, 52,000; 1899, 400,000; 1902, 1,250,000; 1903, 4,750,000. The number of lamps connected to the mains at the present time was, he said, equivalent to 100,000 8-c.p. lamps, and the total horse-power in motors, etc., amounted to nearly 2 000.

**Dunfermline.**—It is reported that the Fife Electric Power Company have decided since the decision of the Government to establish a naval base at Rosyth to make Dunfermline their centre. In the Act incorporating the company and conferring power upon it, provision is made for acquiring lands for generating or power stations only at Comrie, Cowdenbeath, Cupar, Markinch, and Leven, but one of the sections enacts that lands elsewhere may be obtained by agreement. Various sites in the vicinity of Dunfermline have been examined, and it is understood that it has practically been decided to erect a station on burgh lands lying between the Town Loch and the West of Fife Mineral Railway. For a line of tramway to Rosyth at least two routes are available, and both are to be surveyed shortly.

**Devizes.**—At the last meeting of the Urban District Council a report was presented from Mr. Wingfield Bowles, consulting engineer for the proposed electricity supply scheme. It is proposed to place the station near the wharf. The compulsory area consists of the greater portion of the town. The engineer recommended that the central station should be of sufficient capacity to supply the whole of the borough, but in regard to the mains, etc., it is only contemplated to supply the compulsory area. The cost was estimated by the engineer at £15,500, which, with the cost of the order and fees, etc., will amount to £17,000. It was decided to apply for a provisional order, and the engineer was instructed to proceed with the detailed plans and specifications, so that tenders may be invited immediately after the provisional order is obtained.

**Fulham.**—Mr. A. J. Fuller, the borough electrical engineer, is preparing a special report dealing with the conversion of the whole of the side street lighting from gas to electric incandescent lighting. We understand that this report is now before the committee, and probably a trial will be made of some two or three hundred lamps. The output of the past week has more than doubled itself in comparison with the corresponding period of last year, and since Mr. Fuller took charge in March last the consumers have increased from 650 to 1,020. The Granville Theatre of Varieties has been connected to the Corporation system. The connection had to be given temporarily in the first instance owing to the failure of the private plant of the theatre company. In connection with the dust destructor the maximum quantity ever burnt in a week was attained last week, when some 766 tons of house refuse were consumed.

**Kilmalcolm.**—The electric light was switched on for the first time on Christmas Eve, when St. James's Church was successfully lighted. A provisional order was obtained by the Kilmalcolm Electric Lighting Company in May last, and about 40 householders have promised to take the light. The amount of rock which was encountered in the streets necessitated a good deal of blasting, but already about three miles of cables have been laid. The power station is built of corrugated iron, and is divided into engine-room, boiler-house, accumulator-room, offices, and store. There is an engine and two dynamos, and room has been allowed for two other sets and an additional boiler. There is an iron chimney stalk 80ft. high. The burn which flows past the station has been used for feeding the boiler, and next winter it will be used for condensing purposes. The price per unit for the light will be 6d. Mr. James Brown is resident engineer.

**Newquay.**—A meeting of the Urban District Council has consented to the electric light installation proposed to be provided by the Southern Counties Electricity Corporation, subject to a formal agreement being completed not later than Jan. 8, 1904, between the corporation or the Council, and that no constructional work of any kind be carried out during July, August, and September. The corporation is to supply the Council's lamps at any point within 75 yards from the corporation's main and to other lamps not more than that distance from each other, provided the Council agree for not less than three years. Meters are to be supplied free. The system is to be submitted for the approval of the Council. The Council are to have the option of purchase, and within seven years, by giving 12 months' notice of intention to purchase, which will either be by valuation or on terms similar to the Winchester scheme. The cost of public lighting is not to be more than 4d. per Board of Trade unit, and for private use 6d. per Board of Trade unit.

**Electricity Supply in Brescia.**—The water power which abounds on the south side of the Alps in Italy is rapidly being utilised by the erection of central stations. What will be one of the largest of these stations is now in course of construction at Caffaro, for the supply of electricity in the province of Brescia, which borders on the Italian-Austrian frontier. The power-house equipment will comprise five turbo-generator sets of 2,500 h.p. each—total, 12,500 h.p. each. The main transmission line to Brescia is 31 miles long, and the current will be conveyed through same at a pressure of 40,000 volts. When completed this scheme will share the distinction with the Bülach-Oerlikon undertaking, belonging to the Maschinenfabrik Oerlikon, of being the only example in Europe of the practical transmission of electrical energy on a large scale at so high a pressure. In conjunction with the

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power-house at Caffaro a transformer sub-station containing plant of 3 250 h.p. is being erected in Brescia to drive an electro-chemical factory. The whole of the electrical equipment for both stations is being supplied by the Oerlikon Company.

**Woking.**—We learn that the installation of the electric light at Woking Junction has so far given complete satisfaction. The work is being carried out in sections, and at present only the station premises are lighted by incandescent lamps. Standards for a number of arc lamps have been erected at both ends of each platform. The gas lamps will be retained for use in case of emergency. One great advantage of the new system will be the improved lighting of the goods yard, where the shunting operations are bound to entail considerable risk unless there is ample light. The work of completing the installation is being rapidly pushed forward, and will be finished early in the New Year. The current is being taken from the Woking Electric Supply Company, by means of a special cable terminating at the transforming house on the London and South-Western Railway premises. The railway company have undertaken the entire work of wiring and installation, and this has been carried out under the supervision of Mr. Bircham, who is at the head of their electrical engineering department. At present Salisbury is the only other station on the system where the electric light is the only means of illumination employed.

**Blackpool.**—Recently a deputation from the Blackpool Tradesmen's Association, consisting of Mr. T. Donnelly, J.P., Mr. Rhodes, and Mr. R. H. O. Hill, met the Electricity Committee to plead that if the charges for electric lighting are to be reduced at all, they should reduce the 7d. maximum rather than the 2d. minimum. It is proposed to reduce the second to 1d. The Chairman assured the deputation that no decision had been come to at all in the matter. Mr. Furness, the electrical engineer, had prepared for the visit by providing charts showing how the present system worked. He showed how the system would act if the maximum or minimum were reduced. It was proved that if the maximum were reduced it would give the largest discounts to those who were their worst customers—that is, those who use electricity the shortest time—but if they reduced the minimum to 1d. they would be giving the advantage to those who most deserved it from the electricity department's point of view because they were the best customers. The deputation did not advocate a fixed charge, neither did the committee nor Mr. Furness. The latter pointed out that of 200 boroughs 165 had the Blackpool system of charging.

**Engelberg-Lucerne Transmission Scheme.**—Among the generating stations at present in course of erection in Switzerland, that destined to supply Lucerne is perhaps the most noteworthy. This station forms part of a complete scheme submitted by the Maschinenfabrik Oerlikon in competition with other prominent Continental firms, and adjudged to be the best adapted to the local conditions by a committee of experts. Consequent upon this judgment, the firm in question have been entrusted with the carrying out of the whole of the electrical work involved by the scheme, including the equipment both of the central station in Engelberg-Obermatt and of the transformer sub-station in Lucerne. The distance from the power-house to Lucerne is roughly 18½ miles. Turbo-generators for a total output of 14,000 h.p. are to be installed at Obermatt. These generators will deliver to a battery of step-up transformers designed to supply current to the main transmission line at a voltage of 27,000. At the transformer sub-station in Lucerne this current will be reduced again in pressure to 2,600 volts for distribution locally. The same generating station will also provide Engelberg and the whole Canton Obwalden with electricity for general lighting and power purposes, besides for working the Lucerne-Engelberg Railway.

**Explosion Enquiry.**—There has just been issued the report from the Board of Trade Surveyor's Office, 79, Mark-lane, London, of a preliminary enquiry (No. 1,465) into the circumstances of an explosion from two cast-iron tee-pieces at the Brompton and Kensington central electric lighting station, London, which occurred on Aug. 24. No one was killed or injured. Both tee-pieces were fractured, and portions of them, together with their attachments, were blown away from the steam-pipes to which they had been connected, and permitted steam at 150lb. pressure to escape into the boiler-room. The explosion resulted from water-hammer action following the admission of steam to the main range before the pipes were sufficiently drained. Mr. P. Samson, the engineer surveyor-in-chief, in the course of his observations says that it is desirable in all cases that the drain pipes should be so arranged that the attendant, when he regulates the drain valve, can see the escape from the open end of the pipes, so that there can be no doubt as to the pipes being clear or the valve or cock open. The fitting of the non-return valves in the outlet pipes of steam-traps or other draining arrangements is a dangerous practice, being one that is favourable to the formation of a partial vacuum in the steam-pipes and the consequent accumulation of water in them if steam leaks past the boiler stop valves.—*The Times.*

**Redruth.**—At the meeting of the Urban District Council on Monday, a letter from Mr. F. S. Hanning, the resident engineer to the Urban Electric Supply Company, was read, stating that he had visited the two points to which his attention was called—viz., the lamps on the north side of the town and the arc lamps. The former was affected for about an hour owing to the cables in that section being overloaded while the Brewery and Redruth Foundry Company's meters were running. They had taken steps to remedy that defect, and thanked the Council for calling their attention to it, which had escaped their notice. In all arc lamps there was a tendency to jump, owing to the fact that they were mechanically fed. If the chairman of the Lighting Committee would inform them when those lamps were reported unsteady, the matter would have their immediate attention. On the previous occasion when the lighting was reported unsatisfactory he called on the chairman of the Lighting Committee, and ascertained the fault they had to find was with the arc lamps. These were at once attended to, and it was discovered the damp had found its way into the mechanism. This they found was the fault again. They had remedied that to the best of their ability, but in that climate it was very difficult to keep the damp out from the delicate machinery. It was decided to hand the letter over to the chairman of the Lighting Committee.

**Lincolnshire and Yorkshire Electric Power Co.**—A Bill for incorporating and conferring powers on the Lincolnshire and Yorkshire Electric Power Company has been deposited for next session in the Private Bill Office of the House of Commons. The promoters are Mr. Arthur Lupton, Mr. Henry Ernest Leetham, and others. The capital of the proposed company is to be £999,000, divided into 99,900 shares of £10 each, but with power to divide these shares into "preferred half shares" and "deferred half shares." The first directors of the company are to be Mr. Arthur Lupton, Mr. Harry Ernest Leetham, "and three other persons to be nominated by them," but it is provided that the directors shall exercise no compulsory powers until £225,000 of the capital of the company has been subscribed. Borrowing powers are intended to be exercised to the extent of £333,000, which may be raised by the issue of debenture stock. The company propose to acquire land for the erection of three generating stations—one at Market Rasen, in Lincolnshire: the second at Beverley, in the East Riding; and the third at Easingwold, in the North Riding. The area of supply which is proposed to be covered by the company is to be: (1) the whole of Lincolnshire: (2) the whole of the East Riding: (3) so much of the West Riding as is bounded on the south by the River Wharfe, and on the west by the River Wharfe, and by a line to a point where the boundary of the North and West Ridings cuts the road from Kettlewell to Leyburn; (4) the whole of the North Riding, with the exception of the Middlesbrough Union, and parts of the Guisborough Union and the Stokesley Union. Clauses are contained in the Bill empowering the company to erect overhead wires, subject to the consent of the public authorities, and limiting the dividend payable by the company to 8 per cent. per annum, but subject to a sliding scale. Power is also sought to enter into agreements with all the Yorkshire and Lincolnshire railway companies to supply them with energy in bulk "for motive power, lighting, and any other purpose" for use within or without the area of supply. The powers granted by this proposed Act are to cease "if within three years from the date of the passing of this Act the company have not substantially commenced their works for the purposes of carrying out their powers."

**Elgin.**—A report upon the adoption of hydraulic power at the Little Ess on the River Lossie and the installation of an electric lighting system by Mr. D. J. Russell Duncan, calls attention to the River Lossie as a source of power, showing that the elevation of the catchment area has a higher rainfall than that of Elgin; that the average rainfall for 29 years as recorded at Highfield, 27·64in. at 80ft. level, is increased to 29·45in. in the district included from Keith to Grantown, averaging 266ft. level; and that the drainage area of the Lossie, which rises to nearly 1,700ft. level, gets the average rainfall of the whole of Scotland—36in.; 21in. is calculated as the volume of water collected over 33 square miles of drainage area and carried down by the river to the sea. A table is given in the report showing that the mean monthly rainfall during 24 years ending 1890 varied from 1·61in. in April to 3·08in. in August, the driest and wettest months respectively. By building a dam at the Little Ess the water-level can be raised 70ft., the submerged area due to rise in level of water is about 18 acres, and the mean volume of water brought down by the river into the reservoir is 1,630 cubic feet per minute. Calculated on 19·16in. rainfall per annum, this means about 2,347,500 cubic feet per 24 hours, sufficient on 70ft. fall to supply 300 b.h.p. for 13½ hours per day. As the minimum rainfall at Elgin, 19·16in., only occurred once in 34 years, and a corresponding fall is in itself sufficient to supply 300 b.h.p. to the dynamos for 13½ hours per day if necessary, there can be no doubt that the River Lossie will at all times supply an abundance of water to illuminate the whole of Elgin, maintaining current for 60 arc lamps for street-lighting and 10,000 8-c.p. lamps installed, with ample reserve. The high-tension current of 5,000 volts generated at the power-house will be conveyed to the town on the three-wire system by aerial conductors. For the preliminary application of the electric light two turbines and two generators would be installed, the power-house having space available for the erection of the third unit at some future time. The aerial conductor could be taken underground at some point near the foot of Grant-street, where a sub-station, a small building, with the necessary instruments, would be required. From this point high and low tension conductors for the distribution system would be laid through the streets. The report concludes with the following suggestions: (1) the introduction of electric light to the city and Royal burgh of Elgin should not be delayed; (2) the source of power should be the River Lossie; (3) a dam should be constructed at the Little Ess, Birnie Rocks: (4) the power-house should be in close proximity to the dam; (5) the dynamos should be of the three-phase alternating-current type, transmitting current at high tension: (6) the electric light works should be constructed and owned by the Municipal Corporation of Elgin. Mr. Duncan, in a recent lecture on his scheme, said: "Elgin can offer many favourable pleas to the Board of Trade in making a request for sanction to lay an aerial conductor from its source of water power to the city. It has been denied the use of electric light because of the expense of coal; it has available water power at a distance of five miles from the town, which it can employ with great advantage and economy, if the most approved methods of generating and transmitting electrical energy are adopted. There was in the River Lossie power enough to light the whole of Elgin. The point in this connection which I wish to impress upon the audience is this: Assume that the rainfall diminishes to such an extent that only 1,630 cubic feet per minute flow down the river instead of the normal volume of 3,063 cubic feet. This diminished volume of water will amount to 2,400,000 cubic feet, or 15,000 000 gallons delivered into the reservoir in 24 hours, sufficient to provide 300 b.h.p. to the generators for 13½ hours every day, a much longer time than the demands for light will warrant."

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## PROVISIONAL PATENTS, 1903.

DEC. 14.

**27399. Improvements in means for separating accumulator plates.** Henry Leitner, Lynton, Dartnell Park, Byfleet, Surrey.

DEC. 15.

**27410. Improvements in and relating to automatic electric circuit breakers and measuring instruments.** Henry William Clothier, 108, Gilda Brook-road, Eccles, Manchester.

**27446. An improved form of mechanical ear for suspending overhead lines or wires, especially for electric traction purposes.** Frederick Rea and Edmund John Reindorp, 9, Wordsworth-avenue, East Ham, London.

**27456. Improvements in electric ignition particularly applicable for internal-combustion engines and the like.** Frederick Henry de Veulle, 18, Hertford-street, Coventry.

**27497. Improvements in devices for lighting gas-burners by electricity.** Arthur McDougall Duckham, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**27505. A new or improved method of testing for grounds and/or short-circuits in electrically-operated cars or trains.** Charles Ashley Carus-Wilson, Norfolk House, Norfolk-street, Strand, London.

**27506. Improvements in dynamo-electric machinery.** Albert Percy Wright and Albert Henry Midgley, Norfolk House, Norfolk-street, Strand, London.

DEC. 16.

**27576. Improvements in magneto-electric igniting apparatus for internal-combustion engines.** Willy Roos, 65, Chancery-lane, London. (Complete specification.)

**27585. An improved casing and holder for electric wires.** Henry James Walker, 55, Chancery-lane, London. (Complete specification.)

**27628. Improved method of and means for resisting fire and electricity.** Edwin Marshall Fox, 45, Southampton-buildings, Chancery-lane, London.

DEC. 17.

**27654. An improved starter and automatic cut-out for electric motors.** Veritys, Limited, and George Owen Donovan, 11, Burlington-chambers, New-street, Birmingham.

**27662. An improved device for attaching the circuit wires to the terminals of electrical apparatus.** Arthur Frederic Guy, Frank Harold Wheeler, and John Alfred Davenport, 10, St. George's-crescent, Liverpool.

**27677. Improvements in or applicable to dynamo-electric machinery.** Felix John Howitt and P. R. Jackson and Co., Limited, 70, Deansgate, Manchester.

**27696. A new or improved galvanic cell.** William Strickland, 70, Chancery-lane, London.

**27712. Improvements in electric glow lamps with metallic filaments.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London, London. (Siemens und Halske Actien Gesellschaft, Germany.) (Complete specification.)

**27722 Improvements in or relating to alternating-current induction motors.** Louis John Hunt and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

**27733. Improvements in and relating to electrically-driven suspended railways.** Thomas Alfred Hearson, 22, Southampton-buildings, Chancery-lane, London. (Adolf Bleichert und Co., Germany.) (Complete specification.)

**27734. Safety device for the switches of electrically-driven suspended railways.** Thomas Alfred Hearson, 22, Southampton-buildings, Chancery-lane, London. (Adolf Bleichert und Co., Germany.) (Complete specification.)

**27736. Improved electrical means for starting prime movers.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Elektrizitäts Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany.) (Complete specification.)

DEC. 18.

**27765. Improvements in trolley heads for electric tramways and light railways.** Fitz-Roy Owen Jonathan Roose, Corporation Electricity Works, Southcote-road, Bournemouth.

**27783. Improvements in or relating to storage batteries or electrical accumulators.** The Romanoff (London) Syndicate, Limited, 139, Queen Victoria-street, London. (Hippolyte de Romanoff, France.)

**27818. Improvements in arc lamps.** Thomas Hamilton-Adams, 4, South-street, Finsbury, London.

**27825. An improved electric lamp particularly for miners' use.** La Société des Accumulateurs Chelin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 3, 1903, being date of application in Belgium.) (Complete specification.)

**27830. Electric bells.** Friedrich Carl Rentsch and Rudolf Schubert, 40, Chancery-lane, London. (Complete specification.)

DEC. 19.

**27865. A new and improved electrical indicator.** David Wells, 48, Dudley-gardens, Leith, Edinburgh.

**27891. Improvements in bearings for electric or other measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**27892. Improvements in brush-holders for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**27893. Improvements in controllers for electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**27894. Improvements in alternating-current dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**27895. Improvements in electric synchronising devices.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**27900. Improvements in selective telephone systems.** Paul Hardegen, 18, Buckingham-street, Strand, London. (Complete specification.)

**27921. Improvements in systems for the automatic control of electric motors.** Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company Incorporated, United States.) (Complete specification.)

**27924. Safety devices for electric railway systems.** George Gibbe, 46, Lincoln's-inn-fields, London. (Complete specification.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 103-108 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 4½-5 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 96-99 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 106-110 |
| —— Ordinary | 5 | .. | 11-12 |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 3 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¾-1¼ |
| —— 5 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1⅜ 1¾ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 98-101 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¾-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 13¼-14¼ |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 19-20 |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | .. | 34-37 |
| —— 5 per cent. Bonds | 100 | .. | 102-105 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 10-11 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 103-106 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10¼-10⅜ |
| —— 7 per cent. Preference | 5 | .. | 9⅜-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 6¼-7⅛ |
| —— Nos. 20,001-30,000 | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 14½ |
| —— " " £10 Ord. | 6 | .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 103-105 |
| Chelsea Electricity Supply | 5 | .. | 5¼-6 |
| —— 4½ per cent. Debentures | 100 | .. | 107-110 |
| City of London, Ordinary | 10 | .. | 10¼-11 |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 123-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 103-106 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 7⅛-8⅛ |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 | .. | 108-111 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | .. | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red | 100 | .. | 95-98 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7⅛-8⅛ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 10¼-11¼ |
| —— per cent. Debenture Stock Red. | 100 | .. | 100-105 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9½-10½ |
| London Electric, Ordinary | 5 | 1½-2½ |
| —— 6 per cent. Pref. | 5 | 5-5½ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 97-100 |
| Metropolitan, Ordinary | 10 | 17-18 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 110-114 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 96-99 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 98-101 |
| —— Preference | 4 | 100 103 |
| Notting Hill Electric Lighting | 10 | 12½-13¾ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 407-14,310 | 5 | 5½-5¾ |
| —— 4 per cent. Debenture Stock | 100 | 98-101 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 10 | 95-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | 95-90 |
| South London, Ordinary | | 3¼-3½ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | 14½-15½ |
| —— 7 per cent. Pref. | 5 | 7½-8½ |
| —— 3½ per cent. Deb. | 100 | 98-101 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4½-5⅜ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4¼-5¼ |
| Westminster, Ordinary | 5 | 12 13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 6-6½ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 93-96 |
| —— 4 per cent. Pref. | 100 | 99-102 |
| —— " " deferred | 100 | 93-96 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 115-118 |
| City and South London, Consolidated Ordinary | 100 | 47-50 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 126-129 |
| —— " " " '96 | 100 | 123-126 |
| —— " " " '01 | 100 | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | 4½-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 | 13¼-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3¼-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 99-104 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 102-104 p.c |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| British Electric Traction, Ord. 1-300,000 & 60,001-80,000 | 10 | 11¼-11⅝ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | 11¼-11⅝ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 2¼-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼-5½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 4¼-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 106-109 |
| —— Prov. Cert., all paid | 100 | 99-102 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 5-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 100 103 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12-13 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | 113-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 92-95 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 11¼-11⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red | 100 | 104-106 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | 5/16-5/16 |
| —— 5 per cent. Cum Pref., 500,001-814,016 | 1 | ⅛-1¼ |
| New General Traction, Ordinary | 5 | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | 89 94 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 100 103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8¾-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 101-103 |
| —— Deferred Stock | 100 | 77 80 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 13-14 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 96 98 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 102-104 |
| Oriental Telephone and Electric Company | 1 | 1 1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1903. | 1902. | Week. | Current year. | 1903. | 1902. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 26 | 1,174 | 901 | + 237 | + 6,559 | 19½ | 17½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | Nov. 21 | 170 | 166 | + 4 | + 52 | 8 | 6 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | Dec. 26 | 4,970 | 5,126 | − 156 | + 9,879 | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 28 | 1,012 | 886 | + 126 | + 1,270 | 24 | 24 | March 25 | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 24 | 287 | 305 | − 18 | − 159 | 17½ | 16½ | ,, 31 | 211,168 | 6,169,121 | 781,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Tramways | ,, 26 | 226 | 227 | − 1 | − 101 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 27 | 1 834 | 1,678 | + 206 | + 8,435 | 38 | 25 | March 31 | 85,704 | 17,761,605 | 1,896,247 | 1 15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 23 | 873 | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 13 | 3,321 | 2,935 | + 386 | +16,546 | 41 | — | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 27 | 872 | 953 | − 91 | + 2,633 | 6½ | — | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 25 | 5,314 | 5,265 | + 49 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 26 | 1,019 | 788 | + 229 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 27 | 350 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 26 | 2,135 | 1,829 | + 306 | +21,453 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | Nov. 23 | 158 | 124 | + 34 | + 721 | — | — | ,, 31 | — | 2,216,583 | 320,129 | — | — | — | — |
| Central London Railway | Dec. 26 | 6,412 | 6,135 | + 277 | − 5,782 | 6 | — | ,, 31 | 367,225 | 45,305,110 | 1,276,971 | 1·87 | 66·6 | 59,076 | 35·6 |
| City and South London Railway | ,, 27 | 2,979 | 3,143 | − 164 | − 10,302 | 6¾ | — | ,, 31 | 165,003 | 19,069,319 | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 24 | 482 | 487 | − 4 | − 3,375 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 25 | 269 | 273 | − 4 | − 239 | 7·23 | — | March 31 | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 26 | 177 | 204 | − 27 | + 48 | 3 | — | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Railway | ,, 20 | 96 | 86 | + 10 | + 191 | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 159 | 7·68 |
| Dublin U. T., electric cars | ,, 25 | 4,300 | 4,183 | + 117 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06 |
| Dublin S. District, Electric | ,, 25 | 875 | 837 | + 2 | | | | | | | | | | | |
| Dundee City Tramways | ,, 16 | 786 | 748 | + 38 | — | 22 | 22 | May 15 | 35,074 | 9,024,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 26 | 643 | 586 | + 57 | + 7,997 | 10 75 | 7·52 | March 31 | 25,341 | 9,371,337 | 690,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | ,, 9 | 128 | 119 | + 9 | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 26 | 13,497 | 12,472 | + 9 5 | +32,310 | 124 | 101 | May 31 | 656,542 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 | 7·40 |
| Halifax Corporation | ,, 1 | 2,693 | 1,882 | + 2 0 | + 5,741 | 30½ | 27½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 26 | 1,175 | 1,2 4 | − 29 | — | 34 | 35 | March 31 | 56,631 | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 25 | 2,318 | 2,056 | + 261 | + 4,615 | 19 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 17 | 114 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 23 | 201 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 26 | 5,425 | 5,383 | + 42 | +13,051 | 77 | — | March 25 | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 19 | 9,753 | 9 599 | + 154 | +17 275 | 101 | 96 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 27 | 1,561 | 1,411 | + 150 | + 2,857 | 15½ | 15¼ | June 30 | 79,252 | 10,466,726 | 986,185 | 1·82 | 19·30 | 5,110 | — |
| London County Council | Nov. 22 | 9,105 | 6,227 | +2,878 | +63,348 | 40 | 26 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Dec. 15 | 134 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 28 | 126 | — | — | — | 3 | — | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corporation | ,, 25 | 3,997 | 3,462 | + 535 | — | 33½ | 36 | March 25 | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 1 | 1,374 | 1,248 | + 125 | + 4,618 | 29 | 29 | Sept. 30 | 47,651 | 9,158,137 | 862,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 28 | 128 | 127 | + 1 | — | 4½ | — | March 31 | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 24 | 477 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 28 | 4,034 | 3,196 | + 838 | +43,309 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 27 | 4,763 | — | — | — | 53½ | 46¼ | Mar. 25 | 216,769 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 24 | 977 | 864 | + 113 | — | 11 | 11 | ,, 31 | 35,874 | 9 083,522 | 752,814 | 0 946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 27 | 1,208 | 1,238 | − 30 | + 2,150 | 18·48 | 17·18 | ,, 31 | 59,330 | 13,987,121 | 1,270,957 | 1 03 | 11·3 | 3,243 | 6·43 |
| Wallasey U.D.C. | ,, 26 | 638 | 594 | + 43 | + 3,441 | 10 5 | 10·5 | ,, 31 | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,535 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures

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## ELECTRICAL SPEED INDICATORS—SOME UNSUCCESSFUL ATTEMPTS.

BY A. S. CUBITT.

A short time ago attention was called to the advantages of making public any unsuccessful experimental work, both with the idea of calling attention to the difficulties which beset the path of the experimenter, and also to save later workers the necessity of finding out by unhappy experience the unfeasibility of working on certain apparently hopeful lines. With this idea in view, a description of certain experimental and proposed forms of speed indicator which have been devised by the author, and which have been up to the present more or less unsuccessful for reasons which will be stated, may be of interest. Some of the earlier attempts were crude in the extreme, and never proceeded very far even in the experimental stage, but it will be noted that all through one special principle has been adhered to in the main. One of the earliest attempts consisted in interposing a make and break in a circuit comprising an ammeter, a battery, and a resistance, but, as might be expected, it was found that beyond a very small range the value of the current remained stationary for all speeds owing to the fact that the duration of the contact varied inversely as the number of contacts per second, so that the average duration of contact per second remained the same.

It was very apparent that to operate a speed indicator on this principle it would be necessary that the apparatus must be so arranged that the amount of energy imparted

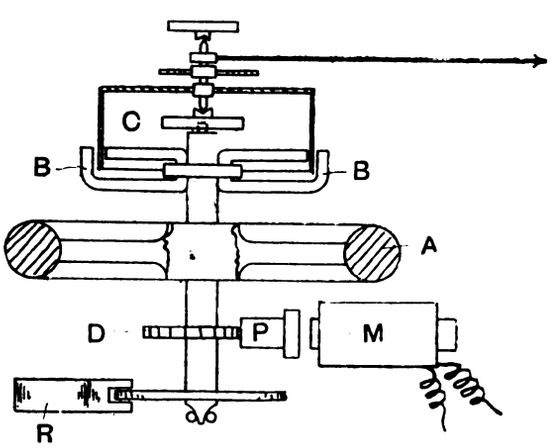


FIG. 1.

to the moving part of the indicator per contact, *or its equivalent*, must remain a constant. With this idea in mind a mechanical model embodying this principle was devised and built, and proved the correctness of this theory. Mechanical considerations, however, rendered this impracticable, as may be seen. Referring to Fig. 1, a flywheel was constructed and pivoted on ball bearings so as to revolve very easily. To this flywheel was attached a set of magnets, B B, designed when revolving to impart a torque to a copper cylinder, C, embraced by them, this torque being proportional to the speed at which the magnets revolved. To the lower part of the flywheel was attached a ratchet wheel, D, and a copper brake disc revolving between the poles of a magnet, R. The ratchet wheel was arranged to be operated as a pawl, which was normally held clear, but which could be pulled into place by a magnet, M, and which when let go would by means of the spring attached to it impart an impulse to the flywheel. Now, assuming that the amount of energy imparted to the flywheel per kick remains constant, the greater the number of kicks per second the greater the energy imparted to the flywheel and the greater the speed. If a copper brake disc were attached to the flywheel, the speed attained would be proportional to the energy imparted—*i.e.*, to the number of kicks per second. With a simple contact on the transmitter a speed of flywheel proportioned to the speed of the transmitter contact could be obtained, and a means of indicating the speed by indicating the torque in the copper cylinder secured. It was found, however, that owing to the fact—which had been overlooked—that the energy imparted per kick was dependent on the speed of the flywheel at any moment, falling off as the speed went up, the speed curve turned over very quickly, and cut down the range of the instrument very greatly. By substituting for the copper brake disc a hysteresis brake having a practically constant back torque independent of speed, the curve was straightened out and a fairly satisfactory instrument attained. Owing to the very high speeds necessary to operate steadily, the life of the instrument was barely 24 hours, and on purely mechanical considerations was abandoned.

At this time the principle of imparting energy to the moving part of the indicator at a rate proportional to the speed to be indicated was shelved for a time, as the difficulties due to the variation of the pressure on tramways—for which purpose the instrument was destined—were considered too great, and experiments were made on a very different type of instrument. A pair of magnets were mounted on a frame which was geared to the axle of the car whose speed it was required to indicate, and this frame and magnets caused to revolve at a speed proportional to the speed of the car. These magnets, which were very powerful, embraced a copper disc controlled by a stiff spring. This disc, under the action of the rotating magnets, took up different positions according to the speed, and, by means of a small arm, made contact on one or other of a series of small contacts connected respectively to a set of electromagnets arranged radially in a cast-iron case forming the indicator. A soft-iron needle pointed to the

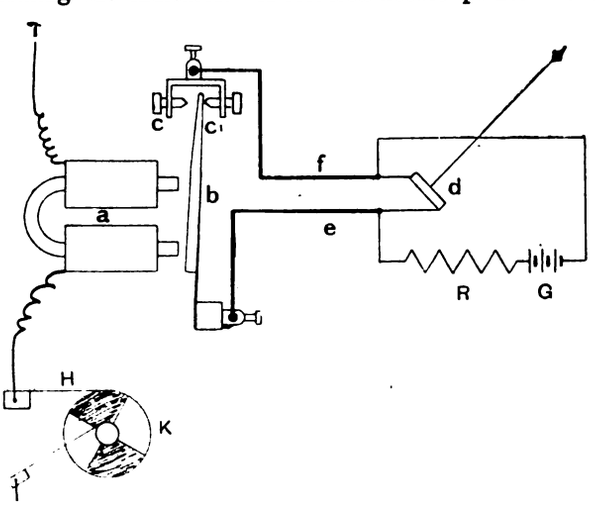


FIG. 2.

electromagnet excited and carried a pointer indicating the speed corresponding. The disadvantages of this instrument were, amongst others, the unreliability of the contacts, the number of wires required, the possible errors of indicating due to the few points available, the method of operating requiring a large torque in order to allow the friction of the moving contact to cut a small enough figure.

After some minor experiments the original principle above referred to was returned to, this time with greater success. After many disappointing experiments it was concluded that a reliable contact, giving a duration of contact independent of the number of contacts per second, was impracticable, it being assumed that this style of contact, *or its equivalent*, was necessary to give the desired result. In order to obtain this result an entirely novel idea was evolved, which had the merit of being extremely simple. Referring to Fig. 2, it will be seen that an auxiliary circuit, comprising a battery, a resistance, and an indicating ammeter, was required. The terminals, *f*, *e*, of the moving coil of the instrument, *d*—in the experiments a Weston milliammeter—were connected by thick wires to the armature, *b*, and the contact screws, $c\,c_1$, so that normally the moving coil was short-circuited and the current flowing through the circuit was directed through the armature, *b*. The battery, G, provided a source of current which was kept to a low value by means of the resistance, R. On the axle whose speed it was required to indicate was placed a contact, K, on which rested a brush, H, and the circuit was so arranged that on revolving the contact, K, the armature, *b*, would be oscillated between

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the stops, $c\ c_1$, at a rate proportional to the speed of the contact, K. The time, however, taken to move the armature from $c_1$ to $c$ or back would be a constant (the electromagnet being designed to be saturated at voltage below the normal) so that the time the circuit, $e$, $b$, $c$, $f$, was open each oscillation would be a constant. During this period the current would be free to flow through $d$, and this would receive a definite impulse. This moving coil was weighted so as to have a considerable mass, and the result was that it took up a definite position corresponding at any time to the number of impulses per second, and, therefore, to the speed required to be measured. This instrument proved quite satisfactory in laboratory operation, but the difficulties of keeping the current constant and the wear of the contacts, $c\ c_1$, made it unsuitable for practical use. Subsequent experiments evolved a method of doing away with the battery, and by making the contacts of hard steel the wear was sensibly diminished, but as the experiments leading up to these improvements were made on a more suitable type of instrument—which will be described later—no further description will be necessary here.

Whilst experimenting with this instrument with a view to stop the sparking at the contact, K H, which was made in the 500-volt circuit, a high-resistance shunt was connected across K H. This, whilst it considerably lessened

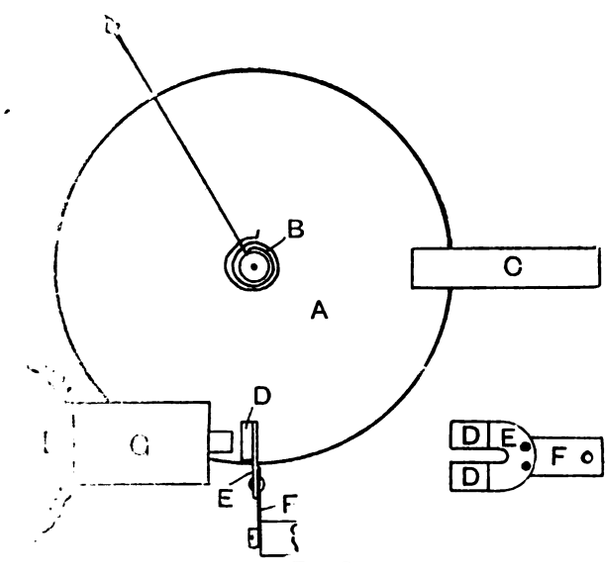


FIG. 3.

the sparking, had the effect of preventing the armature being released when the speed exceeded a certain amount, and the observation of the naturally expected fact, that a considerably less current was required to hold the armature in place than to pull it over, led to the evolution of a novel type of instrument, embodying features which are not to be met in any other type of apparatus. For want of a better name, the principle of this instrument may be described as an "electromagnet ratchet." A reference to Fig. 3 will make this principle clear. A copper disc, A, was pivoted in the centre and constrained to remain in the zero position as shown by the spring, B, the movements of this disc was damped by means of the magnet, C. Embracing the disc was the armature, D D, made in two halves, connected by a non-magnetic bridge piece, E. This armature was kept in a definite position with regard to the disc by means of the spring, F. An electromagnet, G, was so placed that the armature, D D, formed part of this magnetic circuit, leaving a gap of about $\frac{3}{16}$in. between its pole-pieces and the armature, D D. This instrument was actuated by means of a simple make and break on the axle.

The operation was as follows: The electromagnet, G, was connected in series with a resistance and with the contact on the axle, and was supplied with current from the trolley wire. In order that the magnetic flux should be practically constant during any changes in the voltage of the circuit, the electromagnet was so designed that its core would be saturated at the lowest anticipated voltage. When the circuit was made, the armature, D D, was attracted and moved over to the pole-pieces. This movement did not take place, however, until the magnetic flux had risen to a fairly high value, and it will be noted that the whole of this flux had to pass through the portion of the copper disc which laid between the two halves of the armature, D D. Thus, when this armature moved over, it exerted a torque on the copper disc by virtue of the eddy currents generated, and moved the disc slightly forward. When the circuit through G was broken, the armature, D D, returned to its initial position by means of the spring, F. This, however, did not happen until the flux had died down to a minimum value, owing to the reduction of the air-gap, so that the torque exerted on the copper disc during the backward motion was very small compared with that exerted during the forward motion. The distance, therefore, that the disc moved back was less than the distance the armature moved back in proportion to the time interval between the successive movements of the armature—that is to say, in proportion to the speed at which the contact on the axle was being made and broken. The result was that the disc was projected forward by the impulses piling one on the other until such a time as the tension on the spring, B, was great enough to constrain the disc to move backwards at the same speed that it moved forward during one impulse—that is to say, until the pseudo torque imparted by the vibrating armature to the copper disc, A, was equal to the torque upon the spring, B. From this it is clear that for every speed of oscillation of the armature, D D, a corresponding definite angular position of the copper disc, A, with regard to its initial position would be found, and by means of a suitable pointer attached the instrument could be calibrated to read direct in miles per hour.

A full-sized working model of this instrument was built, and it was found that the operation followed exactly the lines anticipated, but, owing to the very small movement of the armature, the resultant torque was not great enough

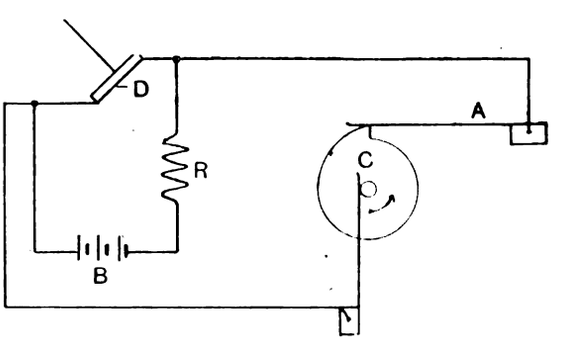


FIG 4.

to be of any commercial value. In order to increase this torque it was found necessary to use as many as four armatures operating on the same disc, which made the instrument too bulky and complicated to be put forward as a practical instrument. Attempts were made to increase the torque by using an iron disc, and although this was slightly more satisfactory, yet its behaviour did not warrant its commercial production. Incidentally it was found that if the armature was allowed to come into mechanical contact with the disc, an apparently satisfactory instrument was obtained with an exceedingly large torque, and an instrument which, moreover, seemed to be perfectly reliable during the short time the trials lasted. But it was anticipated that it would not be possible to make an instrument on these lines which would stand the vibration which such an instrument would have to undergo, and which could be relied on as to its indications as soon as any appreciable wear had taken place.

Some time after this instrument was built a patent was taken out by two gentlemen well known to the author, involving this very principle, and which appeared experimentally to be very satisfactory. This has since been dropped, however, on the same grounds of unreliable operation after any wear had taken place.

During these experiments a very interesting phenomenon was noticed with regard to the curious behaviour of some sheet aluminium in a rapidly changing magnetic field. The bridge piece referred to, as connecting the two parts of the armature, was made of aluminium, and it was found that as soon as the armature was started, oscillating curious fern-

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like shapes seemed to grow out from the metal, in a similar manner to that which has been observed when aluminium comes in contact with metallic mercury. A reason for this was never found out, and it would be interesting perhaps to someone with time to spare to investigate this.

Earlier in this article we referred to a method of doing away with the battery used with the type of instruments in which the moving coil of the indicating ammeter was short-circuited during part of the time the instrument was in use. The instrument about to be described was the one referred to, and it will be seen that the means used to render the indicators independent of any change of voltage will be equally applicable to either types. Referring to Fig 4, D is the moving coil of a Weston type ammeter of very low capacity, B is a couple of cells of storage battery, R is the resistance. The coil, D, is normally short-circuited through the spring contact, A, resting on the cam, C, so that there is practically no current flowing through the coil, D. If the cam, C, is revolved in the direction indicated by the arrow, the spring, A, will rise to the highest part of the cam, as is shown, and then drop down again to the lowest. The time taken to make this drop will be the same whatever the number of times this happens in any given time, and with each drop of this spring the short-circuit of the moving coil, D, will be opened, and therefore current will be free to flow through this coil. We have, therefore, a definite impulse imparted to it in each revolution of the cam, C, and if the moving coil is considerably weighted as before, in order to give it a definite mass, it will be found that for each speed of the revolution of the cam, C, a definite resultant torque will be imparted to the coil, D, due

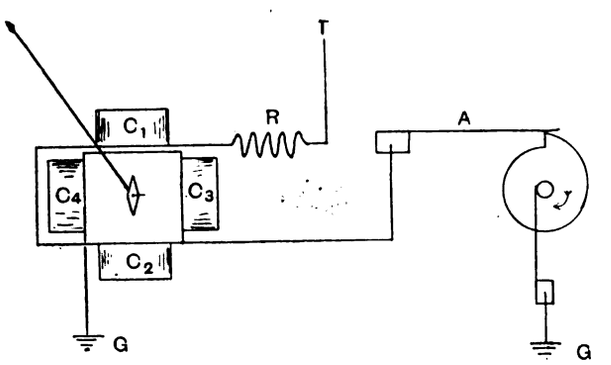


FIG. 5.

to the piling up of the impulses, somewhat in the same manner as in the foregoing instrument. This was the first idea of this method of operation, and in the experiments made it was found that this form of contact was absolutely reliable, provided it was made of sufficiently hardened steel, and provided also that the spring, A, was sufficiently hard and under constant tension, and that all parts in contact at any time were properly cleaned and polished.

In order to overcome the necessity of using the storage battery, or any other external source of energy other than the trolley current, an instrument was devised as shown in Fig. 5. In this instrument, in place of the Weston type ammeter, an instrument of the ratio galvanometer type was used, containing two pairs of coils, $C_1$, $C_2$, $C_3$, $C_4$, and a soft-iron armature, D, of small section. These coils were connected up, as shown in the figure, between the trolley wire, T, and ground together with the resistance, R. One terminal of $C_3$ was connected to the spring, A, as shown, the cam being grounded. It will be seen from an inspection of this diagram that as long as the cam is still the pair of coils, $C_3$ $C_4$, are short-circuited, so that the magnetic field will lie straight across from $C_1$ to $C_2$, and the soft-iron armature will lie across this path, and a pointer attached to this will indicate the zero position. Now, as the cam, G, is rotated for a short period during each revolution, current will be allowed to flow through the coil, $C_3$ $C_4$, and will rise in proportion to the number of revolutions of the cam during any given period of time, and, following a well-known law, the resultant field due to $C_3$ $C_4$, and $C_1$ $C_2$, will take up an angular position whose tangent is equal to the ratio of the strength of the two fields due to $C_3$ $C_4$, and $C_1$ $C_2$. Now, as the strength of the field $C_1$ $C_2$ (assuming constant voltage) has a steady value, this ratio will be in proportion to the strength of the field $C_3$ $C_4$—that is, to the speed of revolution of the cam. If the impressed voltage changes in any way, it changes equally in both sets of coils—that is to say, the ratio of the two currents, and, therefore, of the two magnetic fields, remains the same, so that the indicating instruments are absolutely independent of the impressed voltage, provided that it does not fall to such a low value that the soft-iron armature, D, is not saturated. As this, however, happens at a very low value, the section of iron being very small, for all practical ranges this instrument will be independent of changes of voltage. It will be noted, however, that the cam, C (Fig. 4), is only capable of rotation in one direction.

Fig. 6 shows a form of cam which was devised, which is capable of rotating in either direction. In this case the single cam is replaced by a double cam, C, having similar upper and lower faces, and a diagonal channel connecting them. When the cam revolves in the direction shown by the arrow, the spring, A, rises to the highest point on the upper surface and then falls to the lowest point on the upper surface, the operation being similar to that which takes place with the cam shown on Figs. 4 and 5. If, however, the direction of rotation is reversed, the spring, A, passes through the diagonal slot to the lower surface of the cam, which is similar to the upper surface, but which operates in the opposite direction. Thus the operation of this cam is similar for either direction of rotation, provided the free position of the spring, A, lies in the mid position of the diagonal slot in the cam. It may be mentioned that this type of instrument should not really have been included in the scope of this article, as it promises to be fairly successful in operation. The fact, however, that the instruments which have been described, and which fall strictly within the heading of this article, suggested its conception, led to its being included. This only amongst

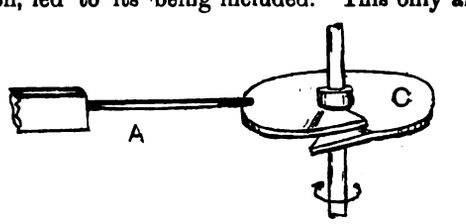


FIG. 6.

the instruments which have been mentioned is covered by patents, although several of the other instruments have been patented at one time or another, and have since been abandoned.

In response to a request from some instrument makers to attempt to devise a speed indicator suitable for use with motor cycles, motorcars, etc., an instrument was devised after the following lines: The principle of this instrument depends on the measurement of the torque required to drive a fan at varying speeds. In the model first built the method of operation consisted in allowing the frame of a small clock gear which was driven by means of a pulley at the speed it was required to indicate, to be moved against the tension of a spring by means of the back torque of a fan connected to one of the gear wheels.

In another form of instrument the motion was communicated to the fan through a simple dynamometer, this being a form of the well-known differential gear. The centre wheel of this gear was constrained to remain in a definite zero position by a spring, the angular change from this position being an indication of the power transmitted—that is to say, of the speed of the fan. An instrument of this sort is so dead beat that, provided a sufficiently elastic shaft is interposed, it can be driven by means of a ratchet motion actuated by an electromagnet, and yet give a fairly steady indication. Owing to want of time and opportunity, nothing further has been done with this instrument, and should our readers consider it worth while, they are at perfect liberty to follow it up.

The foregoing examples are a few of the most important of the experiments which have been made by the author during the last five years, and we hope they will have proved of interest.

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## THE SLOW REGISTRATION OF RAPID PHENOMENA BY STROBOGRAPHIC METHODS.*

### The "Ondographe" and the "Puissancegraphe" (Wave Recorder and Power Recorder).

BY E. HOSPITALIER, FOREIGN MEMBER

*(Concluded from page 935, Vol. XXXII.)*

B. STROBOGRAPHS.

*Ondograph.*—The ondograph belongs to the class of strobographs. The latter name is applied to all forms of apparatus employed to record phenomena (whether rapidly or slowly variable), if they utilise the principle of the stroboscope or of successive phases. The strobographs are the result of an evolution of which M. Joubert's "point method" constitutes the origin and the ondograph the latest development. The object of the ondograph is to inscribe or to register directly upon a band of paper, by means of ink, the representative curves of periodically and rapidly variable electrical phenomena (E.M.F.'s, currents, differences of potential, power, etc.). In principle it is based upon a combination of Joubert's method of successive points, stroboscopic methods, and electrical recording apparatus. Fig. 1 shows the general arrangement of the actual apparatus as made by the Compagnie pour la Fabrication des Compteurs et Matériel d'usines a Gaz. It comprises as essential parts: (1) A synchronous single-phase alternate-current motor actuated directly by the source of electrical energy of which the

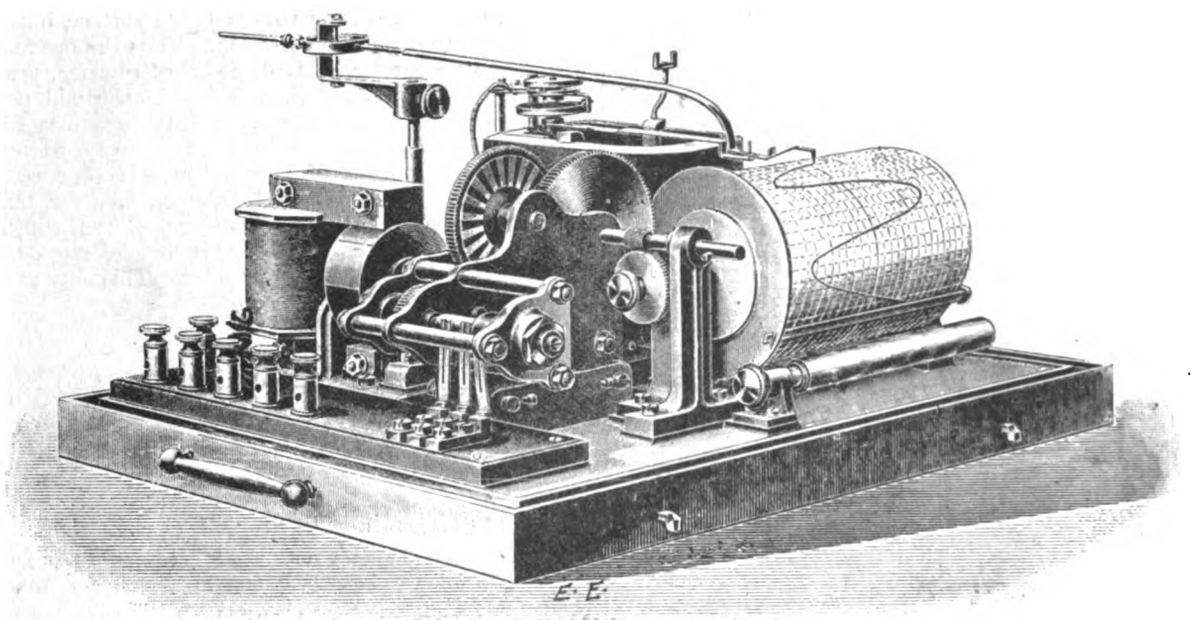

FIG. 1.—General View of the Ondograph.

periodically variable elements are to be recorded. (2) A train of gearing, of which the object is to impart to a revolving contact maker or commutator such an angular velocity that when the motor has made a certain number of revolutions the commutator will have made an equal number (or a multiple), increased or diminished by 1. This retardation or acceleration, which is essential to the system, obviates the necessity of rotating the brushes of the motor. (3) A contact maker or automatic commutator, consisting of a cylindrical block of insulating material carrying a tube of brass suitably cut to shape, with *three* brushes resting upon it. The object of this device is to put a condenser successively in connection with: (*a*) two points in the circuit in which the variable periodic phenomena to be recorded take place; (*b*) a measuring apparatus. During the first operation the condenser becomes charged, and is discharged through the measuring apparatus in the second. For the power curve the contact maker is reduced to a simple conducting bar which, once in each revolution and by means of two brushes, closes the circuit through the fine-wire bobbin of the recording apparatus. Fig. 2 shows the connections of the apparatus in the case in which a condenser is used. (4) A condenser, of which the capacity may be either constant or regulated at will by means of plugs, in order to regulate the sensitiveness of the apparatus. (5) A recording measuring apparatus, suitable to the phenomenon to be examined. For differences of potential and currents, the recorder is a moving-coil instrument of the Meylan type, mounted horizontally. For power curves, the recorder is an ordinary wattmeter; the main current passes continuously through the fixed primary bobbin, whilst the movable fine-wire bobbin is placed in the circuit which is periodically connected by the rotating contact maker to the difference of potential which determines the second factor of the power. Regulation is effected by introducing resistances into the fine-wire circuit (see below, under "Power Recorder"). The direct method may also be applied equally well to the registration of differences of potential or currents, and in this case the use of the condenser is dispensed with. The condenser, however, offers distinct practical advantages in regard both to regulation and sensitiveness. So, also, the wattmeter may be used for recording the curves of potential differences, if a constant current from a battery of accumulators is passed through its fixed coils. In all the above cases the moving part of the recording apparatus receives a series of impulses, the frequency of which is equal to that of the current to be registered. The moving coil has a moment of inertia and damping so calculated that its position at any moment is that which it would be caused to take by the action of the mean current corresponding to the quantity of electricity passing through it during a single period. (6) A recorder, either cylindrical or continuous, driven at a convenient speed directly by the synchronous motor. The record is traced by means of a pen. The four-pole synchronous motor runs with a potential difference of 110 volts at frequencies ranging from 25 to 100 periods per second. The motor is started up by means of hand gearing, and when synchronised is thrown into circuit. The precise moment at which the current should be switched on is determined by the stroboscopic effect of the apparent stoppage of a disc revolving with the motor, and carrying a suitable number of black and white sectors painted alternately. After the motor has been started the hand gearing is disengaged automatically by an arrangement similar to that adopted for use in automobiles. The motor actuates the commutator by a train of gearing so combined that when the motor has made $\frac{n}{2}$ revolutions, corresponding to $n$ periods, the commutator will have made only $\frac{n-1}{2}$ revolutions, with a regular and uniform retardation. The recording cylinder makes one complete revolution for every three periods. Each of the three curves registered corresponds to 1,000 periods and 999 impulses. One complete period takes up a length of 96mm. on the cylinder. The amplitude may be made to vary at will between 10mm. and 50mm. by altering the potential difference and the capacity.

The ondograph allows the frequency of an alternating current to be determined with accuracy. To effect this it is only necessary to determine by means of a chronometer the time occupied by the recording cylinder in making one complete revolution. As this time corresponds to 3,000 periods, this number divided by the duration of one complete revolution in seconds gives the frequency in periods per second. Fig. 3 is a plan of an ondograph, drawn to a scale of one-fifth, showing the arrangement of the apparatus. Fig. 4 shows on a one-third scale the case containing the accessories—viz., long pointer, stand, handle, red and black ink, oil, achohol for cleaning the pen, spare pen, paper, etc. In most recording instruments in which direct tracing is effected, it is necessary to reduce the length of the pointer that carries the pen in order that the friction of the pen on the paper may not sensibly falsify the record. The use of a short pointer in the ordinary way, necessitated by the smallness of the directing force and the friction of the pen, gives rise to several inconveniences: (1) The curvilinear ordinates have a relatively short

* Paper read before the Institution of Electrical Engineers, Dec. 10.

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ratio of curvature, and the curve recorded, therefore, is subject to a deformation that is often troublesome. (2) The curvilinear trajectory of the pen prevents it from accurately touching with equal accuracy at every point of the recording cylinder, of which, if the radius were infinite, it should describe a generatrix. Under these conditions a pen correctly regulated only records by points in certain positions, presses strongly upon the paper in other positions, and, again, does not rest upon the paper at all in positions corresponding to the longest ordinates. (3) The arm

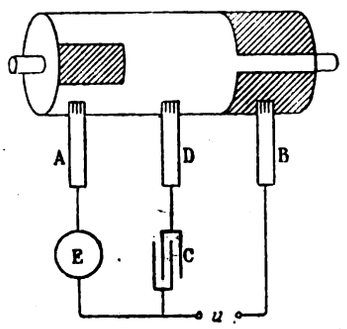


FIG. 2

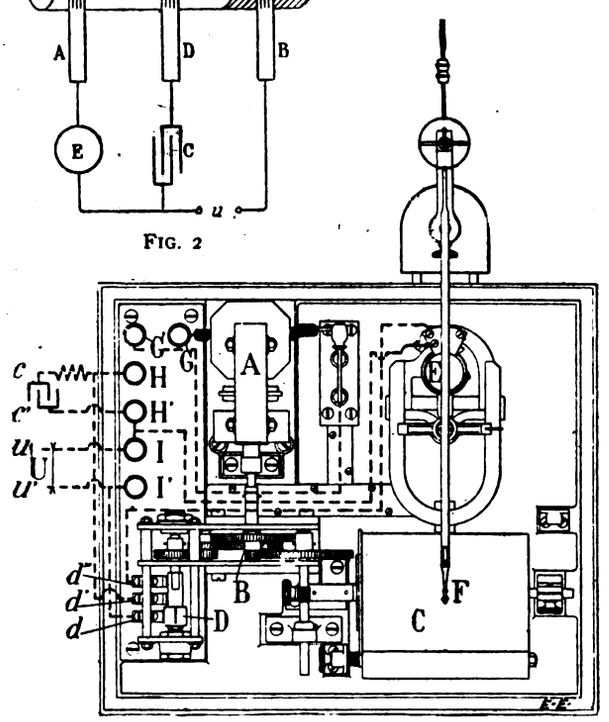


FIG. 3.—Plan of the Ondograph.

carrying the pen should be both rigid to enable its direction to be controlled well, and flexible to facilitate its record; it is difficult to combine these two opposite qualities in the same mechanism.

In order in a large measure, to reduce these difficulties, the author has adopted an arrangement which consists in principle in the separation of the mechanisms for guiding the operator and for recording, without impairing their capability of joint action; and in obtaining, with a guiding system of short radius, a record in which the radius of the ordinates is so great that the record approaches sensibly to that which would be afforded by a registering pointer of which the pen would describe an arc of a circle having an infinite radius. The recording apparatus comprises two distinct parts—the directing arm and the recording pen. The former is a rigid lever attached to the measuring apparatus, with the extremity the more remote from the axis of rotation terminating in a pin which works in a groove provided upon the lever carrying the pen. This pin, during the recording process, describes the path that would be taken by the pen of an ordinary recording instrument during the rotation of the cylinder carrying the paper. The recording pen consists of a lever of great length, so arranged that one of its extremities turns upon an axis parallel to that of the recording instrument, but removed from it by a distance approximately equal to the difference in the lengths of the two levers. The other extremity is provided with a groove engaging with the pin of the directing arm, and carries the recording pen at a point a little beyond the groove. In the actual ondograph the directing arm is 18cm. long, whilst the lever carrying the pen is double this length—namely, 36cm. It will be understood from this that whilst the pin describes an arc of a circle with a short radius, the pen describes one of long radius. By giving sufficient length to the lever the arc may, within the limits of the width of the cylinder, coincide sensibly with the tangent at the middle point of the arc. Thus, the point of contact of the pen with the paper is but very slightly removed from a generatrix of the cylinder, and the registration is effected with perfect regularity throughout the whole extent of the cylinder. The pen and its lever can, therefore, be proportioned so as to satisfy all the necessary conditions as to flexibility and regulation of the recording mechanism, and of this part of the

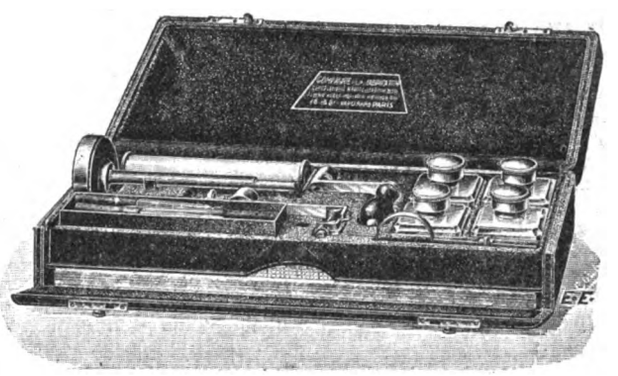

FIG. 4.—Case containing the Accessories of the Ondograph.

apparatus only, since the pen is directed by another mechanism to which in turn it is easy to impart all the rigidity necessary to fulfil this function satisfactorily. The lever is attached at its point of support by a Cardan joint, which allows the pen to move freely and to exert upon the paper a constant pressure regulated by its own weight, in part counterbalanced by a screw counterpoise movable at will. The vertical axis allows for the movement caused by the directing arm, whilst the horizontal axis permits the slight vertical displacement resulting from that of the pen moving over the recording cylinder. The curve is thus inscribed almost exactly on the generatrix of the cylinder, and the pen, which acts independently and is easily regulated, is not liable to fail in its record. The ondograph may also be used to study rectified or continuous currents. To accomplish this the synchronous motor is replaced by a direct drive, effected by establishing an unyielding mechanical coupling between the ondograph and the shaft of the machine to be studied. The apparatus has been designed with a view to facilitating and expediting the work of removing or replacing the motor; the motor having been removed a flexible shaft is placed in position with one of its ends attached to the ondograph, and the other upon the machine under examination.

*Non-Periodic Phenomena.*—The application of the ondograph, or, speaking more generally, of stroboscopic methods, is not limited to periodic phenomena. It can be extended to all phenomena of short duration, provided that the phenomenon can be reproduced identically in such a manner that it is periodic by repetition. By way of example, reference may be made to the curve of discharge of a condenser through a self-induction, a discharge which is of an oscillatory character. The duration of each semi-oscillation is about 1/400th of a second. By means of the differential movement ondograph, permitting

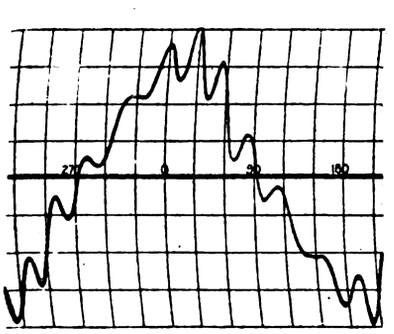


FIG. 5 (Half-scale).—Alternator working on Cable Mains.
Kilowatts = 220
Amperes = 110
Cos $\phi$ = 0·66

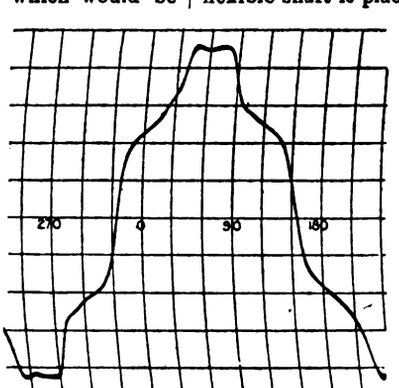


FIG. 6 (Half-scale)—Berlin (Siemens & Halske) old Alternator, November 7, 1903

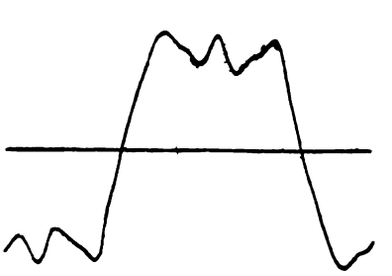

FIG. 7 (Half-scale). — Three-phase Oerlikon Inductor Alternator; with two slots per period per phase, and laminated pole-pieces.

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the retardation at will of the period recorded, it is easy to register phenomena occupying from 1/2 000th to 1/3,000th of a second, obtaining the record by means of a pen upon a strip of paper—a result which has never hitherto been obtained.

*Differential Ondograph.*—In the apparatus which the author has just described, the slip or retardation which allows of the registration of the curve bears a fixed relation to the frequency of the phenomena to be recorded. It is characterised by the number 1,000 in all the apparatus made by the Compagnie pour la Fabrication des Compteurs. That is to say, when the frequency is 25 per second, the record is effected in 40 seconds ($25 \times 40 = 1{,}000$); when the frequency is 50 per second, the record requires 20 seconds ($50 \times 20 = 1{,}000$), and so on. The recording cylinder, of which the circumference is 288 mm., corresponds to three periods, each occupying 96mm. along the axis of time. In a new type, which is styled the differential ondograph, in order to indicate the principle upon which it is based, the period of registration is no longer connected directly with the frequency. On the contrary, it is entirely independent, and, further, the drum registers only two periods, so that each of them is 144mm. long. This increase of the axis of time facilitates the determination of the phase difference between the different curves representing the characteristic factors of the phenomenon recorded. The apparatus still consists of a synchronous motor and a commutator, arranged coaxially, and between them is a differential gear, the crown of which is rotated around the axis common to the motor and commutator by means of an endless screw, turned more or less rapidly by hand. The shaft carrying this endless screw is also provided with a second endless screw, which rotates the recording cylinder with an equal angular velocity. Under these conditions, remembering the well-known properties of the differential gearing, it will be understood that if the crown is stationary the motor will drive the commutator at

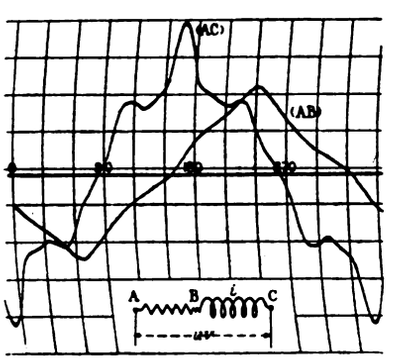


FIG. 8 (Half-scale).—Monocyclic Alternator working on a Self-induction.
(A C) Difference of Potential.
(A B) Current in the Self-induction.

synchronism. If the crown be subjected to a displacement in either direction, the commutator will be accelerated or retarded accordingly in proportion to the amount of this displacement. The apparatus is so arranged that the direction of rotation suitable to recording upon the drum produces retardation. This retardation will correspond to one complete revolution of the commutator—that is, to one period—for each half-revolution of the crown and each half-turn of the recording drum. By the time that the crown of the differential gear has completed one revolution the commutator will have suffered a retardation equal to two revolutions, and the recording cylinder will have made one turn, and in doing so will have recorded two periods. As the slip of the contact and the retardation of the drum are controlled by hand, the record of a single period may be produced as slowly as may be required without being correlated with the frequency of the phenomenon under examination. It is possible to dispense with hand control by employing either an auxiliary motor driven electrically, or by means of a spring, or by using direct control by means of gearing, or a series of stepped pulleys by which different speeds may be obtained by the shifting of a cord which passes over two of the corresponding pulleys. This type of ondograph does not, in the author's view, lend itself for industrial use, but is rather an instrument for use in the laboratory or for research. The author has employed it in studying commutation in continuous-current dynamos in such a way that he could follow the smallest variations—variations for which the period traced with 999 points for 1,000 periods did not afford a sufficient approximation.

*Puissancegraphe (Power Recorder).*—The author has applied the principle of the ondograph in designing the apparatus, which is intended to trace direct the curve of the instantaneous value of the power expended in a circuit, and to which he has given the name of the "puissancegraphe." In order to trace the curve of the instantaneous power supplied in any circuit by means of the ondograph, a Thomson meter used as a wattmeter is substituted for the moving-coil galvanometer. The spindle of the meter is controlled by two special springs, which act as conductors through which the current flows in and out of the movable armature, thus avoiding the use of brushes. The main current traverses the fixed coils, and the movable fine-wire coil is connected by means of the commutator and the brushes as a shunt to the potential difference determining the power to be measured, for a very brief interval, once during each period. For this purpose the rotating commutator consists of an ebonite cylinder, in which is embedded along a generatrix a plain strip of brass of suitable width. The duration of contact is governed by the width of the strip. It may be modified at will by shifting the points of contact of the two brushes with the strip. The regulation of the period of contact allows of a change in the sensitiveness of the apparatus, an effect which may also be obtained by introducing a variable resistance into the fine-wire circuit of the wattmeter. The coil, under the influence of the successive impulses which it receives from the intermittent currents passing through it and from the main alternating current, is deflected from its position of equilibrium through an angle proportionate to the power of each instant of the period determined by the position of the commutator; either directly or indirectly the coil guides the pen of the recorder. This proportionately results from the fact that the angle described by the moving coil around its position of equilibrium never exceeds from 10deg. to 12 deg. on either side of zero. Under these conditions the drum-wound armature of the wattmeter may be considered as having suffered no practical displacement as far as electro-dynamic forces are concerned. The aluminium damping disc of the meter serves to give to the system the inertia and damping neces-

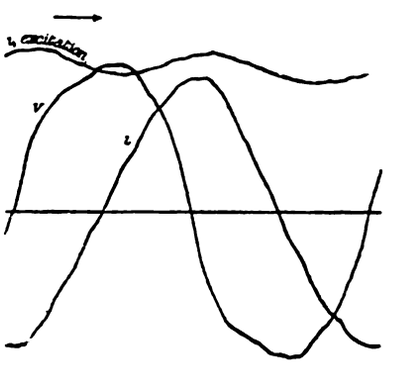


FIG. 9 (Half-scale)—Siemens Alternator (armature without iron) supplying an inductive circuit:—
Potential-difference ($v$) = 112 volts; current ($i$) = 16 amperes.
Self-induction (air-core) = 0·0175 henry; resistance = 0·6 ohm.
Frequency = 50 ∿ per second.
Machine excited from accumulators without any resistance in series:—
Exciting current = 2·3 amperes; resistance of circuit = 0·4 ohm.

sary to the normal working of the apparatus. This normal working corresponds on the one hand to the critical damping, and on the other hand to the time of oscillation of the armature, being comprised between the periodic time of the phenomenon to be recorded and the time occupied in recording a complete period. The "puissancegraphe" has enabled the author to obtain on the same sheet of paper curves showing the instantaneous values of the potential difference, and the current and also their product—the instantaneous power—in an alternating circuit. This was accomplished as follows. It has been shown that the "puissancegraphe" traces out the instantaneous power by joining (for a very short time during each period) the potential difference to the moving coil of a wattmeter, the fixed coil of which is traversed by the alternating current. The impulse is proportional to the product, $v\,i$, of the difference of potential at that instant, $v$, multiplied by the instantaneous value current, $i$, and the instrument traces the curve of instantaneous power. In order to trace the curve of $i$, it is sufficient to connect the commutator to a constant potential difference, V. The impulses are then proportional to $V\,i$, or, that is, to $i$, since V is constant. To obtain the curve $v$, a constant current from one or two accumulator cells is passed through the fixed coils, and the commutator is connected to the difference of alternating potential, $v$. The impulse is then proportional to $I\,v$—that is, to $v$—since I is constant. The ondograph is especially useful to manufacturers of dynamos, motors, and transformers; to alternating-current generating stations; to makers of high-tension cables, to whom it is important to know the wave-form of the alternating current to which their cables will be subjected; and to technical schools, to research and teaching laboratories, as it renders visible at a glance many facts of which the explanation is often both difficult and troublesome.

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APPLICATIONS OF THE ONDOGRAPH.

In order that this communication may not be unduly prolonged, we will at once proceed to a description of some of the uses to which the ondograph has been put with the object of studying or of improving the working conditions of apparatus designed for the production and distribution of electric energy.

FIG. 10 (Scale 1 1).—Difference of potential between the terminals of a two-phase Alioth Rotary Converter on open circuit. Secteur de Neuilly. Curve repeated five times

*Alternators.*—Alternators should, in principle, give a sine curve, or approximately a sine curve, as free as possible from higher harmonics, so as to avoid those resonance effects which are so prejudicial to cables. The curves reproduced in Figs. 5 to 8 prove that this is far from being the case. Some of them show the influence of the shape of the pole-pieces, which introduce the third and fourth harmonics, whilst others exhibit the effect of the teeth. A careful study of these curves makes it possible so to alter either the pole-pieces or the number or shape of the teeth that these objectionable distortions are greatly reduced. These curves are, of course, of an exceptional shape, and selected mainly for illustration of the registering qualities of the ondograph.

*Reaction of the Alternating Current on the Excitation.*—It is well known that the armature current in an alternator reacts on the field and produces in it a varied magnetisation, with a frequency double that of the alternator. This effect is exhibited in Fig. 9, which shows the potential difference between the terminals of a Siemens alternator with an iron-less armature, when working on an inductive circuit and producing a current with a lag of about one quarter of a period. The wavy line, representing the exciting current, would be straight were it not for the reaction of the armature. This effect becomes more pronounced with an increasing lag of the current behind the E.M.F. of the alternator.

*Rotary Converter.*—Fig. 10 shows the variation in the difference of potential between the terminals of a two-phase rotary converter. This curve has been repeated five times to demonstrate that the small changes caused by hunting do not alter the general appearance of the curve.

*The Synchronous Motor of the Ondograph.*—This little motor works as a variable self-induction motor having a very large difference of phase, well shown in Fig. 11, which gives the difference of potential, $v$, and the current, $i$, at each instant.

*Brush Machine.*—The current given by a very old Brush machine is shown in Fig. 12, which was obtained by driving the ondograph direct from the machine with the aid of a flexible shaft. This figure exhibits the amplitude of the variations in the E.M.F. caused by the passage of each elementary coil under the pole-tips. The machine was supplying arc lamps.

*The Determination and Recording of Harmonics.*—It may be admitted in principle that an alternating wave-form contains all the odd harmonics with larger or smaller amplitudes, and zero amplitude for those that are absent. The first problem to be solved consists, therefore, in discovering the order of the highest harmonic present. Calling the pulsation of the fundamental wave $\omega$ ($\omega = 2\pi$ frequency), and the order of the harmonic $n$, it is required to determine $n$—that is to say, to discover the order of the highest harmonic.

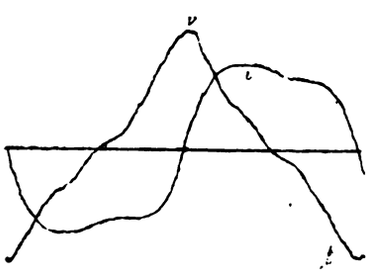


FIG. 11 (Half-scale).—Potential-difference ($v$) and Current ($i$) Wave-forms of the Ondograph Synchronous Motor.

FIG. 12 (Half-scale). — Current given by Brush Machine supplying Arc-lamps

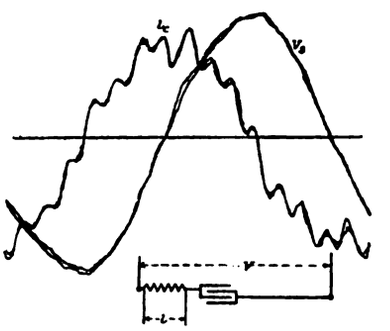


FIG. 13 (Half-scale).—Charging of a Condenser :—
Capacity = 16 microfarads.
Potential-difference = 110 volts.
Resistance in circuit = 20 ohms.

*Determination.*—The author employs two methods, the one based on the properties of a circuit having capacity, the other on those of an inductive circuit.

*Capacity Method.*—As large a capacity as possible is connected to the periodic potential difference to be analysed, and the curve of the charging current of the condenser is recorded by connecting the ondograph to the terminals of a non-inductive resistance included in the circuit through which flows the charging current of the condenser. This resistance should be as small as possible. Designating the effective (r.m.s.) difference of potential corresponding to the $n$-th harmonic, $V_n$, the corresponding effective current, $I_n$, for this harmonic may be expressed thus :

$$I_n = n \omega C V_n .$$

Hence, by this method, the $n$-th harmonic is magnified in proportion to its order $n$, and an indented curve is obtained in which the number of teeth indicates the order of the highest harmonic with the greatest clearness. Fig. 13 for example, shows very clearly the discovery of the fifteenth harmonic in the Secteur de la Rive gauche, a harmonic that the sinusoidal looking potential difference would not have enabled one to predict.

*Self-Induction Method.*—A circuit formed of a highly inductive coil, having as long a time constant as possible, and a non-

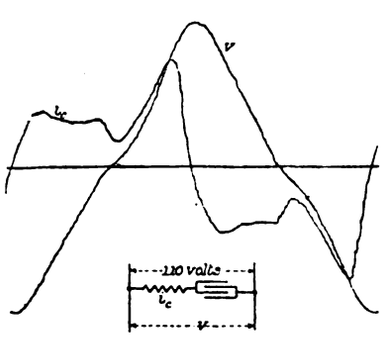


FIG. 14 (Half-scale)—Charging of a Condenser (Zipernowsky machine, without slots) :—
Capacity = 16 microfarads.
Potential-difference = 110 volts
Resistance in circuit = 20 ohms

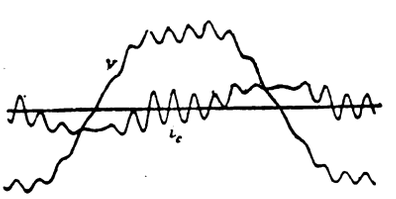


FIG. 15 (Half-scale).—Labour Alternator old type), with 18 teeth per cycle, Ring.
Potential-difference between the terminals ($v$) = 95 volts.
Capacity current = $i_c$.
Capacity = 3·5 microfarads.
Resistance in circuit = 50 ohms.

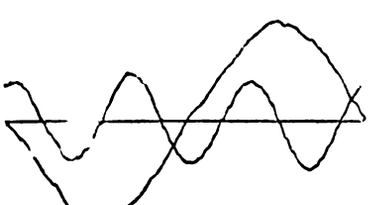

FIG. 16 (Half-scale).—Resonance of Third Harmonic :—
Capacity = 2·45 microfarads.
Resistance = 6 ohms.
Self-induction = 0·76 henry.
Frequency = 40·4 ∿ per second

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inductive resistance, is connected to the terminals of the difference of potential to be analysed. The difference of potential, $V_s$, between the terminals of the inductive coil may be approximately expressed as follows, if its resistance may be neglected as compared with its self-induction:

$$V_s = n\,\omega\,.\,L\,.\,I.$$

By using the ondograph to record the instantaneous values of the potential difference between the terminals of the self-induction, an indented curve is obtained analogous to that given by the charging current of the condenser, and the order of the highest harmonic is readily deduced from this curve.

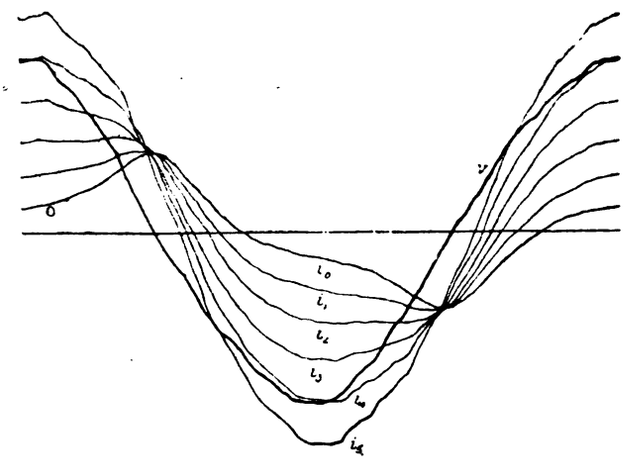

FIG. 17. (Scale 1 : 1).—Gaulard Transformer.

*Record.*—When the order $n$ of the highest harmonic is once known, it is easy to trace the fundamental wave and all the harmonics with their several amplitudes, actual or enlarged, in a given proportion, as well as their difference of phase relative to the curve under analysis. The method employed by the author is that given by Prof. Pupin in 1894. It consists in forming a resonating circuit for each of the harmonics, using the recognised relation

$$n^2\omega^2\,L\,C = 1,$$

with a variable condenser and capacity connected in series and as a shunt to the difference of potential to be analysed. If the resistance, R, of this circuit is sufficiently low, when resonance is obtained for a harmonic of the order $n$, the impedance offered by the circuit to all the other harmonics is considerable, and the current passing through the circuit is exactly due to the $n$-th harmonic, defined by the relations

$$V_n = R\,I_n\,;\ \tan\phi = 0.$$

With an ondograph that has been calibrated beforehand, the instantaneous values of $I_n$ can be recorded, and from them $V_n$ may be deduced. In order to make sure of the resonance of the harmonic, a determination is made of the theoretical value that must be given to the product, L C, corresponding to the frequency; L and C are then added to satisfy this; finally, L and C are varied slowly in the neighbourhood of the theoretical value, until a thermal ampere-meter placed in the resonating circuit indicates the maximum current. With the aid of the ondograph this resonance is confirmed by the amplitude and regularity of the sinusoidal curve, a curve which becomes deformed by the interference of the next harmonic. To show the lower harmonics, of which the amplitude is usually sufficiently great, the ondograph may be connected to the terminals of a non-inductive resistance placed in the resonating circuit. The curve traced by the ondograph is in phase with the harmonic. The sensitiveness would not be sufficient for higher harmonics of small amplitude. It is therefore augmented by means of a device which consists in recording the difference of potential between the terminals of the self-induction instead of between those of a resistance placed in the circuit. Under these conditions a much greater potential difference is obtained, and the curve traced by the ondograph shows a difference of phase in advance from the actual harmonic to an extent defined by the relation,

$$\tan\phi = \frac{n\,\omega\,.\,L}{R}.$$

In practice, $n\,\omega\,L$ being very large and R comparatively small, tan $\phi$ is also very large, and the curve recorded is thrown out of phase, showing a lead of a quarter of a period. It is, therefore, important to keep this phenomenon in mind when it is desired to reconstruct the fundamental curve synthetically. It would also be possible to obtain a record of the higher harmonics by connecting the ondograph between the terminals of a capacity, in which case the curve traced would show a lag of a quarter of a period. It is, however, preferable to connect the instrument between the terminals of the self-induction in order to avoid the sparking at the brushes of the apparatus at the moment when the measuring capacity is shunted upon the resonating capacity, which charges it too suddenly. Figs. 13, 14, and 15 relate to the determination of the highest harmonics of a difference of alternating potential by means of the charging current of a condenser connected to that difference of potential. It will be seen from Fig. 14 that only the third and fifth harmonics are present, whereas the curve shows the fifteenth harmonic. Fig. 16 shows the third harmonic resonated, and so accentuated.

*Transformers.*—Fig. 17 illustrates the variations in the primary current of a Gaulard transformer, of which the secondary is connected through a gradually diminishing non-inductive resistance. The successive curves show the increase in the primary current accompanying the increase of charge in the secondary, as well as the diminution in the difference of phase. Fig. 18 relates to an iron-less transformer; $v_1$ is the difference of potential acting on the primary circuit; $i_1$ is the primary current rendered almost completely sinusoidal by the influence of self-induction; $v_2$ is the potential difference between the terminals of the secondary or open circuit in opposition to the potential difference of the primary.

*Electrolytic Rectifier.*—Fig. 19 refers to a Nodon valve arranged as a Wheatstone's bridge and working on a circuit consisting of a simple resistance. $v$ is the difference of alternating potential supplied to the valve, and $i$ the rectified current supplied by it. Fig. 20 relates to a valve feeding a circuit consisting of a battery of accumulators. Curve 1 is the primary potential difference, and Curve 2 the primary current. Curve 3 is the secondary current as rectified, whilst Curve 4 is the potential difference between the terminals of the accumulators during the charge. From this it will be seen that charging takes place twice during each period. It would be easy to multiply the number of curves showing the application of the ondograph to the study of the Wehnelt interrupter, the continuous-current arc, rectifiers, the oscillatory charge and discharge of condensers, polyphase currents, the simultaneous record of potential difference, current, and power in an alternating circuit, etc. The author's collection of curves obtained during the last two years embraces specimens referring to all the above applications, but those which are here reproduced suffice to indicate the wide scope of the instrument, and it would be an encroachment upon the hospitality of the *Journal* of the Institution of Electrical Engineers to increase still further the number of the reproductions.

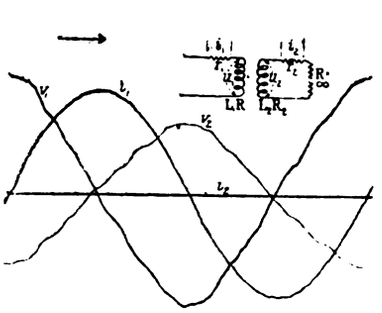

FIG. 18 (Half-scale).—Study of an Iron-less Transformer.

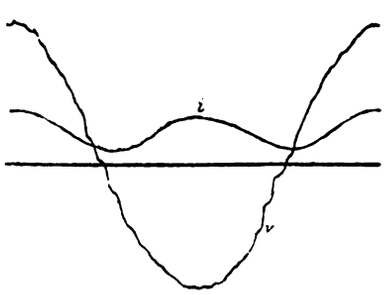

FIG. 19 (Half-scale). — Electrolytic Rectifier, connected up as a Wheatstone Bridge, supplying current to a resistance. Supplied by Secteur Rive Gauche.

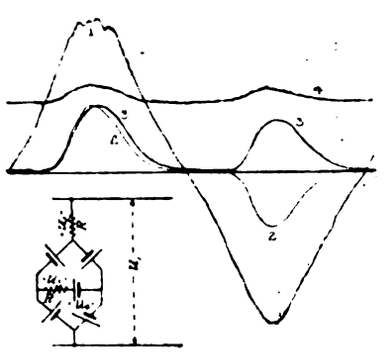

FIG. 20 (Half-scale).—Nodon Valve connected up as a Wheatstone Bridge, charging accumulators.
1 = Potential-difference of supply.
2 = Current.
3 = Current, rectified
4 = Potential-difference of accumulators.
r.m.s. current = 11 amperes.
Mean current rectified = 6 amperes.

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## NOTES.

**Telephonic Communication with France.**—The French Government has approved the convention concluded in July, 1902, between France and Great Britain for the better regulation of the telephonic services between the two countries.

**Electrical Iron Smelting.**—Advices from Canada state that the Canadian Government is looking into the subject of the electrical smelting of iron, and is sending a commissioner to Europe to study the subject. Canada has many valuable iron ore deposits in the vicinity of large water powers which could be utilised for generating a cheap supply of electrical energy.

**Royal Institution.**—The Friday evening discourse on Jan. 15 at the above institution will be delivered by Lord Rayleigh, his subject being "Shadows"; on Jan. 22 the address will be by the Rev. W. Sidgreaves, on "Spectroscopic Studies of Astrophysical Problems at Stonyhurst College Observatory"; and on Jan. 29 the discourse will be by Mr. D. G. Hogarth on "The Marshes of the Nile Delta."

**Conference of Teachers.**—A three-day conference of teachers in technical institutes was opened yesterday under the auspices of the Technical Education Board for London, at the South-Western Polytechnic, Chelsea. A very full programme has been arranged, which includes an address by Mr. W. Hibbert, A.M.I.E.E., on "New Apparatus for the Teaching of Electricity and Magnetism," which he will deliver at the afternoon meeting to-morrow (Saturday) at two o'clock.

**West Indian Cable Communication.**—The West India Committee have called the attention of the Colonial Secretary to the further interruptions in the West Indian cable communication which occurred on Dec. 21 and 28 last, cutting off St. Kitts, Antigua, Dominica, St. Vincent, and Barbados. At any time, they say, this would be a serious matter, but it is especially so at the present moment, when the reaping of the sugar crop is about to begin, and it is of the utmost importance that the estates proprietors should be fully informed as to the course of the sugar markets.

**German Submarine Cables.**—The first part of the new German Atlantic cable between Borkum and New York has been completed, thus fulfilling the conditions under which the German Government placed the German Atlantic Telegraph Company in regard to the laying of the cable. The section completed is that between Borkum and the Azores. Under the agreement between the Government and the company the latter will receive a sum of £35,700. The second part of the cable between the Azores and New York, which will complete the line, is to be laid by the end of the current year.

**An Electric "Charger."** — We understand that Messrs. Baldwin and Co. have recently introduced at their ironworks at Newport, Mon., an electric "charger" for feeding the furnaces, which is said to be the second of its kind used in this country. Only meagre details are available, but it seems that the charger is mounted on a sort of motor-car, which runs on rails along the front of the furnaces, and that the action of the machine is controlled by electricity. With it a furnace is filled with 30 tons of material in about 40 minutes with the attention of only two men, whereas previously, with hand labour, it took more than four hours to do the same amount of work.

**St. Marylebone Electric Light.** — Pending the verdict of the ratepayers at the public meeting to be held on the 19th inst., matters in regard to the St. Marylebone purchase are at a standstill. The Bill which the Council propose to promote in the ensuing session must receive the consent of the majority of the ratepayers before it can proceed, and from the present appearance of things it is not at all certain that such consent will be given. At all events the Council have summoned a special meeting for the 21st—two days after the public meeting—when a resolution will be submitted confirming the propriety of the promotion of the parliamentary Bill.

**Electric Pumps in South Africa.**—A remarkable instance of the durability of electric pumps is reported from South Africa, where, in the mining districts, electricity and compressed air are fighting for supremacy. It was after the cessation of hostilities that the two shafts of the Knights Deep mine were found to be flooded out. The plant and other apparatus had been left just as they were before the war broke out, and the electric pumps and cables which were used at the mine had been under water for quite 2½ years. Notwithstanding, the motors were brought out, dried, and set to work again. The firm who supplied the motors is not mentioned, but their name deserves to be placed on record.

**Education of Engineer Apprentices.**—The subject of the technical education and general training of youths entering engineering works is ably discussed in the report which has been published by the Educational Committee of the North-East Coast Institution of Engineers, and which we gave in full in our last issue. The recommendations therein made are sound in principle, and should meet with a ready welcome from all engineering firms in this country. The institution is taking the necessary steps to bring the report to the notice of the various engineering and shipbuilding firms in North-East England. We trust it will meet with the earnest consideration it merits, and that the recommendations will be accepted by these firms.

**Lodge - Muirhead Wireless Telegraphy.** — We hear that the system of wireless telegraphy which is the joint invention of Sir Oliver Lodge and Dr. Alexander Muirhead, has been the subject of some exhaustive experiments by the War Office during the past six months. The results obtained are said to have fully satisfied the Government experts, who have declared the system to be a reliable method of signalling without lines. The Indian Government, who have made independent tests of the system, have, we understand, decided on an installation being made for establishing communication between Port Blair, in Andaman Islands, and the Diamond Island, at the mouth of the Irawaddy, a distance of 300 miles, the apparatus for which will shortly be sent out.

**New Book.**—"The Law Relating to Motorcars," by H. Langford Lewis and W. Haldane Porter (Butterworth and Co., Temple Bar). 2s. 6d. Appropriately enough, the authors issue the second edition of their book coincidently with the coming into force of the new Act relating to motorcars. The Hon. Rupert Guinness in a short prefatory note expresses the conviction that the new Act, if reasonably interpreted, will not, at the present stage of motorcar development, work any serious injury either to the industry or to motorists. Meanwhile the motorist needs a plain guide amid the intricacies of the law, and this Messrs. Lewis and Porter have succeeded in giving him in the present book, a valuable feature of which is a comprehensive list of decided cases which clearly lay down the law relating to motorcars.

**Indian Telegraph Extension.**—In July last the construction was commenced of a special telegraph line between Darjiling and the British camp at Khambajong, Tibet, a distance of about 160 miles, and the line was

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completed in September. Mr. F. B. McMahon was in charge of the work, and it appears from an account which has been published that the working party suffered much from exposure to heavy rains at high altitudes, and the line was carried through dense jungle in the face of extraordinary difficulties. The maximum height reached was at Subebe La, where the posts were placed at an altitude of over 17,500ft. This is the highest point to which a telegraph wire has ever been carried, and the Indian Telegraph Department also holds the world's record for the distance above sea-level of a telegraph station, Khambajong being about 15,700ft. high.

**Application of Electricity to Mining.**—Articles by M. Emile Guarini have recently been appearing in the *Engineering Magazine* on the subject of "Electric Power Appliances in Mines," and in closing his remarks on this very interesting subject the writer instances two cases showing the economy resulting from the adoption of electricity, and these should be carefully noted by all interested in the question. M. Guarini says: "Prior to the introduction of electricity the Burma ruby mines were unable to make any dividends, the expense of the operation being too high. Since its adoption the expenses have been reduced by the sum of £6,000 per annum, permitting the payment of profits; and at the Sheba mine the economy in operating expenses since the introduction of electric power in 1896 has amounted to £10,000 per annum." The power equipment for both the Burma ruby mines and the Sheba gold mines was supplied by Messrs. Johnson and Phillips, of Old Charlton, who have made a speciality of transmission of electric power in mining.

**Test of Westinghouse Turbine.**—Our American contemporaries report the results of an economy test of a 1,250-kw. Westinghouse steam-turbine generating set built at Pittsburg for the Interborough Rapid Transit power-house. The net results showed a steam consumption of 15lb. per electrical horse-power with 27in. of vacuum, and 14½lb. with 28in. of vacuum. The barometer reading was 30in. Dry saturated steam was delivered to the turbine throttle at 150lb. gauge pressure. At the close of the test the automatic safety stop, with which all Westinghouse turbines are now equipped, was tested by holding down the governor lever so that the speed of the turbine was uncontrolled. The turbine accelerated its speed immediately, and just before the rate of speed reached 10 per cent. above the normal rate the safety stop automatically released and shut off the steam supply. This was followed by a test for regulation under extreme conditions, the full load being thrown on and off instantaneously several times. The variation in the speed of the unit between no load and full load, as indicated by the change in tone of the note given out by the generator, was barely perceptible.

**Electricity on an Ocean Liner.**—The new White Star liner "Baltic," which is to make her maiden voyage across the Atlantic in the summer, is probably better equipped electrically than any other boat either afloat or building. In addition to the usual electrical appliances to be found on board present-day ocean liners, the "Baltic" is equipped with an electrical device for preventing collisions with other vessels. The moment another ship enters the "magnetic field" of the "Baltic" the needle of the indicating instrument points in the direction of the vessel approaching or being overtaken, and the steersman knows at once what course to take. Even the rhythmic beats of an unseen steamer's screws are registered by means of this delicate apparatus. Another safeguard is an electrical contrivance to show if the ship's lights are burning properly. An electric log for ascertaining the speed of the ship is another acquisition, and an electric lead for ascertaining the depth of the water is also on the list. There is, further, an electric device for registering all signals, including steam sirens. The "Baltic" is equipped with electric refrigerating as well as electric cooking apparatus.

**Reinstatement of Pavements.** — Amongst the many departments of municipal work in which profits may be made is one to which attention is not often called. We refer to the charges made by local authorities for the reinstatement of pavements after companies have opened them up for various purposes. The majority of the metropolitan borough councils have schedule rates for this work, which are, as a rule, equitable when only a small stretch of pavement is disturbed. Whenever a long length has to be broken up and renewed these rates become excessive, and we are aware of instances in which 200 and 300 per cent. profit has been made by the local authorities. This profit is not shown in the accounts, and can be used by the surveyor's department to cover excess expenditure on other work. We notice that the matter has recently been taken up by the Postmaster-General with the St. Marylebone Council. As a result of a letter expressing the hope that the Council would see their way to reduce their charges for this work, a report was prepared by the borough accountant on the question of the difference between the prices charged for the work and the actual cost of doing it. The committee who had the report prepared have now agreed, subject to the approval of the Council, that the present charges be reduced by 10 per cent. We trust that public companies will receive equally favourable consideration from the councils in the future, but have not much hope that this will be the case.

**The Giesel Emanation Body.**—In a note recently read before the German Physical Society, E. Goldstein presents the results of his experiments on the Giesel emanation body. This body, recently derived from pitchblende, seems to be related to cerium as to its chemical character; it shows emanation phenomena to a very high degree. On account of the small penetration power of this emanation, the author presumed that air would itself exert a strong absorption on the latter, so that its effects would be augmented in exhausted tubes. This hypothesis is borne out by the experiments recorded in the present communication. As regards the question whether the observed luminescence is due either to a gas or simply to a special form of energy issuing from the substance, the experiments of the author seem to be in favour of the latter hypothesis. When cooling exhausted tubes where the active matter had been introduced by means of liquid air, the author observed a very strong luminescence of the wall. This luminescence, so far from arising in the coldest portions of the wall immersed in liquid air, seems to be confined to a zone immediately above the level of the liquid air. This phenomenon is thus characteristic of a definite temperature above the temperature of liquid air. The author next states that the emanation is given off even at the temperature of liquid air; he does not think the emanation energy in question to be identical with that of radium, the mean distinguishing feature being the absence of a coloration of the tubes, and, second, the excessively low penetration observed.

**Radium in Bath Waters.**—The interesting discovery has been made that radium exists in the mineral waters for which the city of Bath is famous. A few weeks ago Prof. Dewar found from an analysis of the gases that arose in the largest of the hot mineral springs at the King's Bath that the rare element helium was present, and a further examination of the deposit from the new Royal Spring has revealed the existence of radium. The discovery

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was made by the Hon. R. J. Strutt, son of Lord Rayleigh, who, in a communication to the Bath City Council, says he has found that the deposit contains radium in appreciable quantities, though not enough to pay for extraction. The letter continues: "It will be remembered that the gas which bubbles up from the springs contains a small proportion of helium. Sir William Ramsay has recently made the most important discovery that radium slowly evolves helium by a spontaneous change. I think there can be little doubt that the helium of Bath owes its origin to large quantities of radium at a great depth below the earth's surface. A little of this radium is carried up by the rush of hot water, and is found in the deposit. When I speak of 'appreciable quantities' of radium I mean quantities such that its presence may pretty easily be detected. But the percentage of radium in the deposit is very much less than that in the ores which are at present used to obtain it from. The reason why the presence of radium is so easily detected, in spite of the smallness of the proportion present, is that the tests are exceedingly sensitive—indeed, the only reason why so small a proportion of radium could be detected was the unique and extraordinary properties of that substance."

**Electrification of the Inner Circle.**—When the London Tube Railway Bills were before the Select Committees of Parliament, counsel both for the Yerkes group and the Pierpoint Morgan interests gave ample pledges on behalf of their clients that all material required in connection with the work should be purchased in this country. Had the members of the committees shown proper caution, they would have requested the promoters of the Bills to bring forward a clause that might be embodied in the Bills making it binding on the companies to carry out the sentimental intentions so ably turned to account by their learned counsel. We are led to this reflection by the disappointing news that the Underground Railway Company, controlled by Mr. Yerkes, has recently placed a large order for rubber cables abroad apparently for no reason other than cheapness. The specification to which the manufacturers were asked to tender was a document drawn up by a man who no doubt had a good all-round knowledge of electric railway practice, but consequently could not have a first-class experience of the difficulties and peculiarities of the indiarubber business. It is not surprising, therefore, to find that there was considerable latitude open to manufacturers in quoting, and we cannot help thinking that under the circumstances the order ought to have been placed in this country. The point will doubtless be made good use of in future by some of those who may not see eye to eye with Mr. Yerkes when next he appears before the parliamentary committees. We very much doubt whether foreign manufacturers can supply any rubber cable that is likely to be so durable under the ever-changing conditions of this country as that which our own manufacturers can supply.

**Reduction of Metals and Alloys.**—It has been frequently found by experimenters that when an oxide of a metal, whose temperatures of reduction and volatilisation are nearly the same, is mixed with sufficient carbon to combine with the oxygen, and heated to the temperature of reduction, the main resulting product is not the metal which is wanted, but a carbide. The reason is thought to be that the metal becomes volatile as soon as it is formed and combines with free carbon present in the mixture. In a patent granted to Mr. F. J. Tone, engineer of the Carborundum Company, of Niagara Falls, and described in the *Electrical World*, these disadvantages are overcome by maintaining proper conditions of temperature, proper distribution of heat, and proper arrangements of the charge. The method may be described by its application to the production of silicon for a mixture of silica and carbon. The constituents are finally subdivided and thoroughly mixed, and the design of the furnace is such that the discharge of heat is over a wide zone (as opposed to localised heat), so that the progress of the reaction is relatively slow and the best conditions are maintained for agglomerating the particles. The most even temperature possible is maintained throughout the zone of reaction, to prevent the silicon from being volatilised as soon as formed, and the charge is so arranged in the furnace as to allow globules of reduced silicon to drop by gravity out of the zone of reaction to a lower portion of the furnace. It is evident that for these purposes an arc furnace would be unsuitable. Mr. Tone therefore employs a resistance furnace. The heating resistance in the centre of the furnace is made up of carbon blocks piled together with intervening spaces. The charge is fed into the furnace at the top, and as the silicon is reduced it sinks down into the cooler portion of the furnace, and finally into the receptacles at the bottom, where it solidifies as a metallic block.

**A New Submarine.**—The United States have lately added to their service fleet a submarine boat which is built on quite novel lines. It is the invention of a Mr. Lake, and is known by his name. The new boat has been put through her trials with extremely satisfactory results, and it is believed that she represents a marked advance on previous types. Primarily the boat is driven by two 125-h.p. four-cylinder White and Middleton gasoline engines which employ electric ignition. These are located in the rear of the boat, and directly back of each is a 50-h.p. shunt-wound Diehl electric motor, which is connected to the engine on one side and to the propeller shaft on the other through friction clutches. Ordinarily, the engine is started by the motor, after which the clutch operating the propeller is thrown in and the brushes are lifted from the motor commutator if a long run is to be made. If the battery need recharging, this can be done while the boat is running by altering the pitch of the screws, thus driving the boat more slowly and using the surplus power to run the motors as dynamos and allow them to recharge the battery. This consists of 60 cells of the Gould type, weighing 75,895lb., and capable of furnishing 1,680 amperes, or 85½ h.p., for three hours, which gives the craft a radius when submerged of 18 to 20 miles. By means of a special valve in the top of the sighting hood, which supplies air for the motors, it is possible to run on the engines till this hood is nearly submerged; and by placing a similar valve in the end of the omniscope, the inventor hopes that he will eventually succeed in being able to use the engines for propulsion when all but a short length of the tube is submerged. This would make it possible to creep up quite close to an enemy under engine propulsion and only use the electric motors for the very end of the approach, when about to torpedo the objective. Some illustrations of the new submarine are given in the *Scientific American*, from which it seems that the inventor has placed four guide wheels at the bottom of the boat, two forward and two aft. The object of these is that when the boat is close in shore under water she shall not touch bottom herself. The wheels are operated by hydraulic rams, and besides easing the shock when bottom is reached, they enable the boat to run along the sand, driven, of course, by her propellers.

**Behaviour of Unattachable Anodes.**—Following is an abstract of a paper by Messrs. R. Luther and F. J. Brislee given in the current number of the *Journal* of the Chemical Society: When in an electrolytic cell containing hydrochloric acid a gradually increasing anode potential

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difference is applied, the current strength after its first rise remains constant for an interval, subsequently increasing again. According to earlier workers, the existence of such a horizontal part in the P.D. current curve means that the ion primarily concerned in the electrolysis is exhausted. In the experiments carried out by the authors, the Cl′ ions cannot have been exhausted, and they suggest that there is probably something else in the solution, which is in equilibrium with the Cl′ ions, and primarily liberated at the anode, and to the exhaustion of which is due the constant value ($i_{lim}$) of the current strength. The experiments described show that $i_{lim}$ is proportional to the second power of the Cl′ concentration, and to account for this the authors assume the existence of an ion $Cl_2''$. The condition and previous history, however, of the platinum anode is an all-important factor. When the anode P.D., after a gradual increase, is gradually diminished, without break of current, the corresponding variation of the current strength is not always that given by the first P.D. current curve. The current strength may fall away rapidly almost to zero, the electrode having become 'passive.' If, while the electrode is still passive, the P.D. is again increased, the horizontal position of the P.D. current curve cannot now be obtained. This passive condition is due to a superficial change of the platinum anode, and has nothing to do with the solution. It disappears immediately if the current is broken, and if the anode P.D. is allowed to fall below 1·6 volts, a passive electrode becomes spontaneously active. Further, if the change of P.D. is reversed before $i_{lim}$ is reached, the passive condition does not set in. The authors can thus distinguish three states of the platinum surface. The production of the passive condition does not depend on the presence of Cl′ ions, but begins in acid solutions at about 1·9 volts and vanishes at about 1·6 volts. The evolution of chlorine in hydrochloric acid solution at 1·66 volts is secondary, for it is possible, when anodes of carbon or iridium are used, to obtain P.D. current curves of quite different form. Iridium does not exhibit the passivity spoken of above.

**The Cauvery Falls Power Plant.**—Success has attended the enterprise of the Mysore Government in putting down a hydro-electric power plant at the Cauvery Falls for supplying the Kolar goldfields with electric power over a distance of nearly 100 miles. At the time the scheme was severely criticised by a section of the Indian Press, but, as time has shown, with no justification whatever. The demand for electric power at the goldfields has since the initiation of the scheme greatly increased, and, as we stated some time ago, the generating plant is to be extended to nearly twice its present capacity. The power-house at the base of the hill is to be extended down stream to allow for the installation of five additional generating sets of 720 kw., which will be duplicates of the six now in operation. A new fore-bay is under construction down stream from the present fore-bay, and below the existing step-up transformer station. Five additional pipe lines are to be laid from the new fore-bay, so that each generating unit will be directly supplied, instead of one pipe line to each pair, as at present. The transformer station is also to be extended. In order to lessen the line losses consequent on the necessary output, the voltage transmission is to be raised to 35,000 volts. The new machinery is being supplied—the electrical plant by the General Electric Company of America, and the turbines by Messrs. Escher-Wyss, of Zürich. *Indian Engineering* publishes some figures showing the cost of the initial installation—*i.e.*, 4,500 h.p. This represents a total capital outlay of £359,817, but deducting the cost of the first year's working and the cost of the compressor houses on the goldfields, which latter is chargeable to the mining companies, the actual capital cost stands at £327,697. The actual power of the initial installation is 500 h.p. greater than was at first contemplated, and the cost per horse-power as originally computed and as now installed works out as £71·84 and £72·82 respectively. The courageous policy of the Mysore Government in entering on this important undertaking receives striking approval from the way the electric power has been taken up by the mining companies, which has necessitated the large expansion of plant indicated above. And it is possible that the city of Bangalore will soon take a supply of energy for lighting purposes, as the transmission line runs within about 18 miles of the town.

**Electricity in Lead Mines.**—The *Engineering Journal*, periodically published by the University of Birmingham, is always bright and informing reading. In the issue for the present month there is an excellent paper by Mr. Thomas Warth which shows the extent to which electricity has been adopted in the lead mines of the North of England. The author is describing a visit to the Greenside lead mines, which are situated some three miles from Patherdale, in the Lake District, and tells how his party entered the mine in trucks drawn by an electric motor, the line running by way of an adit in the hillside tunnelling the solid rock for two miles before striking the vein. Through this they travelled at the rate of about six miles an hour, and one great difference between mining in hard igneous rocks and the softer sedimentary strata was speedily realised by the visitors, the hard firm walls of the former requiring practically no timber, whereas in one mine operated by the mining company the annual cost of this item alone is £100,000. Electricity is also used for driving the winding drums at the adit level by means of a bipolar motor running at a speed of 450 revolutions per minute, with 66 amperes and 500 volts, cage, wagon, ore, and rope weighing 2½ tons. A three-throw Tangye pump at the 60-fathom level, pumping to the adit, is also worked by an electric motor, and delivers 4,000 gallons per hour. The power station, from which the electricity supply is obtained, is situate four miles from the mines in the heart of the mountains. It is a water-power plant, the fall obtained being 400ft. A 15in. pipe conducts the water down the steep mountain side, which is approximately at an angle of 45deg. The plant, which has been running for 12 years, consists of a powerful turbine and a Pelton wheel, each of 100 h.p. These each drive a four-polar dynamo at 500 revolutions, which generates current at 85 amperes at 600 volts. We notice that in this issue of our contemporary a new feature has been introduced in the shape of a most useful list of forthcoming events arranged by the technical societies in the Midland capital. The list includes the arrangements of the Birmingham Mechanical Engineers, the Birmingham Local Students of the Institution of Civil Engineers, the University Engineering Society, and the Birmingham Local Section of the Institution of Electrical Engineers. We are glad to see that all these institutions are, to a certain extent, working in conjunction with each other, and in the list in question there are at least three meetings announced which will be open to all members of the local engineering societies.

**The Outlook in South Africa.**—In Mr. Henry Birchenough's report on the prospects of trade in South Africa it was shown that the outlook in matters electrical is especially promising, and that the British manufacturer who will go to the trouble of acquainting himself with South African requirements need have no fear of the competition of other countries, keen and pushing as it undoubtedly This is strongly confirmed by the events

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of the past few months since Mr. Birchenough prepared his report, and the present outlook is exceedingly encouraging to manufacturers of electrical plant and accessories in this country. In every part of South Africa the application of electricity in some form or other is being undertaken or contemplated in connection with lighting, traction, and power. As an integral part of harbour equipment, electricity, whether for lighting or power purposes, has been adopted at all the South African ports, while it is in vogue in all the principal diamond and gold mines. According to some figures published by the *British* and *South African Export Gazette* it is clear that, taken in the aggregate, the electrical installations in South Africa under way or under consideration are prodigious in their number and magnitude. For instance, it is estimated on the authority of the Government mining engineer for the Witwatersrand that there will be 8,000 additional stamps at work within the next five years, involving the installation of machinery of the value of over 12 millions sterling, of which electrical plant will form an integral part. All the larger and many of the smaller towns are adopting important schemes, which collectively, when carried out, will create an important and increasing market for electrical work. Naturally the installation to which prior attention is being directed is that of Johannesburg, where it is estimated that for public lighting and tramway electrification about £1,240,000 will be spent. At Port Elizabeth a similar scheme is engaging the attention of the local authorities, and should this be adopted in its entirety, something like one million sterling will be invested in the undertaking. Other important schemes which have already come within the range of realisation or serious consideration are those of Pretoria, Pietermaritzburg, Bloemfontein, Kimberley, Potchefstroom, East London, Queenstown, Durban, and many other places of more or less importance. An enterprising step has been taken at Pretoria, where there is a general tendency to introduce electric power in the local factories in place of the present steam or other motive power. The Municipal Council have taken up the proposal with zest, and have been gathering statistics as to the total horse-power now used by the various steam plants running in the city, with a view to their eventual displacement by the electric motor. Not only does the Transvaal offer an excellent market for electric motors for all purposes, for municipal, shop, and domestic use, but the mines, in the future, intend to largely make use of electric machinery. The reasons for this are several, occupation of less room and greater ease of subdivision of power being the chief. Among the services to which electric driving power is adapted are mechanical wire-rope haulages above and below ground, pumps for surface and underground work, rock-breakers, drills, ore conveyors, batteries, etc. Noteworthy in this connection is the fact that the three-phase alternating-current system is preferred over either the two-phase or continuous-current systems. British engineering firms need to be keen to compete with foreign makers, who have obtained in late years some sort of lead in supplying this type of machinery. In the design of this plant, economy of mass and weight, in so far as it does not affect stability, is advisable on the score of price and carriage.

**Kalgoorlie Electric Tramways.**—Australia is not rich in electric tramways, but the one or two tramway systems at present employing electric traction in the Commonwealth represent the most advanced and up-to-date work of its class, and will bear comparison with anything to be found on this side of the equator. Of course, the largest and pre-eminent electric tramway system in Australia is that controlled by the New South Wales Railway Commissioners, and which provides an efficient means of communication between the different parts of the city of Sydney and the outlying districts. It has over 100 miles of track, the greater part of which is already electrified, and the remainder is rapidly being converted from steam to electric traction. In Western Australia there are at present two electric tramway systems in operation, the first in importance being the Perth undertaking, which operates about 20 miles of track. The system, however, of which we propose to give a short description here is that owned by the Kalgoorlie Electric Tramways, Limited, which began to work on May 20, 1902. Kalgoorlie itself has a population of about 30,000 persons, and the tramways have been put down to furnish a rapid means of communication within the city and to the goldfields which surround it. They comprise 16 miles of track, of which 10 miles are double and six miles single. In the construction of the permanent way the work was rendered fairly arduous by the fact that the soil is practically a good natural cement of ironstone composition, which, however, though hard to work, forms a good permanent road-bed. The rails, which weigh 90lb., are laid on ties of jarrah wood, which is particularly suited to the purpose, as it is absolutely proof against the attacks of white ants and is impervious to moisture. For the double track lines the double-bracket style of overhead construction is employed with a single line of 35ft. poles of jarrah wood between the tracks. On the single-track lines single-bracket construction is used. An interesting feature about the car-shed, which is built of steel throughout, is its novel mode of construction. There is, strictly speaking, no floor, the rails being supported on cast-iron columns 5in. in diameter resting upon cement concrete piers, and all work of maintenance and repair is done from the pit level. At the back of the shed on a lower level is a set of cross tracks, so that armatures and truck and motor parts can be dropped to this level and taken under the cars. The arrangement for providing an economical water supply is also novel. Two concrete tanks run the whole width of the building into which is drained all the rain-water falling on the roof, and this water is used for washing the cars and for fire protection, and represents a saving of about £1,000 a year. The rolling-stock consists of 10 double-truck cars and 15 single-truck cars all of which are of the enclosed type. The cars are mounted on Brill trucks, and are equipped in the case of the latter with two and in the case of the former with four G.E. 58 motors each. The Kalgoorlie Electric Power and Lighting Corporation supplies the electric energy for working the system. The power plant consists of three vertical units, each comprising an 800-h.p. Stewart engine direct connected to a 500-kw. G.E. alternator. These units supply two cycle alternating currents at 600 volts, which for tramway purposes is changed to 550 direct-current in two G.E. rotary converters, located at the power-house. A battery of Babcock and Wilcox boilers, using Australian gumwood as fuel, supplies steam to the plant. Now that the Kalgoorlie water-supply system has been completed—fresh water being pumped from the coast 400 miles away—there is no difficulty in getting a sufficient supply, but previously the only water available for power-house purposes was a brackish water obtained from the low levels of the mines. In the dry seasons, water which is practically a saturated solution of ordinary and other salts was used. A flat-rate system of charging is in vogue on the tramways—*i.e.*, 3d. a ride within the municipal boundary, and 6d. to any point outside the city. Messrs. J. G. White and Co. were entrusted with the construction of the lines, and this firm also designed and put down the plant which supplies power for the tramways.

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## THE G.B. SURFACE-CONTACT SYSTEM.

On Wednesday last the technical Press were invited to inspect a trial line at Ilford equipped on the above system by the G.B. Surface-Contact Company, of Hamilton House, Bishopsgate-street Without. The line in question has been constructed on the border of low-lying land which was flooded very frequently last year. The line is about one-fifth of a mile long, and being oval in plan, permits of continuous running in one direction. The curves and

FIG. 1.—View of the G.B. Surface-Contact Track Flooded at Ilford.

grades are such as to represent the worst conditions of general practice. This, coupled with the flooding above mentioned, has enabled the inventors of this system to prove their design under the most trying conditions before proceeding with work on the public streets. The system has been jointly perfected by Mr. W. Griffiths, who is an expert in road construction, and Mr. G. H. Beedell, who has had the electrical details under his control.

The following is a description of the principal details of the system. The current from the generating station is conveyed through a bare galvanised iron cable about 1in. diameter carried on insulators in a conduit, and it is conveyed to the cars through studs placed at intervals along the middle of the track. The connection between the studs and the cable is effected magnetically at the moment the car magnet comes over them, and ceases immediately it leaves them. The conduit in which the cable is carried is illustrated in Fig. 2. It consists of sections of ordinary glazed vitrified 5in. stoneware pipe. It will be understood that the sections shown in Fig. 2 occur only at places where studs are required, the other sections of the conduit being perfectly plain butt-jointed pipes. A special bituminous joint is used to connect the sections of conduit. The conduit is completely embedded in concrete, but the total depth of excavation necessary does not exceed 19in., and this can be decreased by 6in. or 7in. should it become necessary in order to pass over the crown of a bridge or other obstruction. Thus no removal or alteration of pipes already laid in the roadway is necessitated by this system. The mechanical strength of the design is ample to meet the exigent demands of heavy road traffic. The arch and invert formed by the concrete above and underneath the pipe make together a structure which is stronger than the ordinary 6in. paving base used for the public roads.

The insulators in the conduit (Fig. 3) which carry the cable are made of the finest insulator clay, thoroughly vitrified and glazed. The creeping surface is long and of constricted cross-section, providing a particularly high insulation resistance. The galvanised steel pins on which the insulators are mounted pass through the conduit on one side, through the hole in the centre of the insulator, and into a stopped hole on the opposite side of the conduit. The ends of the pins which project through the conduit are connected together by means of a galvanised iron strip, which is connected at intervals to the rails. This entirely prevents any leakage from the bare wire getting to the stud, which is a valuable point in favour of the system over most other types of surface-contact switches. There is not space between the flanges of the insulators and the pipe for the cable to pass, and in consequence there is no difficulty in drawing in the cable round curves. This was shown at the trials on Wednesday. Access boxes are placed at intervals of 200 to 400 yards along the track. Each box consists of a cast-iron body and manganese steel cover, which is paved in with granite setts or wood blocks in the usual way. Two sections of conduit enter the box on opposite sides, and the two cable ends are led to terminal bars mounted on insulators fixed to the box. Drainage connections are provided from the bottoms of those access boxes which are situated at the lowest points of the track. Any water, therefore, which by accident might find its way into the conduit would drain away.

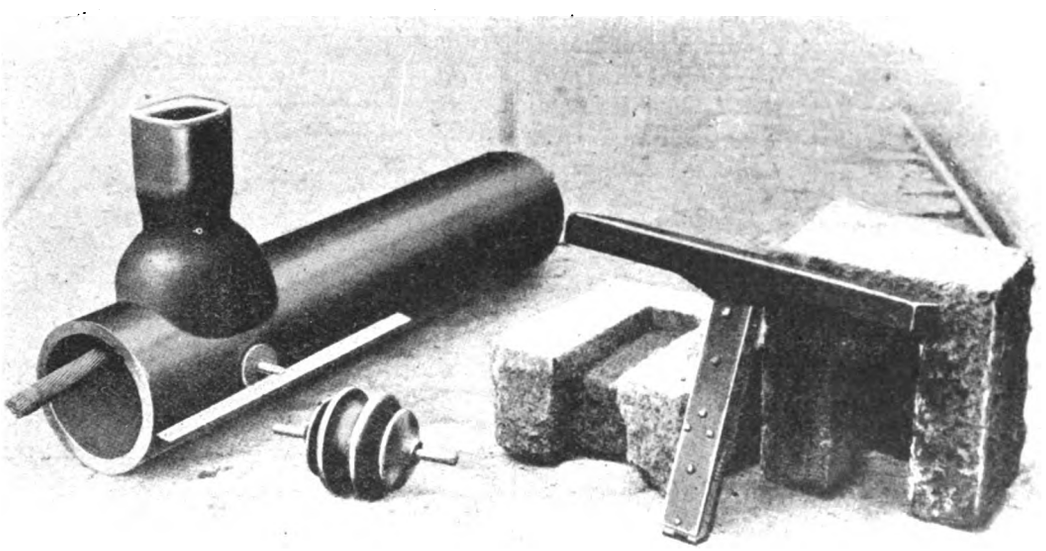

FIG. 2.—Parts of the G.B. Contact-maker and the Granite Settings for the Stud.

The studs, as shown in Fig. 3, have cast-iron heads, the top surfaces of which are level with the rest of the paving. They measure 2½in. by 14in. on the straight parts of the track, and are 5in. wide at curves. They are supported on granite blocks recessed to receive them. Special attention is directed to the fact that these blocks are made of natural granite and not of any composition material, and are, therefore, able to stand the heaviest traffic and wear uniformly with the rest of the paving.

The iron stalk of the stud, which projects downwards into the upright piece of pipe shown in Figs. 2 and 3, is

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forked at the lower end and lined with brass. Within the fork is mounted the only moving part in connection with the electrical equipment of the track. This consists of a piece of iron protected with copper, and suspended freely by means of an insulated phosphor-bronze spring from the top of the fork. Its movement is limited by a brass pin, which passes through a slot and is riveted into the jaws of the fork. Upon the lower end of the moving piece a carbon contact block is fixed. Flexible copper leads connect the moving part with the main portion of the stud. When the magnet carried by a car passes over the stud, the moving piece is magnetically attracted towards the cable against the pull of the spring, so that the carbon block is in contact with the cable, and current passes from the cable through the carbon and flexible copper connections to the stud head, where it is collected by the car in a manner described below. As soon as the car has passed and the stud has ceased to be under the influence of the magnet carried by it, the pull of the spring withdraws the moving part from contact with the cable, and the stud is left absolutely dead. It should be mentioned that the joint between the vertical portion of the stud and the upright pipe into which it passes, is made by filling in the interspace between them with bitumen, supported on a packing of jute yarn. The joint so formed is completely watertight, and non-conducting without being too rigid. Bitumen is also run in round the stud heads, filling any spaces between the granite blocks and the stud. The magnet (see Figs. 4 and 5) is suspended rigidly from the car. The coils and the battery are connected, so that when the motors are taking current, their current, when small, assists the battery in exciting the magnet, and when large also recharges the battery, as can be gathered from the diagram of connections (Fig. 5). In the case of the bogie cars at Ilford the magnet was divided into two portions, one part being mounted on each bogie. This construction avoids the necessity of making any alteration to the standard height of the motors or the truck, and also prevents the magnet being magnetically short-circuited by the motor cases. It is proposed, however, to use one long magnet in future, as this will reduce the pitch between studs.

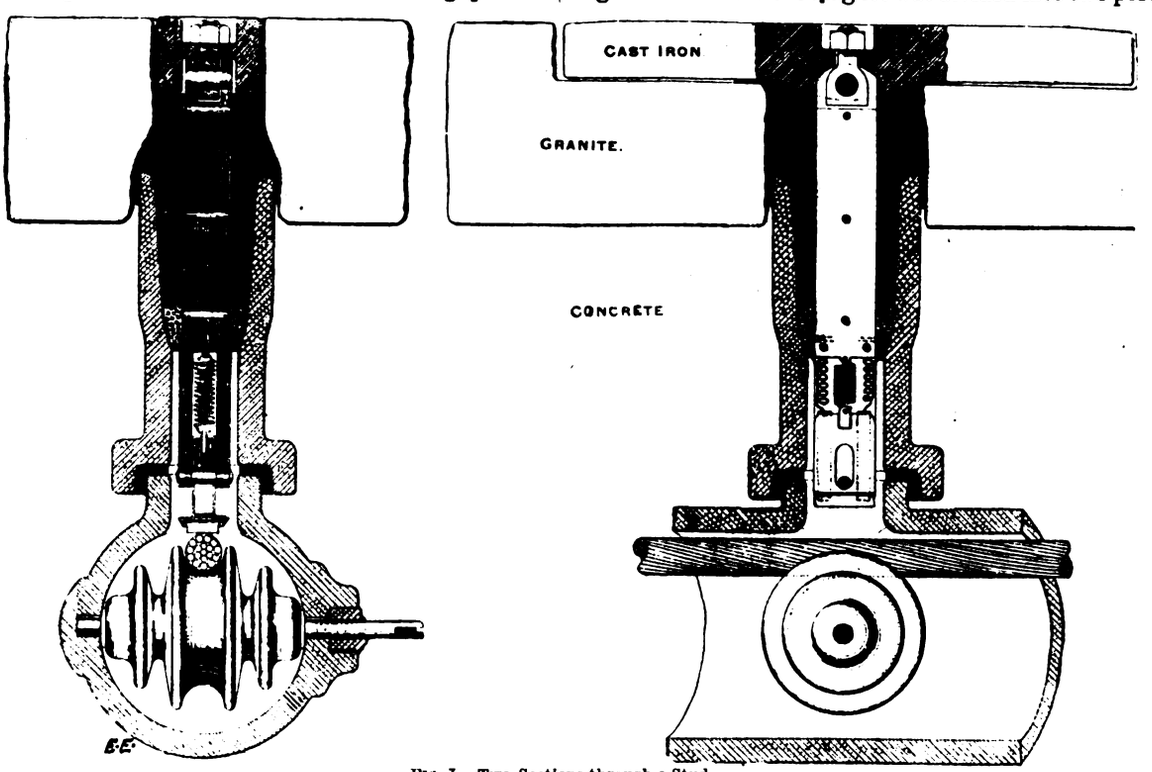


FIG. 3.—Two Sections through a Stud.

The collectors are of an original design, and fulfil their function of collecting from studs level with the paving in a manner which has hitherto not been accomplished by any other form. They consist of iron tongues, spring suspended within one pole of the magnet, their motion being limited by manganese steel pins passing through slots in their centre and fixed to the sides of the magnet pole. In the final form, horizontal links are used to connect the lower ends of the tongues shown in Fig. 5. Their method of operation is as follows: When the pole of the magnet passes over a stud head the magnetic attraction causes the tongues to move down and make contact with it. As each

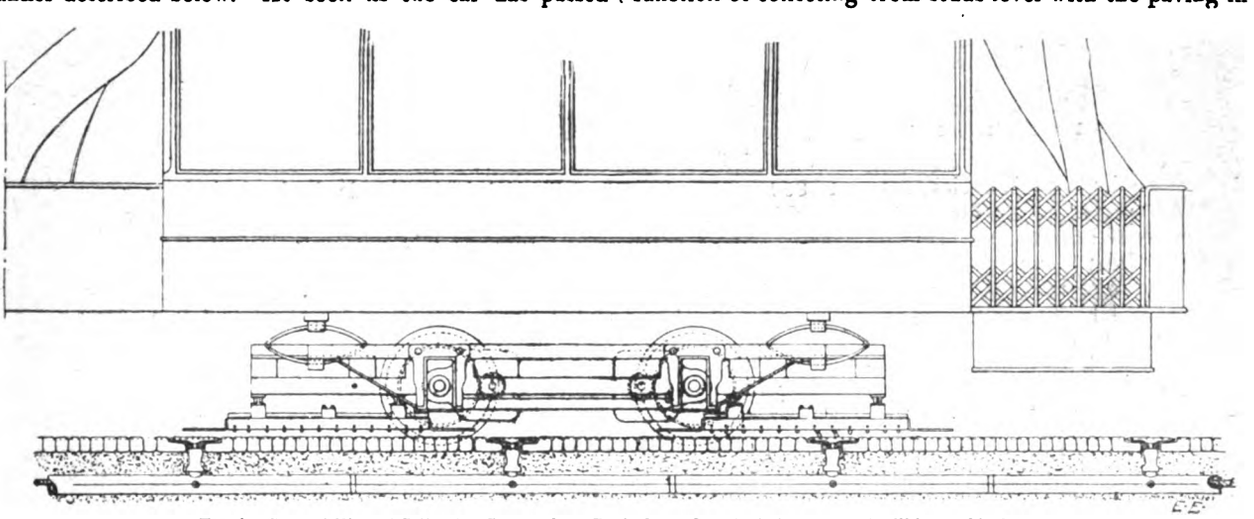

FIG. 4.—General View of Collecting Gear under a Bogie Car. One single long magnet will be used in future and the number of studs reduced.

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collector reaches the end of a stud it is drawn up out of contact with the road by the spring. As the magnet is itself mounted some 2in. above the road level, it will be seen that this method of collecting lends itself exceptionally well to clearing stones and other obstructions in the road.

Having now generally described the system, we may add some further particulars after the critical examination of the same which we were enabled to make at Ilford on Wednesday. To commence with the cable, this is made of galvanised iron with a hemp core to give flexibility. Its cross-section is such that it has the same conductivity as the ordinary copper trolley wire. It can hence be used in half-mile sections. The connection between this cable and the carbon plate on the plunger seemed to be a weak point. It must be remembered, however, that the current is never broken at this point, but always by the skate on the stud surface if a fault should occur at the incoming contact. The projecting iron extensions at either end of the magnet are sufficient to hold up the switch until after the collector has passed off the stud. We were shown a carbon contact which had been used to make connection with 80 amperes passing, and then to break a leakage current of two amperes. This operation had been repeated 22 times a minute until no less than 110,860 interruptions had taken place. The wear was not considerable, and it led Mr. Beedell to the conclusion that these carbon contacts will last at least four years on the heaviest grades.

The feature of the magnet control is that it is unipolar in action, and hence a number of difficulties of alignment found when two poles are used to work the switch are avoided. The iron cable serves to bring back the leakage lines over a large area, and hence the bulk of the magnetic reluctance is in the $\frac{5}{16}$th air-gap between the moving armature and the iron cable. The magnets on the car at Ilford required 320 watts to excite them, which is equivalent to ·04 of a unit per car mile. With this excitation the unbalanced pull on the moving armature was said to be 6oz with the armature up and 16oz. when it had moved down on to the cable. We were informed that the excitation losses would be considerably reduced in the next design. The action of the moving collector, which comes down to the stud in the form of a chain and rises again after the stud has been passed, is exceedingly neat, and gave no trouble in the trials we witnessed. It has the very great advantage of allowing the studs to be placed flush with the street-level, and hence avoids the objection which general users of the road have to all other surface-contact systems. Another advantage is that it prevents a considerable loss from friction between raised studs and the collecting skates. The car is provided at either end with an earthing device, as illustrated in Fig. 5, which is intended to reveal the presence of any stud left alive after the car has passed. The latest arrangement proposed by the company is as follows. These earthing chains will be connected to the rails through a resistance and an automatic switch on the car, which will interrupt the motor circuit, and hence warn a driver that he has left a live stud behind him. He will then go back and locate the defective stud, placing a danger signal on a tripod over the same, which will warn other users of the road of the fact that the stud is alive. Each succeeding car conductor will have to remove and replace this tripod in order to let his car go by, but the device will allow of the service being maintained until such time as the repairing apparatus can be brought to the spot.

We were able to take at Ilford some interesting figures as to the insulation resistance, or rather leakage currents, from the insulated conductor and from the studs. With a single stud alive, the leakage current was ·5 of an ampere immediately after a pail of water had been thrown over the stud and track. This quickly fell to ·25 of an ampere. With all the studs dead the leakage current from the iron cable was only ·025 ampere, in spite of the fact that the insulators had not been cleaned since the last time the track and conduit were flooded. We were informed that if a solution of salt were used on the track, the leakage per live stud went up to between 2·5 to 3 amperes. From the evidence acquired at Ilford we are of the opinion that the leakage to earth on this system will be less than that on others where ordinary insulated cables are used, which have to be looped into boxes under every stud. As regards the cost of the system, it is claimed by the company that it will not cost more than 10 per cent. higher than the trolley system to instal when a new road bed has in any case to be made. They also claim that the cost of maintenance will be less than with the trolley system. We are pleased to hear that the Folkestone Corporation have agreed to use this system, and that the work will be proceeded with as soon as a formal contract has been prepared by the Corporation's consulting engineer. The work at Ilford has been going on for 18 months, so that the company has some experience of value to make use of when laying the system down for commercial use. The G.B. system has several points to commend it, and we shall await the results of its use in the public streets with interest.

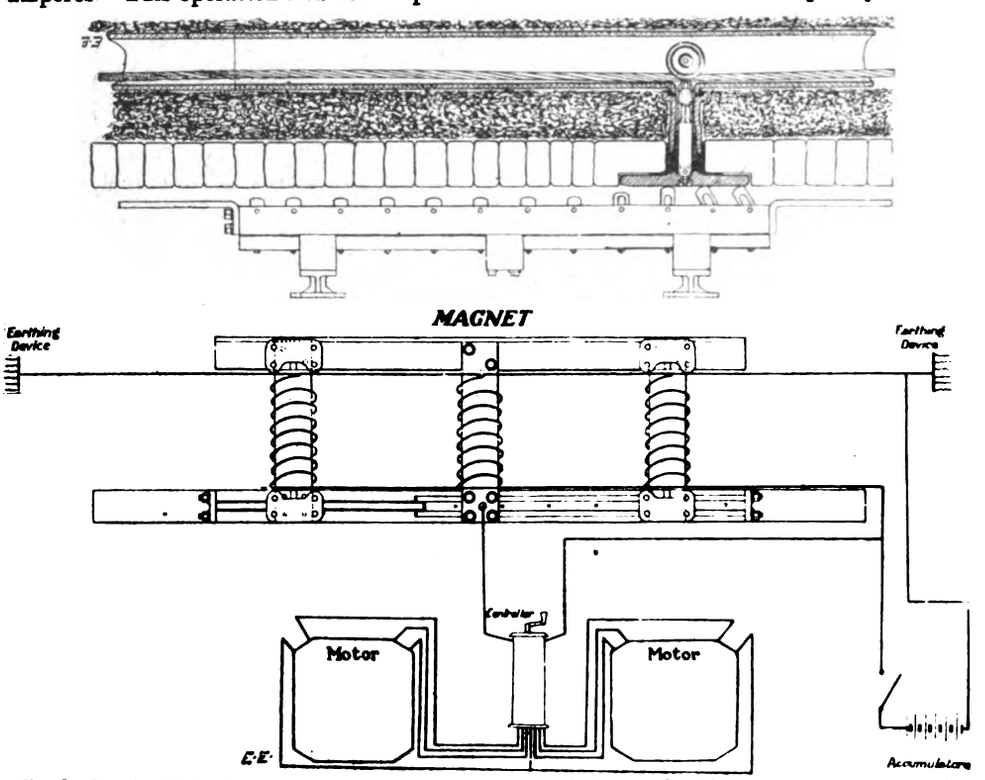


FIG. 5.—Details of Collecting Gear, with Diagram of Connections. The lower ends of the tongues are now connected by iron links which slide on the studs.

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## INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

*(Continued from page 12.)*

### (11) TESTING.

The testing which is essential in a local telephone system is for faults on the local lines. Faults may be divided into three classes—disconnections, earths, or contacts.

1. *Disconnections.*—A total disconnection, such as a broken wire with its end insulated or an intermittent disconnection caused through a bad joint.

2. *Earths.*—A total earth due to wire resting on a good conductor, a partial earth due to defective insulators or wires resting on imperfect conductors, or an intermittent earth caused through wire touching at intervals bodies in connection with the earth.

3. *Contacts.*—Total contact due to wires being hooked or twisted together, a partial contact due to imperfect conductors thrown across the wires, bad earths, defective insulation on wiring, or an intermittent contact due to wires touching each other at intervals.

The method of centralising local faults has been outlined in article No. 4, and it now becomes necessary to describe the method of roughly localising them at the test frame. The test frame is the junction of the switchboard cables and the outside cables, and is fitted with test jacks into which a four-way plug can be inserted, thus bridging the

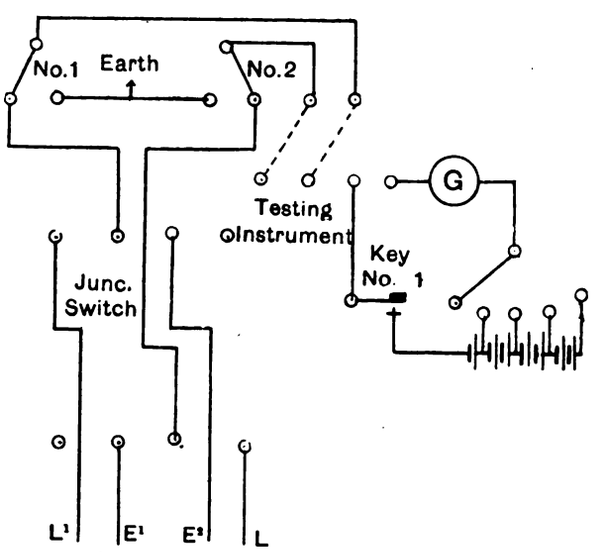


FIG. 57.—Testing Set. L, Line; E, Exchange; G, Galvanometer.

testing instruments across the line. Fig. 57 shows a testing set fitted at Portsmouth by means of which faults can be localised simply and rapidly. Before inserting the test plug into the jack the test clerk should see that the junction switch is in the "through" position, so that if the line is in use the conversation will not be cut off. To test outside, turn the junction switch over to "line" and place the left-hand switch to "galvanometer." If on depressing key No. 1 there is no deflection, the line is obviously disconnected; if there is a heavy deflection, the line is short-circuited. Should there be a normal deflection, move earth switch No. 1 to the right and depress the key again. If there is a deflection the line is earthing, and the fault should be given to the faultsman to trace. It will be observed that on moving the left switch to the testing instrument any subscriber's instrument can be rung from the testing set, and the telephone instrument in connection with the testing set is connected to the line, and the subscriber can consequently be informed as soon as the fault is cleared. Next to the testing set should be fitted an instrument in connection with the exchange, so that when a faultsman or inspector wishes a line tested he can communicate with the test clerk, who by means of the plug and testing set already described can test out the line before the faultsman or inspector leaves.

Other instruments requisite in a large test-room are a sensitive galvanometer, a set of shunts, resistance coils, and Wheatstone bridge. A Thomson reflecting galvanometer consists primarily of a simple needle composed of one or more pieces of watch spring cemented upon a small circular flat mirror of silvered glass, which is suspended by a short thread of cocoon silk without torsion. This needle is suspended in the centre of a coil of very fine wire. Above the coil is a bar magnet, which can be raised or lowered or turned upon its centre by means of a screw. This exerts

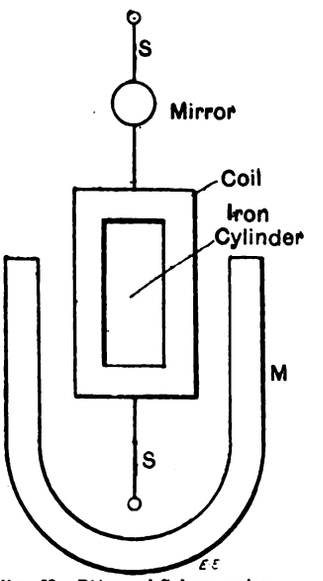


FIG. 58.—D'Arsoval Galvanometer.

a directive force on the needle, and is so adjusted to cause the mirror to reflect a beam of light passed through a small slit on to the centre of a scale.

A D'Arsonval galvanometer consists essentially of a powerful electromagnet, M, as shown in Fig. 58, between the poles of which is suspended a rectangular frame, on which is wound a coil of wire. The suspension is accomplished by a hard-drawn silver wire, and another short length of silver wire holds the coil in place underneath. Inside the coil, and fixed to the frame of the instrument, is a cylinder of soft iron, which concentrates the lines of force through the coil. This galvanometer is "dead-beat" in its action, and sometimes goes by that name. Resistance coils are generally so arranged that the resistance actually in circuit can be varied at will from 1 to 10,000 ohms by the insertion or withdrawal of brass plugs between brass blocks. The coils themselves consist of silk-covered platinoid wires wound upon bobbins, and, in order to avoid the effects

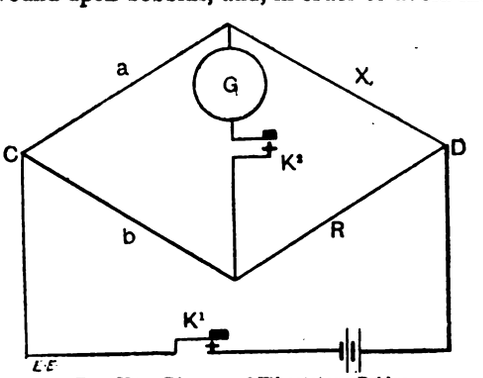


FIG. 58A.—Diagram of Wheatstone Bridge.

of extra currents from self-induction, the wire is doubly wound upon the bobbins, the inner ends being connected together and the outer ends treated as the two ends of the coil. By this means the induced current from one half is neutralised by that from the other, because they are in contrary directions.

The principle of the Wheatstone bridge can best be explained by a diagram. There are two arms of resistance coils, *a* and *b*, and a set of resistance coils, R, which can be varied by inserting or withdrawing plugs from 1 to 11,110 ohms. The unknown resistance, X, is joined up, as shown in the diagram, and to commence testing any resistance is put in R. When the key $K_1$ is depressed (the key $K_2$ also being depressed), a current splitting at C flows over the arm "*a*" and the unknown resistance, X, and over the

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arm "$b$" and the known resistance, R, back to the battery, if the resistance in R is equal to the unknown resistance, X. If the resistance in R is less than X, the current splitting at C will flow over arm "$b$" and resistance, R, back to the battery, and also flow over arm "$a$," through the galvanometer (deflecting the needle), and R, returning to the battery. Similarly, if the resistance in R is greater than X, the current will flow the opposite way through the galvanometer. The resistance in R should consequently be increased or decreased as the case requires until there is zero deflection on the galvanometer. Then

$$X = \frac{a}{b} R,$$

and as $a$, $b$, and R are known, the resistance in X can be calculated.

Shunts are for the purpose of preventing heavy currents from passing through a delicate galvanometer, and consist of resistance coils so wound that the currents passing in parallel through the shunt and galvanometer bear a fixed ratio to one another. They are generally constructed to give 10, 100, and 1,000 readings—that is, one-tenth, one-hundredth, or one-thousandth part of the current is passing through the galvanometer.

Having now described the instruments, the methods of

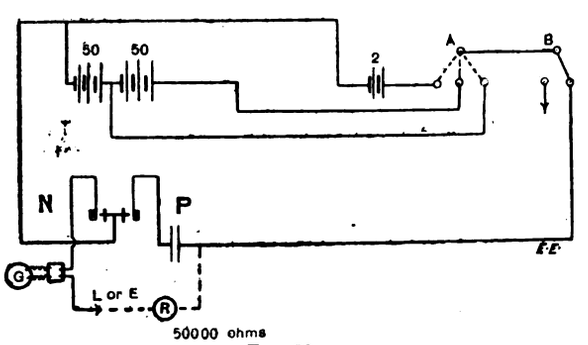


FIG. 59.

using them will be considered. In an underground system, after the cables are laid it is necessary to test them for insulation, capacity, and conductivity. Fig. 59 is a diagram of the instruments generally used. To test for insulation, use 100 cells with the one-thousandth shunt, and take a deflection by depressing key N. Then join up the wire and throw switch B over to earth and take a second reading by depressing key P. To test for capacity, unplug the condenser and note the deflection by discharge on releasing key N. From these readings the calculations are easily made. Other tests are sometimes necessary in large exchanges, and the more usual ones will be given.

*Submarine.*—There are various methods of testing for faults, and the three principal ones will be given.

(1) *Overlap.*—

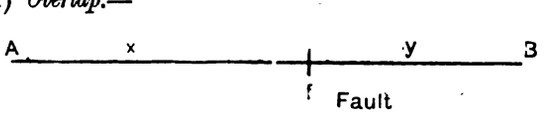


Diagram of Test for Submarine Cable—Overlap Method.

Test from A and get resistance $x+f$

" B " " $y+f$

$\therefore$ A − B $= x+f-y-f$ . . (1)

L = resistance of line when in perfect condition,

$$\therefore L = x+y.$$

$$\therefore y = L-x$$

From (1)

$$A-B = x-y$$

$$A-B = x-(L-x)$$

$$A-B = x-L+x$$

$$\therefore 2x = A-B+L$$

$$\therefore x = \frac{A-B+L}{2}.$$

(2) *Murray's Method.* (Loop test.)—

When the cable is severed and the fault itself offers no resistance, the distance from the test end to the fault is

$$\frac{R}{r_k} \text{ knots,}$$

when R = measured resistance from one end,

$r_k$ = resistance of the cable per knot.

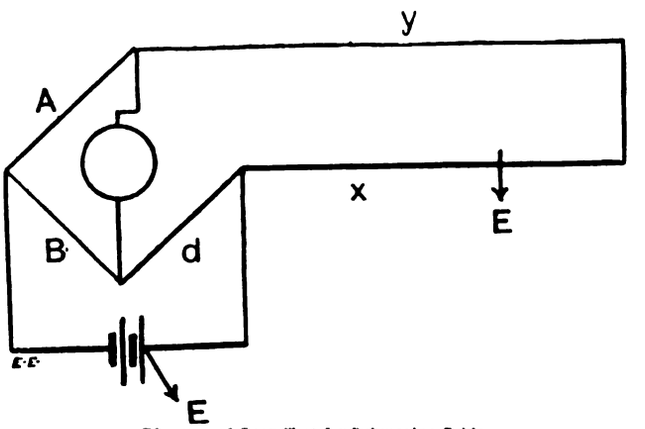


Diagram of Loop Test for Submarine Cable.

In the case of other faults join up Wheatstone bridge as shown:

$$A\,x = B\,y$$

$$L = x+y$$

$$\therefore y = L-x$$

$$A\,x = B\,(L-x)$$

$$A\,x = B\,L - B\,x$$

$$A\,x + B\,x = B\,L$$

$$x\,(A+B) = B\,L$$

$$x = \frac{B\,L}{A+B}.$$

(3) *Blavier's Method.*—

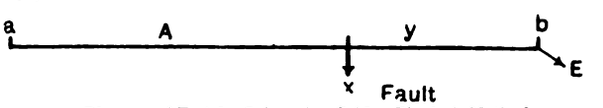


Diagram of Test for Submarine Cable—Blavier's Method.

Tests taken from "$a$." First earth the wire at "$b$," and take test giving resistance, E, equal to resistance of line up to the fault, plus the joint resistance of the line beyond the fault and the fault, or

$$E = A + \frac{1}{\frac{1}{y}+\frac{1}{x}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Secondly, disconnect wire at "$b$," and take test giving resistance, D, equal to resistance of line up to fault, plus resistance of fault, or

$$D = A + x \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

L = resistance of line when in good condition, or

$$L = A + y \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (1) and (3) $L - E = A + y - A - \frac{1}{\frac{1}{x}+\frac{1}{y}}$

$$= y - \frac{xy}{x+y}$$

$$= \frac{xy+y^2-xy}{x+y}$$

$$L - E = \frac{y^2}{x+y} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

From (2) and (1) $D - E = A + x - A - \frac{1}{\frac{1}{x}+\frac{1}{y}}$

$$= x - \frac{xy}{x+y}$$

$$= \frac{x^2+xy-xy}{x+y}$$

$$D - E = \frac{x^2}{x+y} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

From (1) $A = E - \frac{1}{\frac{1}{x}+\frac{1}{y}}$ .

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$$= E - \frac{xy}{x+y}$$

$$A = E - \sqrt{\left(\frac{xy}{x+y}\right)\left(\frac{xy}{x+y}\right)} \quad . \quad . \quad . \quad (6)$$

Multiplying (4) and (5),

$$(L-E)(D-E) = \left(\frac{y^2}{x+y}\right)\left(\frac{x^2}{x+y}\right)$$

$$= \frac{x^2 y^2}{(x+y)(x+y)}$$

$$(L-E)(D-E) = \left(\frac{xy}{x+y}\right)\left(\frac{xy}{x+y}\right) \quad . \quad . \quad . \quad (7)$$

Substituting (7) in (6),

$$A = E - \sqrt{(L-E)(D-E)}.$$

E, D, and L being known, A can be calculated, and we have only to divide A by the resistance per knot of cable in order to get the distance in knots of the fault from station "*a*."

*Testing the E.M.F. of a Battery.*—

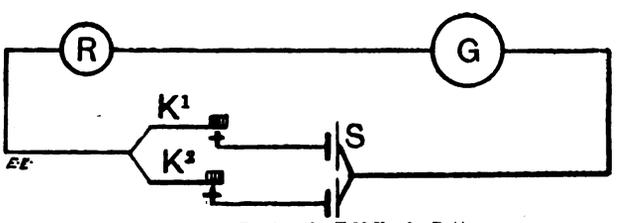


Diagram for Testing the E.M.F. of a Battery.

$s$ = a standard cell. First depress $K_1$; a current will then flow from the standard cell through, and thus deflecting the galvanometer, and then through the set of resistance coils back to the cell. Secondly, release $K_1$ and depress $K_2$, when a current will flow through the galvanometer (deflecting same), then through resistance coils, and back to the cell. Vary the resistance in R until the current from the unknown cell gives the same deflection on the galvanometer as the current from the standard cell.

Then $$C_s = \frac{E_s}{R_s} \text{ ($s$ equals standard cell).}$$

$$C_x = \frac{E_x}{R_x} \text{ ($x$ equals unknown cell).}$$

But $C_s = C_x$, as they give equal deflections.

$$\therefore \frac{E_x}{R_x} = \frac{E_s}{R_s}.$$

$$\therefore E_x = E_s \times \frac{R_x}{R_s}.$$

*Testing the Resistance of a Battery.* Half deflection method.—

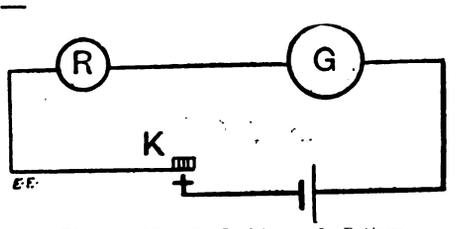


Diagram of Test for Resistance of a Battery.

Make R = 0. Thus practically there is no resistance in circuit; the galvanometer resistance being so small, it need not be taken into consideration. Depress K and observe galvanometer deflection; depress K and insert R in the resistance coils until the deflection of the galvanometer falls to half that produced in the first case.

$$C_1 = \frac{E}{r}$$

$$C_2 = \frac{E}{R+r}.$$

But $C_1 = 2\,C_2$

$$\therefore \frac{E}{r} = 2\,\frac{E}{r+R}$$

$$\therefore \frac{1}{r} = \frac{2}{r+R}$$

$$\therefore R + r = 2r$$

$$R = r.$$

So that the resistance inserted in the resistance coils is equal to the resistance of the cell.

*Testing the Capacity of a Condenser.*—

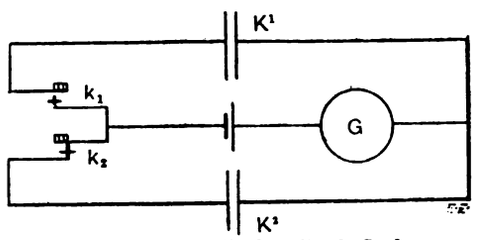


Diagram of Test for the Capacity of a Condenser.

Join up the condenser $K_2$ with a standard condenser $K_1$. Depress $k_1$ and observe deflection, $d_1$, caused by discharge.

„ $k_2$ „ „ $d_2$ „ „

Then $$\frac{d_1}{d_2} = \frac{K_1}{K_2}$$

$$\therefore K_2 = K_1\,\frac{d_2}{d_1}$$

$\therefore K_2$ is known.

*Testing Covered Wire.*—The coil of wire is immersed in a tank of water for 24 hours to test insulating material. The water is kept at a known uniform temperature. The negative pole of a battery of about 300 volts is then connected to one end of the coil, the other end being kept dry and clear of the water. The positive pole is connected through a galvanometer to the tank, and by the deflection of the mirror the amount of leakage which takes place through the insulating material can be ascertained. If a coil is found to be faulty, it is wound upon a reel and the wire is then drawn slowly off and passed through the water, the connections of the battery and galvanometer remaining the same. Immediately the fault reaches the water the mirror is deflected, and the exact locality can thus be readily found.

*(To be continued.)*

## THE MEASUREMENT OF THE FORM FACTOR OF AN ALTERNATING VOLTAGE.*

The form factor, $f$, of an alternating voltage is the ratio of the effective value to the average value of the voltage. Fig. 1 shows the curve with regard to time of an alternating voltage, $e$, one period of which occupies $v$ seconds. The curve cuts the axis of time at the points $t = 0$, $\frac{v}{2}$, and $v$. The form factor of this voltage may be expressed as

$$f = \frac{\sqrt{\frac{1}{v/2}\int_0^{v/2} e^2 \, . \, dt.}}{\frac{1}{v/2}\int_0^{v/2} e \, . \, dt.}$$

A knowledge of this factor, $f$, is of use in many cases, amongst others, when taking iron tests by means of a wattmeter, for it gives a simple relation between the voltage measured at the terminals of the apparatus and the maximum value of the induction in the iron. If E represents the terminal voltage, or, more exactly, the E.M.F. of self-induction in the iron tester, $n$ the periodicity, N the number of turns in the magnetising coil, and Z the maximum flux in the iron, then

$$E = 4\,.\,f\,.\,n\,.\,N\,.\,Z\,.\,10^{-8}.\dagger$$

* Translation of an article by P. Rose and A. Kühns in *Elektrotechnische Zeitschrift* for Dec 3, 1903.

† G. Benischke has pointed out a case in which the above formula does not lead to a correct value for the maximum flux—viz., when the curve connecting flux with time has several maxima in the half period (*Elektrotechnische Zeitschrift*, 1900, p. 765). This flux curve corresponds to a voltage curve in which the instantaneous values change sign

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With a sine wave of voltage the effective value is $\frac{E_{max.}}{\sqrt{2}}$ and the average value $\frac{2}{\pi} E_{max.}$, where $E_{max.}$ is the peak voltage. The form factor in this case is $\frac{\pi}{2\sqrt{2}} = 1{\cdot}111$.

For other curves the form factor has usually up to the present been determined by means of a planimeter. The area of an experimentally determined voltage curve divided by the length of its abscissa gives the value of $a$, the average voltage, in units of length.

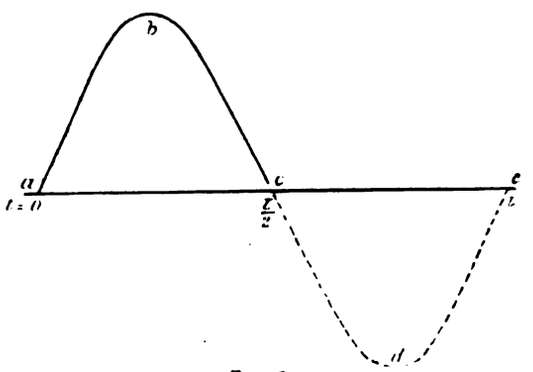


FIG. 1.

If the curve is converted into a polar curve and its area found, the radius, $b$, of a semi-circle of equal area will be equal to the effective value of the voltage in units of length. Then, supposing the same units of length have been used in both cases, the form factor will be the ratio $\frac{b}{a}$.

This method is inconvenient and lengthy. The determination of the curve shape and its area is complicated, and requires much time and care, in spite of all the improvements in curve-tracing apparatus which have been introduced. The lengthiness of the process is especially felt in the case of small machines with high self-induction, as the form factor of such machines changes with the load, so that numerous determinations have to be made. As an example of such a change of form factor, reference may be made to

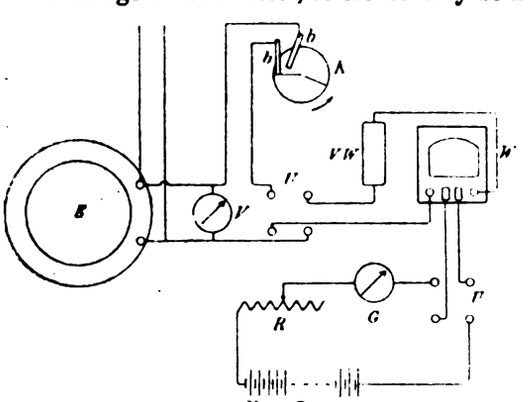


FIG. 2.

a test on a 3-kw. machine used to excite a Möllinger iron tester. The form factor was found to have changed over 20 per cent. with the higher current values employed, as compared with the no-load measurement. By means of the method described below, the average value of an alternating voltage can be directly measured and the determination of the form factor thereby greatly simplified.

By means of a rotating contact disc, making a number of revolutions per second equal to the periodicity of the alternating voltage, unidirectional current impulses lasting half a period each are delivered to the measuring instrument. Of the whole period shown in Fig. 1, for instance, only the part $a\ b\ c$ is utilised, while for the remaining part of the period, $c\ d\ e$, the instrument receives no current.

The average value of this pulsating unidirectional voltage is equal to half the average value of the alternating voltage, since for the same area the abscissa is twice as long. At first a wattmeter, connected as described below, was employed to measure the average value of the pulsating voltage, as it was feared that the available direct-current D'Arsonval voltmeter might give unreliable results, due to inductive effects. Comparisons between the wattmeter results and those given by a Siemens and Halske standard direct-current voltmeter, however, showed very close agreement. At the same time, such direct-current instruments must be employed with caution. When using the wattmeter as a voltmeter the volt coil was connected to the

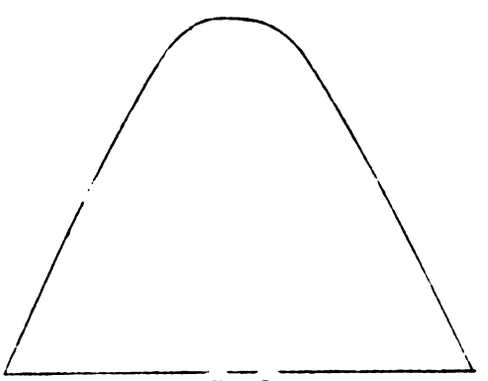

FIG. 3.

pulsating voltage, whilst the series coil was supplied with an independent direct current of a constant amount. With this arrangement a wattmeter is, in a sense, converted into a voltmeter, and can be calibrated as such if the series-coil current is constant. If the effective value of the voltage, given by an ordinary alternate-current voltmeter, is divided by twice the average value read off the wattmeter, the result will be the form factor.

In the diagram of connections (Fig. 2) E represents the iron tester, K the contact maker, V an alternate-current voltmeter, W the wattmeter, and G a continuous-current ammeter. Both circuits of the wattmeter are provided with reversing switches, U, whilst regulating resistances, R, in the main circuit and, V W, in the shunt circuit are also inserted. The rotating part of the contact maker employed consisted of a circular ebonite disc about 6 cm.

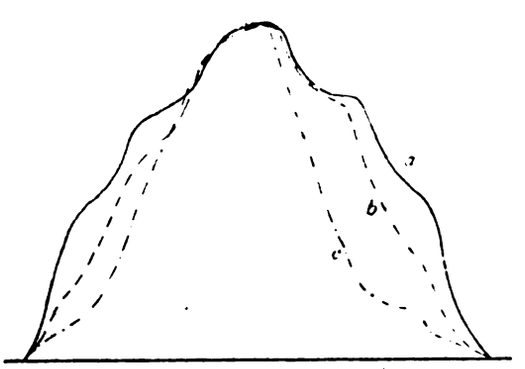


FIG 4.

in diameter, on one side of which a thin sector-shaped brass plate was fixed with which the brushes made contact. The angle of this brass sector was slightly greater than 180deg. The brushes, $b\ b$, were movable around the axis of the disc, and also relatively to one another. By moving both brushes at the same time the instants at which the contact commenced and ended could be regulated, whilst by moving them relatively to one another the duration of the contact was adjusted. The brushes were adjusted until, for a given voltage, the wattmeter showed the maximum deflection. This maximum deflection is obtained when the contact begins exactly at the zero point of the voltage, and lasts for exactly half a period. Every change, both in the instant of commencement and in the duration of the contact, must cause a reduction of the wattmeter deflection. The exact setting of the brushes is not a difficult matter so long as both contact plate and brushes are kept clean. It is advisable to wipe the contact plate after such measurement with a rag dipped in petroleum. Sparking

several times between the beginning and end of a single half period. In most practical cases, however, the above formula would hold, and gives the desired result more quickly than a calculation using Fourier's series.

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disappears entirely after the brushes have been correctly set.

The wattmeter, a standard Siemens and Halske instrument for a maximum current of five amperes, was calibrated as a voltmeter for a particular value of the auxiliary current read on G. When using the wattmeter to determine the form factor, the pointer of the direct-current instrument was kept at the same scale division. In this way the value read off the wattmeter scale, multiplied by the calibration constant, gave half the average value of the alternating voltage.

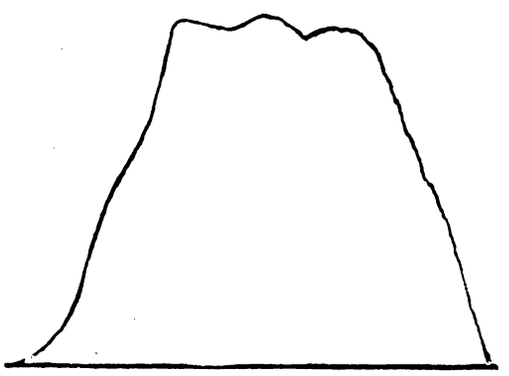

FIG. 5.

Both in the calibration and in the test itself the average of two readings on the wattmeter with reversed currents in both circuits was taken so as to eliminate the effect of the earth's field or other disturbing fields. The contact maker was driven by means of a small two-polar synchronous motor, to whose spindle the ebonite discs was attached by a brass bush and screw. In place of using a synchronous motor, the disc may be driven from the alternator itself by the aid of suitable gear, such, for instance, as that employed by Dr. Rudolf Franke for the direct driving of his curve tracer (*Zeitschrift für Instrumentenkunde*, January, 1901). The accuracy of the method described is directly dependent on the accuracy of the instruments employed, so that a preliminary calibration of these is absolutely necessary.

The serviceableness of the method was tested by measuring the form factors of the three machines whose voltage

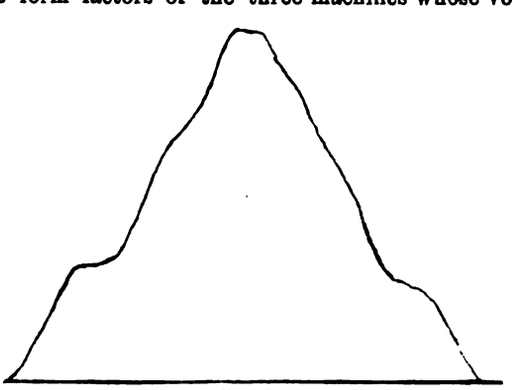

FIG. 6.

curves are shown respectively in Figs. 3 to 6. Fig. 3 is the curve of a 10-kw. direct-current machine fitted with slip-rings for the production of an alternating current. The three curves in Fig. 4 refer to a 3-kw. three-phase alternator, curve *a* being for open circuit, and curves *b* and *c* with loads of 6 and 18 amperes respectively, the current being supplied to an iron ring wound with 100 turns and belonging to a Möllinger iron tester. Figs. 5 and 6 are taken from a 30-kw. three-phase machine, Fig. 5 being the curve with the normal star coupling, and Fig. 6 the curve obtained on connecting all three phases in series, one phase being reversed. The curves were obtained by means of Dr. Franke's curve tracer. The contact maker in the wattmeter circuit was driven by the same synchronous motor as the curve tracer. Whilst the curves were being traced measurements of the form factor were made by the above described method. The form factor was then also calculated from the voltage curves by means of a planimeter, as explained above, and the results of these measurements and calculations are given in the following table, the directly measured and the planimetered values of the form factor being shown side by side:

| Curve. | Form factor — Directly measured. | Form factor — Obtained by planimeter. | Average difference, per cent. |
|---|---|---|---|
| Fig. 3 | 1·131, 1·13 | 1·129 | +·1 |
| Fig. 4A | 1·121, 1·121, 1·122, 1·122 | 1·120 | +·2 |
| Fig. 4B | 1·18 | 1·184 | −·3 |
| Fig. 4C | 1·312, 1·308, 1·311, 1·309 | 1·311, 1·314 | −·2 |
| Fig. 5 | 1·135, 1·136, 1·135 | 1·133, 1·137 | ± 0 |
| Fig. 6 | 1·167, 1·165 | 1·168 | −·2 |

This table shows an agreement between the two methods which is quite sufficiently close for all practical purposes, and also shows that the experimental errors are about equal in the two cases. The double measurements by planimeter given for Figs. 4C and 5 refer in each case to two separate curves taken under exactly the same conditions.

## THE PROBLEM OF THE SHIFT ENGINEER.

[COMMUNICATED.]

The charge of a shift in central stations is entrusted to men the majority of whom regard their position merely as a stepping stone to another job. They leave no stone unturned to exchange their duties for others—shift engineers in large undertakings suffering a reduction of salary to become chief assistants in much smaller stations; compared with business houses such as banking establishments, or even manufacturing firms, the proportion of annual removals to strength of staff is startlingly large. Assuming that the average temperament of the shift engineer is not more discontented than that of the rest of mankind, there must be solid reason for this want of rest in the central-station fraternity. The more potent causes appear to be as follows:

1. *Lack of Uniform Employment while at Work.*—While a station is running steadily the work resolves itself into the dullest of routines—the introduction or withdrawal of boilers and machines (usually at previously-known times), the supervision of the stoking and driving, watchfulness over oil filtering, pumping, etc., and methodical inspection of plant. In times of peace the wildest form of excitement is probably "card taking." But alternating with this—liable to occur at any instant—emergencies of the utmost intensity may arise, calling for sharp decision and energetic action. To perform the first class of duties well, a methodical man, devoted to a humdrum existence, is necessary. The emergencies call for the highest type of activity and decision. A love of adventure is not undesirable in a "smash." The shift engineer who combines these qualities is a "rare bird" who ought to be cherished—but not spoilt—by his chief. Usually the very methodical man gets his nerves shattered by the startling circumstances that occasionally confront him, and seeks a less exciting mode of existence, as, say, a draughtsman; the adventurous man, on the other hand, must force himself to the routine or else become lax—in any case becoming dissatisfied with himself and everything about him.

2. *Indefiniteness of Responsibility.* — In nearly every station a continuous supply is maintained, and two or more shift engineers are needed. One engineer receives the plant—running and standing—from the other, whose responsibilities then end whatever faults may be developing. After eight or ten hours the engineer hands over the plant to another man in the best condition possible, and then washes his hands of the station. Now, if plant is unwisely treated, it may break down at once or the fault may mature for weeks. When two or more men are responsible in the same sense for the same plant, interest evaporates unless *esprit de corps* is unusually strong, for neither credit nor

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blame belongs entirely to any particular man. Again, outside causes—some of them so uncontrollable as to be classed as *force majeure*—disturb the running and unsettle the engineer's ideas as to where his responsibility begins or ends. Cases have also been known where the chief or chief assistant has interfered with the running of the plant without consulting or informing the engineer in charge. This is the surest way to produce discontent and a change in the staff.

3. *Social Isolation due to Irregular Hours.*—It may seem a fantastic argument, yet it is a matter of experience that in times of restlessness and dissatisfaction the fact that social ties formed in his leisure by a man in ordinary employment will have to be broken by removal very often deters him from seeking a fresh post. The shift engineer finds that his hours of work are often the times of relaxation of the rest of the world, and he becomes isolated. "A good job" is then his only passion in life, and if his present place becomes distasteful he changes it as promptly as may be. A chief of a station should be thankful when his shift engineer marries. A wife and home are a most effective sheet anchor in a storm of discontent.

4. *Smallness of Pay in Proportion to Responsibility.*—This question has been ventilated almost to excess by interested persons, but the criticisms have been ineffective because sufficient comparative figures are not available. The writer would suggest that some organisation, such as the recently-formed Shift Engineers' Society, should gather from its members and others particulars such as the following: (*a*) Value of machinery entrusted to the shift engineer. (*b*) Number of engineers on watch at one time, and length of shift of each. (*c*) Commencing salary of shift engineer, and maximum salary obtainable at the post—if possible, the time necessary to reach the maximum. Where possible, the salaries paid to assistant shift engineers should also be taken into consideration. (*d*) Number of years of recognised engineering training and experience passed through by each engineer before his post was obtained. Statistics thus obtained could then be compared with the responsibilities and training required and salaries received in our navy and mercantile marine, or in land berths where there is charge of running machinery. The result of such an investigation would be a basis on which the recognised inequalities of payment in our generating stations could be adjusted. It would be as much to the interest of master as man that fair salaries be paid, as nothing is more prejudicial to the economical running of plant than that a new (nominal) engineer-in-charge be introduced every few months to gain his local knowledge by enquiry of the men and loss of their respect.

5. *Favouritism.*—Anyone raising this cry runs the risk of being considered envious and possibly incompetent, so that it is necessary to clear the ground a little. The writer does not intend to countenance the mutual dislikes of fellow-engineers with varied trainings. The college-bred, electrical-works man does not understand how the mercantile-marine man scrapes through his shift, and the latter regards the former as unpractical. But both are competent for the job. The man who is the real incompetent—and there are many of his stamp—is the one whose uncle is a town councillor, and who served his apprenticeship to engineering by lubricating the bearings of a coffee-roasting apparatus. When he becomes a shift engineer he is, firstly, a nuisance, and, secondly, a great danger; for in this work each man has not merely responsibility for his own actions, but frequently pays the penalty for mistakes of the previous shift. One man, backed by the avuncular town councillor and a brazen unconsciousness of defect, can make things unpleasant enough to cause the rest of the junior staff to leave. A premium pupil of the chief engineer, if unduly advanced, can cause the same amount of trouble from the same cause.

The only remedy for this seems to be (*a*) education of the general public and (*b*) registration of competent engineers. There are still men having a vote who talk of electricity as being yet in its infantile stage. They know the difference between a commercial traveller and a shop-walker, but they think a trained engineer and a plumber-wireman are the same thing. When these men obtain a position of power over a central station—either as company shareholders or town councillors—the humour of the situation is carried a little too far. The responsibilities of the engineers can only be demonstrated by signs and tokens to these men, and the most convenient method of so doing would be to make a register of men with competent training and experience. The Board of Trade gives certificates to sea-going engineers who pass their examinations and obtain so many years' experience with machinery on board ship. A young civil engineer assures his position by passing the Institution's examinations and getting his name on the list of associate members. Similar societies, such as the Institute of Bankers, give status to the competent men in commercial circles. But for the vast number of shift engineers—men whose work has vital peculiarities necessitating special training—there is no criterion, except the individual bluff of the applicant for a position and the minimum wage for which he will work. The Institution of Electrical Engineers is ineffective in this connection, as purely electrical men and purely theoretical men have the same status in that society as the man who combines theory and practice, mechanical and electrical experience. It is the latter type of man only who is fit to be a shift engineer.

In giving voice to the general discontent which exists among shift engineers, and which manifests itself in rapid changes of situation, the writer is not seeking to foster dissatisfaction, but, by analysing it, to discover the remedy. The first three causes enumerated cannot be avoided, and are mentioned to show how impossible it is to cultivate an easy-going disposition in this profession. The last two reasons can be shown by abundance of proof to be very potent, and the sooner reform is effected in this direction the earlier will the junior engineers settle down to something more like steady work. We are in a state of "exchange or barter" at present; there is no fixed currency. When standards of competency and remuneration are established, there will be less chance for the wireman adventurer, and more satisfaction among the large body of skilled engineers who at present feel that they have wasted their training and best years of work for nought.

## THE BRISTOL FIRE—ITS PROBABLE CAUSE, EFFECTS, AND PREVENTION.

This subject is so interesting to all central-station engineers, that we have pleasure in commencing an analytic examination by Mr. H. W. Clothier of the causes and results of the fire. Unfortunately the diagrams were received too late for preparation for this issue, so will be given with the further remarks next week.

### Part I.—Probable Cause and Effect.

Judging by recent publications, expressions of opinion, and practical experiences in the many electricity supply stations in this country using the Ferranti cellular switch gear, the breakdown which has been freely reported in the technical and daily Press must have come as a surprise, even to those who hold the most pessimistic views respecting this particular type of gear. It is true that the efficacy of the design has been occasionally questioned for extra high-tension and polyphase working, but it has been accepted on all sides as the standard of safety and reliability for the purpose for which it was originally installed—*i.e.*, single-phase, alternating-current working at 2,000 volts, such as the system at Bristol. The number of these switchgears in use, and the remarkable freedom from serious accidents and disturbances, even when working on higher voltages, have created a confidence in the design so deep-rooted that the experience at Bristol must be looked upon as a unique exception. At the same time the writer hopes that a study of the probable cause and effects may be beneficial to those who are interested in the design or working of high-tension switchgears, and that it may help to forearm us against a repetition of such catastrophes, which, exceptional though they may be, do an immense injury to the electrical industry, not only locally, but universally. Further, it is the object of these notes to consider essential improvements on existing switchgears and the various steps that

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can be taken to eliminate risks of similar disturbances; in short, to answer the questions which at the moment must be uppermost in the minds of engineers who have this equipment under their control.

*System.*—The alternating-current system at Bristol consists of two generating stations. The first was built in 1893 at Temple Back, and has since been extended so that it now contains 10 alternators (four 400-kw., four 210-kw., two 88-kw.), the switchgear being made in the year 1899. This gear has since been extended to include 40 circuit panels. The whole equipment in this station is very cramped, the rapid growth of the demand necessitating an enlargement in the size of the machinery originally installed. In consequence, the small space occupied by the design of switchgear adopted was considered an important factor at the time. The Avonbank station has only recently been built, and contains four 750-kw. alternators. The whole of the distribution is from the switchgear at the old station, this gear being interconnected with the new Avonbank switchgear by four trunk mains. Just before the accident the summation instruments indicated a load of about 3,000 kw., which was being supplied by two 400-kw. steam alternators running at Temple Back and four 750-kw. steam alternators running at Avonbank, the latter feeding through the trunk mains, the entire plant running in parallel. The frequency is 93 periods per second, and the usual power factor under similar conditions is about 0 9.

*The Interruption.*—From a moral point of view, the most serious result was that soon after five o'clock on Wednesday evening, Dec. 23, 1903, the consumers' lights flickered, went dull, and then disappeared altogether. Some portions of the Corporation supply were re-established at 2.30 the following morning, but, despite the strenuous work of the Corporation officials and men, it was impossible to supply the entire locality before eight o'clock in the evening of Dec. 24. Thus there was a discontinuance in the supply to some districts for about 27 hours. Moreover, it was necessary to announce publicly that on Sunday, the 27th, the supply would be discontinued for two hours for the purpose of making alterations in the connections, and it is possible that further stoppages for short periods may be deemed necessary before the system finally settles down.

*Damage.*—As compared with the foregoing, the direct pecuniary loss due to the injury and destruction to the apparatus and building is slight, and would presumably be covered by insurance. The effect of the failure on the switchgear was that several of the fuse and switch panels on the machine portion of the gear were literally burnt out by the arc and pulverised by the heat therefrom; the remainder was damaged and placed out of commission by the conflagration which ensued.

*Cause and Effect.*—In such occurrences it is an onerous task to locate the exact origin of the fault, the difficulty being to discriminate between the after results and the origin, but an examination of the *débris* leads one to suppose that one or both of the machine fuses blew with a loud report due to an excess current passing through them. This action was immediately followed by a severe arc melting the metal contacts of the fuses and burning through the 2in. horizontal slate above. The arc quickly fused all metal within the darkest patch shown on the figure, and destroyed all slate, porcelain, etc, within the shaded patch shown. Even the wall shared in this treatment, a portion of it covering a surface of three or four square feet and at least 2in. deep in parts has disappeared; the hole being deeper at places where the metal conductors were most severely damaged by the arc. Such an arc fed by two 400-kw. machines from one side and by four 750-kw. machines from the other side, may well be imagined. The hopelessness of endeavouring to extinguish it was at once appreciated, and steps were immediately taken to shut down the Temple Back machines on the stop valves and to instruct Avonbank by telephone to follow suit. It will be obvious that some appreciable time, possibly three minutes or more, elapsed between the commencement of the outbreak and the cutting off of the supply. Yet the electrical destruction—*i.e.*, that directly due to fusing by contact with the arc—was confined within the four machine panels. A serious conflagration, however, must have been almost simultaneous with the formation of the arc, this being started possibly by an electrical failure on the cables, by the dropping molten metal, or the heat from the arc, to the linoleum and platform floor covering, and also to the insulation over the inner conductors of the cables adjoining the terminals under the bottom horizontal slate of the switchgear structure. The ignition and combustion of this highly inflammable material was doubtless rapid, and the heat therefrom must have been intense. The flames quickly spread over a wall space of about 40ft. The flames also leapt up to the wooden structure supporting the roof of the building, the assistanee of the fire brigade being requisitioned to extinguish the fire.

*The Re-establishment of Supply.*—According to authentic reports, it was after seven o'clock, or 1½ hours after the outbreak, that the building was entered, and the damage investigated by the aid of oil lamps which had to be procured for the purpose, the gas service being rendered unavailable by a local disturbance. No time was lost by the officials in preparing to resume the supply. A large gang of men was engaged upon clearing away the remains of the cables, etc., from under the switchboard platform. Steps were promptly taken to join up the trunk mains from Avonbank direct with some of the distributors. This meant a great deal of excavating, it being necessary to open up the road adjoining the works in order to make connections to sound cables. Ultimately the system was joined up solid by the aid of temporary 'bus bars and connections, the whole demand for load being taken up by the machines at Avonbank and one generator at Temple Back.

*(To be continued.)*

## SIR OLIVER LODGE ON RADIUM.

At the Birmingham Town Hall on Tuesday evening, Sir Oliver Lodge, principal of the Birmingham University, gave an address on "Radium and its Meaning" to a crowded audience. Indeed, so great was the demand for admission—for which a charge was made, the proceeds being devoted to the university funds—that the lecturer kindly consented to afterwards repeat his remarks to an audience of working-men, which shows the absorbing interest which the subject of radium has for all classes of the community. Mr. Chamberlain took the chair, wearing his academic robes, and was accompanied by Mrs. Chamberlain. Lady Lodge was also present on the platform.

Mr. CHAMBERLAIN, in introducing Sir Oliver Lodge—which, however, he said was quite unnecessary to a Birmingham audience—remarked that a great and almost revolutionary discovery had been made which interested the whole world of science, and their principal had, at some sacrifice of time and labour to himself, undertaken to make it clear to them, to explain it, to indicate the conclusions to which it pointed, in order that they also might share the pleasure which men found in all acquisition of new knowledge wrested from the mysteries of Nature.

Sir OLIVER LODGE then entered upon his subject. He said that in science the calculator and interpreter and wielder of theory was most looked up to by his colleagues, but the experimentalist was usually best understood. The man who could combine theory and practice to the full was a leader in science. A bare fact by itself was nothing, or was little; it was a bald, bleak thing until it was clad in theory. Sometimes a fact was born into the world before its clothes were ready. Sometimes a "layette" had been provided before the fact was born. Radium was in the latter predicament: its properties as now known went, indeed, beyond the anticipation of theory, but they were all in line with theory, and there was no difficulty in understanding them and fitting each into its niche. Not one fact concerning radium need stand outside in the cold for lack of theoretic shelter.

*Radium and Science.*—This circumstance was not generally appreciated. It was thought that the behaviour of radium revolutionised the doctrines of science. It did revolutionise some of them, but the revolution had been prepared for

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beforehand, far away from practical chemistry, in the study of the mathematician, in the laboratory of the pure physicist; a few of the leaders of physical science were on the look-out for evidence of some kind of atomic radiation, and, after the discovery of spontaneous radioactivity, were on the further look-out for some kind of instability, or some rearrangement of parts in the atom of matter. Some thought that X radiation might be found in conjunction with the phenomenon of fluorescence, and it was owing to a vague and indeterminate suggestion of this kind by the French mathematician, Poincairé, that the discovery of radioactivity was actually made by Becquerel in Paris in the year 1896, one year after the empirical, and, at first, puzzling discovery of the X-rays themselves by Röntgen in Germany had been achieved. For the X-ray theory was not ready; it came later. For all the properties of radium theory was ready, and, if not exactly waiting, was available the moment each fact was known. He intended that night to run over a few of the salient facts without attempting the impossible task of completeness in a single hour; and he would endeavour to state their meaning as now apprehended by those with whose views he was himself in accord, without delaying to controvert opponents and without pretending to marshal all the arguments and reasoning on which those views were based. It was, indeed, the meaning of the facts on which he would mainly concentrate attention, and for brevity he would have to be dogmatic, and to deal mainly with definitely stated results. To judge of the arguments on which they were based required long consideration and expert knowledge, but every educated person might be interested in the results themselves, and, indeed, it should be the privilege of the citizens of a university city to have the latest advances in science explained to them. At the outset, and to avoid disappointment, he wished to state that he intended to say nothing about the price of radium, the point which aroused most attention; nor should he speak about its hoped-for medical uses, which was the second point of general interest, for the development of that side lay in the future.

*Theory.*—In order to be clear he must begin with theory and state our present view of the nature of the atom of matter. They owed this view to the labours of many, but to two Englishmen in especial did they, in his judgment, owe it. At this point a page of the Cambridge Calendar was thrown on the screen, showing the position in the Tripos for 1880 of the two great men Larmor and Thomson, now professors, at Cambridge, of mathematics and physics respectively. From them and others they learned, Sir Oliver Lodge proceeded, that electricity existed in small particles, which they could in a manner "see" in the cathode or Crookes rays and which were called "electrons." These composed the atoms of matter. Atoms were small; 300 million of them could lie in a row side by side in 1in., and there were a trillion of them in each granule of lycopodium dust. But electrons were very much smaller, 100,000 of them could lie in the diameter of an atom, for they were a thousand-million-million times smaller in bulk than atoms were; they were to atoms as a grain of dust shot is to the size of the town hall. On the screen was now thrown a portrait of an atom of matter, as near as they could estimate it at present, consisting of positive and negative electricity and nothing else—the negative electrons in a state of violent movement, with occasional possibility of escape. An electric charge in motion constituted all the electric currents and magnetism, and it possessed momentum; further, when accelerated it should, by Poynting's theorem, generate radiation. Hence, on the view, or mathematical theory, that the atom was actually so constituted, the absence of atomic radiation in the year 1895 was a difficulty; the escape of the electrons as projectiles was probable; and soon afterwards it was realised that, since the atom was composed of parts, the occasional disintegration of an atom was not unlikely. These three expected effects had now been experimentally observed in the radiation from two or three different elements, and constituted what were called the Gamma rays, the Beta rays, and the Alpha rays respectively.

*Experiment.*—But here they opened a new chapter. The phenomenon of fluorescence was first understood by Stokes, and after the discovery of Röntgen rays the phosphorescent substance, uranium, was studied by M. Henri Becquerel in 1896 to see if it emitted rays which could affect a photographic plate after penetrating black paper or other opaque material. Becquerel found that even when it had not been exposed to light it did give off such rays slowly, and thereby he effected the discovery of radioactivity, the most sensitive test for it being the discharge of an electroscope in the neighbourhood of the substance. All compounds of uranium did the same thing, and Schmidt found that thorium and its compounds likewise had the property. Mme. Curie, then a senior student at the Municipal School of Physics and Technical Chemistry in Paris, took up the subject of radioactivity as a thesis for her doctorate, and made quantitative measurements of the radioactivity of a great number of minerals. She found that pitchblende and oxide of uranium, especially the variety found in Bohemia, was even more radioactive than uranium itself, showing that it must contain a specially radioactive impurity, and this she set herself to isolate. The only test she had for it was its radioactive power, and the method was to try chemical processes upon the ore, such as solution, precipitation, evaporation, crystallisation, and the like, so as to divide the substance into two parts, and then to test which part was the more radioactive. In that way the trace of radioactive substance could be followed up through a number of chemical processes. It was found that the residue of the pitchblende, after extracting the uranium, was 4½ times as active as uranium. These residues were fused with carbonate of soda treated with acid, precipitated with sulphuretted hydrogen, and so on, the guiding principle being that, while the chloride of the substance was soluble, the sulphate was insoluble, until at length 16lb. of material was obtained out of a ton of the residues by semi-manufacturing or large-scale processes, these 16lb. being 60 times as strong as uranium, and consisting chiefly of barium chloride. When this barium chloride was dissolved and crystallised the part which crystallised first was found to be five times as radioactive as the remainder. Hence, by repeating the process of solution and crystallisation a great number of times, and getting a result five times stronger each time, a substance was ultimately obtained, though in very small quantities, which was a million times more active than uranium. At first only a tenth of a grain was obtained by Mme. Curie from two tons of residue, but with this she proceeded to determine the atomic weight of the new element, and gradually came to the conclusion that it was 225 on the scale hydrogen = 1 The German chemist, Giesel, was now able to obtain four grains of radium bromide from one ton of pitchblende or uranium residues. The spectrum of radium had also been observed, and it behaved like an element of the calcium-strontium-barium series. The Austrian Government, advised by Prof. Suess, assisted Mme. Curie by placing some tons of the residue at her disposal, for poverty was a considerable barrier in the early stages of this research. Prof. Curie now joined his wife in the investigation, and by them and others many curious details concerning the behaviour of the several radioactive substances were detected—*e.g.*, their activity was not constant, it gradually grew in strength, but the grown portion of the activity could be blown away, and the blown away part retained the activity only for a time; it decayed in a few days or weeks, whereas the radium rose in strength again at the same rate as the other decayed; and so on constantly. It was as if a new form of matter was constantly being produced, and as if the radioactivity was the concomitant of the change of form. Last year, also, Prof. Curie found that radium kept on producing heat *de novo* so as to keep itself always a fraction of a degree above the surrounding temperature, also that it spontaneously produced electricity. The production of heat attracted general attention; it was taken up by the English Press, and the whole thing emerged from the scientific world and came into public notice.

*Analysis of Radiation by Magnet.*—Speaking of the analysis of radiation by magnet, he said the rays from any of the substances were found to be of three kinds—Gamma rays, which were very penetrating, could be detected after passing through a foot of iron, and were possibly

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a variety of X-rays; Beta rays, which consisted of flying or escaped electrons; and Alpha rays, the nature of which was investigated by Rutherford, late of New Zealand, then an 1891 student at Cambridge, now of Montreal. These last were found to consist of atoms of matter, each 1 per cent. of the weight of a radium atom, projected from it with a velocity of 100,000 miles a second. These were the projectiles which made the luminous splashes on a target in Crookes's spinthariscope. The material which remained behind was called the "emanation"; it was much more active and unstable than radium itself, and was the part which could be blown away like a gas. Its amount was infinitesimal, but its radioactive power enabled it to be followed, and to be generally investigated. It rapidly collapsed into other substances, and at the end of a few days or weeks had changed into something which was non-radioactive, and could, therefore, be no longer followed. The whole phenomenon was intelligible and simple on the theory that activity was due to atomic disintegration; it was entirely unlike any chemical operation; it was enormously more energetic for one thing, and it was quite unaffected by temperature for another, being of the same intensity at red heat and at the temperature of liquid air. Rutherford's measurements last February made it probable that the atomic particles thrown away in the Alpha rays, to the bombardment of which the heat production was due, consisted of helium, because their atomic weight appeared to be twice that of hydrogen; and now quite recently Ramsay and Soddy, working together at University College, London, had confirmed this beyond cavil by actually seeing the spectrum of helium gradually develop in an excited vacuum tube into which only radium emanation had been put.

*Consequences.*—The spontaneous breaking up of an atom constituted a novel source of energy larger than any previously known. The amount of energy of any weighable collection of atoms was enormous if it could be got at, but in practice only a very few atoms were unstable from instant to instant. Most behaved as if they were permanent; but they were probably none of them really and eternally permanent. The discovery of this new or intra-atomic energy affected their estimate of the possible life of the sun, and, to some extent, of the probable geologic age of the earth. But the most important consequence was the discovery of the mutability of matter, the transmutation of elements, and the liability of material atoms to break up or explode. In old days Heraclitus promulgated the doctrine that the universe was not a "being," but a "becoming"; that everything was in a state of flux—"Πάντα ρεῖ"—that nothing was stationary, or fixed, or permanent. It was absolutely true. In human life the fact was easily recognised; all their efforts were towards the future, their instinct would not allow them to rest on their oars and enjoy the present. Vegetation and degeneration awaited any man or any nation that ceased to energise; they were working always for a future, for the next improvement or advance that they saw to be possible, for a state of things not yet realised, but attainable; and when it was attained they should be working for something still further ahead, and so always. Activity was the rule through the whole world of life, through the solar system and the stellar universe also. Birth, culmination, and decay was the rule, whether it were for a plant or an animal, or for a nation or a planet, or a sun. Twenty years ago it was thought that the atoms of matter were exempt from this liability to change. The form or grouping of the visible material aggregates changed, indeed, but, as Maxwell said, the atoms themselves "remained constant . . . they were the foundation-stones of the material universe, and were perfect in size and number and weight, unchanged and unchangeable, not capable of wear, but as true to-day as when they were coined at the mint of the mighty artificer in some inconceivable dawn of creation." Not so; the process of change has now been found to reach to these also. Nothing material was permanent. Millions and billions, aye, trillions of years it might last, but it was slowly changing, not merely the groupings, but the foundation-stones themselves. The atoms were crumbling and decaying; must they not also be forming and coming to the birth? This last they did not know as yet; it was the next thing to be looked for. Decay only, without birth and culmination, could not be the last word. The discovery might not come in their time, but science was rapidly growing, and it might. Science was still in its early infancy; they were beginning to comprehend a few of the secrets of Nature; they were yearly coming nearer to some sort of comprehension of the mind and method infused into the material cosmos. They now knew things which had been hidden from the wise and prudent of all time. Surely somewhere there must be joy at seeing man thus entering into his heritage and realising these primal truths concerning his material environment, whereof he had been living in ignorance all these thousands of years.

At the conclusion of the lecture, which was illustrated by limelight views, the audience unanimously gave a vote of thanks to Sir Oliver Lodge.

## FORTHCOMING EVENTS.

SATURDAY, JAN. 9.

**Glasgow Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "The Manufacture of Weldless Chains," by Mr. Alex. G. Strathern.

**West Hartlepool Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Boiler Feed-Water," by Mr. J. W. Patterton.

MONDAY, JAN. 11.

**Institution of Mechanical Engineers** (Graduates' Association).—At 7.30 p.m., ordinary meeting. Paper: "Electric Passenger Lifts," by Mr. P. H. Stevens.

TUESDAY, JAN. 12.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper: "The Electrical Reconstruction of the South London Tramways on the Conduit System," by Mr. Alexander Millar.

**Institution of Electrical Engineers** (Glasgow Section).—Ordinary meeting.

WEDNESDAY, JAN. 13.

**Society of Arts.**—At 5 p.m. Juvenile lecture: "Navigation of the Air," by Mr. E. S. Bruce, M.A. (Lecture II.).

**Liverpool Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "Motor Vehicles," by Mr. W. Norris.

THURSDAY, JAN. 14.

**Institution of Electrical Engineers.**—At 8 p.m., ordinary meeting. Paper: "The City and South London Railway—Working Results of the Three-Wire System applied to Traction, etc." by Mr. P. V. McMahon (adjourned discussion); "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg. Dublin Section.—At 8 p.m., ordinary meeting. Paper: "Three-Phase Working, with Special Reference to the Dublin System," by Mr. Wm. Brew.

**Birmingham University Engineering Society.**—Ordinary meeting. Lecture by Prof. T. Turner on "Carbon in Iron."

FRIDAY, JAN. 15.

**Institution of Mechanical Engineers.**—At 8 p.m., ordinary meeting. Paper: "Sixth Report to the Alloys Research Committee on the Temperature of Steel," by the late Sir Wm. C. Roberts-Austen, K.C.B., etc., and Prof. Wm. Gowland.

**Royal Institution.**—At 9 p.m., discourse by the Right Hon. Lord Rayleigh on "Shadows."

## APPOINTMENTS VACANT.

**Electrician** to take charge of test-room of large electrical engineer's works. See advertisement.

**Electrician** for London music hall. See advertisement.

**Assistant** in mains department; able to make all necessary plans and records of mains laid. Apply by letter only to Manager, National Electric Supply Company, Limited, Preston. See advertisement.

**Clerk of the Works,** St. George's Union, London. Applications by Jan. 11. See advertisement in former issue.

**Assistant Electrical Engineer,** Bengal-Nagpur Railway Company, Limited. Jan. 15. See advertisement in former issue.

**Installation Foreman Canvasser,** Woolwich Borough Council. £104 per annum and 3d. per equivalent 8-c.p. connected. See advertisement in last issue.

**Chief Assistant Electrical Engineer,** Supply Company near London. Apply, 429, *Electrical Engineer* Office. See advertisement in last issue.

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**Assistant Jointer,** Electricity Works, Tynemouth. See advertisement in last issue.

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THE
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## GAS AND ELECTRICITY.

The questions of cheapness, of dearness, of expediency, together with a host of others, are not easy of general solution, otherwise the controversies anent gas and electricity would have been settled long ago. It is all very well to talk about these things in the abstract and to prove a particular case up to the hilt, but in practice we have to deal with the concrete, and to consider varying conditions. The same state of things holds good for most mundane affairs. Men have to specialise in business life; they learn the ins and outs of their own business, but are usually wholly uninformed about other businesses or the intimate interconnection of one with all others. If a man dogmatises to the extent of saying the business of primary importance in this world is connected with the getting of foodstuffs and all others are subsidiary to it, he would possibly be laughed at by the multitude, but as a matter of demonstrable fact he would not be far wrong. Did not the late Charles Kingsley write "Alton Locke" with a purpose or purposes, one of these purposes being to show that the highest cult of business life was not buying in the cheapest and selling in the dearest market. The limitations to this cult are numerous, but none more so than when it is applied to considerations of gas and electricity. During the past year one of the most interesting meetings of the Municipal Engineers was held at Runcorn and Widnes. At the latter place Mr. J. Carr, the gas engineer, and one of the ablest men in his profession, explained why Widnes had not taken to electricity. He is reported to have said: "The prices charged for gas are lower than those of any other gas authority in the world." The prices are 1s. 4d. and 1s. 2d. for lighting and 1s. for power per 1,000 cubic feet. Not only are these prices low comparatively, but they are low relatively, as the calorific value of gas at Widnes is high (670 B.T.U.). Mr. Carr holds that such gas at 1s. per 1,000 cubic feet is cheaper than Mond producer gas at 3d. per 1,000 cubic feet, and that electrical energy, to be directly equivalent as regards prices, must be sold at ¼d. per unit; that means, roughly, that its cost of production must not be more than ⅛d. per unit. Here, then, you have a particular case, but that case cannot be applied to any other district when the conditions are different. The case of Widnes is exceptional. No other town situated on or near coalfields has approached it. Why? The answer to the question is summed up in "the man and the prevailing conditions." The charges for gas last year at other towns favourably situated was per 1,000 cubic feet: Smethwick, 1s. 9d. to 2s. 9d; Wigan, 2s. 3d. to 3s.; St. Helens, 2s. 6d.; Leicester, 2s. 6d.; Liverpool, 2s. 8d; Salford, 2s. 9d. to 2s. 10d.; Stafford, 2s. 10d.; Workington, 2s. 11d.; Atherton, 3s.; Warrington, 3s. 1d.; Darlington, 3s. 3d.; Tyldesley, 3s. 5d.; Newcastle, 3s. 6d.; Barry, 3s. 9d.; Coalville, 4s. 7d. That is, from about double to more than four times that charged at Widnes, and we think we are correct in stating in all cases of a lower calorific value. Taking the figure used by Mr. Carr when comparing electricity with the gas supplied at Widnes—¼d. per unit—in the cases of these other towns the figure for electricity would work out at ⅜d. to more than 1d. per unit—that is to say, if electricity, to be as cheap as the cheapest gas produced in the United Kingdom, that of Widnes, must be sold at ¼d. per unit; to be as cheap as the gas sold in the most favoured towns apart from Widnes, it must range in price from ⅜d. to appreciably more than 1d. per unit. To be exactly comparable with Widnes, owing to the high heating value of the Widnes gas, slightly higher figures would have to be taken for electricity, as the gas in the other towns is of a lower heating value than that of Widnes.

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This would bring the figures for electricity, to be equal to the gas in the other towns, to a larger fraction of 1d. than ¾d. as the lowest limit, and to a fraction over 1d. for the highest limit, say ·90d. and 1·15d. Let us see what the best terms are on which electricity is being supplied for power uses other than for electric tramway purposes at the present time. For industrial uses alone electricity is being supplied at the undermentioned rates in the number of towns stated:

| Rate per unit. | Number of towns supplying at the rate (for power). | |
|---|---|---|
| 1d. | 5 | 22 |
| 1¼d. | 3 | |
| 1½d. to 1d. | 2 | |
| 1½d. | 12 | |
| 1¾d. | 2 | |
| 1⅞d. to 2d. | 1 | |
| 2d. to 1d. | 4 | |
| 2d. | 29 | |
| 2d. to 1⅛d. | 2 | |
| 2d. and 1d. | 11 | |
| 2d. to 1¼d. | 2 | |
| 2d. to 1½d. | 6 | |
| 2¼d. | 1 | |
| 2d. and 1⅛d. | 2 | |
| 2¼d. to 1¼d. | 4 | |
| 2½d. | 37 | |
| | 123 | |

From the above it will be seen that at the present time in 22 towns electricity is being supplied for industrial power uses at charges between 1d. and 1½d. per unit, a range approximating very closely to the range of the best gas supplies in towns other than Widnes. In 123 towns supplies of electricity are provided at charges within a range of 1d. to 2½d. per unit. This range, of course, shows gas to be the cheaper medium, but to compare the two sets of figures simply without regard to conditions, would be an unfair and misleading comparison. There are facts affecting each set of figures which must be taken into account if a correct conclusion is to be arrived at by a comparison of the figures. As regards gas, it will be recognised that the charges for gas supplied through town gasworks are not likely to be much reduced. Producer gas, doubtless, is destined to play an important part as a medium for heating and power production, and is being generated at a cost slightly above 1d. per 1,000 cubic feet. The computations of the earnings of the South Staffordshire Mond Gas, Power, and Heating Company, at the time of the formation of the company, were based on a sale price of 2d. per 1,000 cubic feet, though the company are empowered to charge 3d. and 4d. per 1,000 cubic feet. Producer gas of the kind is, however, likely to be used for heating rather than in gas-engines, though that gas-engines of a larger class will gradually come into use is certain. Such engines are hardly likely to become serious rivals of electricity in the power field for different reasons. It has yet to be proved that, with the larger engines, gas power will be more economic than electrical power. The pregnant facts of the present hour are that much electricity is being supplied for power purposes at a price which is not higher than that of coal-gas as generally obtainable; that a very large supply of electricity is now obtainable at a charge but little higher than that for coal-gas, and that, surely and steadily, the charge for electricity is being reduced. Generally, the charge is not yet as low as that for coal-gas, but the striking fact is that the charge for electricity has in so short a time been reduced to what it now is. Setting aside the solitary case of Widnes, much electricity is being supplied at a price as low as the lowest price of gas, and week by week the quantity so sold is being increased. The situation reveals the remarkable advance which has been made in the past in the provision of electricity for industrial purposes, and indicates that at no distant time electricity will be at least as economic a medium for power use generally as coal-gas has ever been, or is ever likely to be. It will be seen that even if costs are compared directly, electricity has not much further ground to gain before taking the leading position. The figures given are useful, but far less so than is the gradual acceptance of the idea that the indirect advantages greatly outweigh any small difference in direct cost.

## REVIEWS.

**Electric Traction: A Practical Note-Book on the Application of Electricity as a Locomotive Power.** By J. H. Rider, Chief Electrical Engineer to the London County Council Tramways. 10s. 6d. Whittaker and Co., 2, White Hart-street, E.C.

This latest addition to the well-known "Specialists' Series" by the same publishers is well worthy to take its place amongst the other excellent books in the series. In it the author has dealt with the subject of electric traction from the practical and commercial point of view. The book only contains some 450 pages, and yet the information is exceedingly full. To put the matter generally, the book gives evidence that the author has condensed information for his own use, and then incorporated it in the present volume for the use of others. The result is that he has avoided long detailed descriptions of apparatus, and given instead outlined descriptions which are quite clear to electrical engineers. The author's comments at the end of such descriptions of electrical traction systems, or of detailed apparatus used on electric tramways, are exceedingly valuable. As mentioned in the preface, the mathematics used in the book are exceedingly simple, and, wherever possible, curves are used instead of algebraical formulæ. In the introduction, which forms the first chapter of the book, one quickly becomes acquainted with Mr. Rider's methods of considering all problems from the commercial point of view. For instance, in dealing with comparisons of cost of working, he shows the utter fallacy of working out these figures at so much per car mile. The object of a tramway or a railway is to carry passengers, and we agree with the author that the "cost per passenger mile" is the only reliable figure for comparison. The cost per car mile is made quite worthless by the fact that the capacity of a car varies from 24 passengers on some lines up to 124 on others. At the end of this chapter the relative advantages of corporation and company ownership of tramway undertakings is discussed. The fact that a corporation, while able to borrow money at cheaper rates than companies, has to repay annually a certain portion of the capital, is referred to. Mr. Rider goes on to say: "With a company the case is different, its capital being borrowed in perpetuity is subject to no sinking fund charges, and any working profit is available for paying dividends. In the long run, the advantage is bound to be with the local authority, because the annual sinking fund payments are gradually extinguishing the capital debt. But, for the moment, the company can work more cheaply than the local authority." While the author is right as far as he has gone, we think it would have been advisable to have mentioned the fact that the company, while borrowing its capital in perpetuity, has only a limited period to its tramway powers; in consequence, unless a company is prepared to provide annually a sinking fund, as corporations are bound to do, there will be considerable trouble with its finances when its powers expire, and when the undertaking is transferred at its then value to the corporations interested.

In the next chapter, which deals with generating plant, the commutator trouble with large direct-current generators is referred to. It is pointed out that it is exceedingly difficult to get a commutator built up of small pieces of copper and insulation of satisfactory strength to resist the expansion forces due to changes of temperature. The author adds that if only satisfactory alternating-current motors could be obtained, there is little doubt but that direct-current machines would disappear from tramway power stations. It is interesting in the face of this prediction to note that in the most recent developments of single-phase motor design for traction purposes, the change as

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above suggested would only result in the transfer of the commutator troubles from the power station to the motors on the cars.

At the end of this chapter some useful figures are given as to the comparative efficiencies of direct and alternate current generators, and also of the way in which the losses in these machines may be divided up. On the question of engine design Mr. Rider has a good deal to say, and here, as in other parts of the book, his general conclusions will, we think, be endorsed by the majority of tramway experts. He concludes, for instance, that for the varying loads found in tramways there is no advantage in installing triple-expansion engines for steam pressures up to 160lb. per square inch. Even with pressures as high as 200lb. per square inch doubt is expressed as to whether the added complication of a third cylinder, with its crank and valve gear, is warranted in view of the comparatively small increase in efficiency due to three expansions instead of two. On the question of governing steam-engines used for driving alternators in parallel, the author condemns specifications which require as low a variation as 2 or 3 per cent. between no and full load. Unstable governing is likely to ensue, and the author considers engineers would do well to decline to accept any governors which control the engine speed closer than 5 per cent. If this limit is adopted and due care taken to secure an even turning movement from the engines, there is not likely to be trouble in parallel running.

In the chapter dealing with switchgear the utmost simplicity and reliability is advised for all traction switchboards. With the introduction of high voltages much more care has to be taken in the design of switchboards, with the result that the old flat panel type is disappearing. Even in those instances as illustrated in the book, in which the front of the switchboard is flat, it is usually found that the hand-wheels and handles on this board are not directly connected to the switches. In other words, there is no high-voltage metal on the face of the board. The switchgear is then placed behind and worked by insulated levers. Even then the space at the back of the board is dangerous, and the author gives preference to the Ferranti type of construction.

The chapter on distribution is one in which authors as a rule display their mathematical knowledge. We are pleased to see, therefore, that Mr. Rider has given sufficient information for any reader to work out his distributing cable without any mathematical formulæ. Instead, a series of curves are given which enable the most economic section to be ascertained, both from the point of view of voltage drop and also on the economic grounds laid down by Lord Kelvin. The author advises that these curves should be enlarged if they are to be used for practical work, but even on the scale on which they are reproduced in the book they will be found of service for making preliminary determinations of the sizes of traction cables. In this chapter information is also given of sub-station equipment supplied on the three-phase system, and the rotary converter *versus* the motor-generator question is discussed. After giving the advantages of each system, the author leaves his readers to decide which system is best for individual cases.

The other chapters in this book deal with the subdivisions of electric traction work in the following order: motors, controllers, rolling-stock, permanent way, overhead systems, conduit systems, surface-contact systems, accumulators, combined lighting and traction stations, and electric railways. The chapter dealing with surface-contact systems is typical of Mr. Rider's method. All the principal systems are mentioned and the essential details of each given, but their faults are not passed over. Thus of one system it is said: "The fact that the circuit is broken in a vertical direction tends to maintain any arc which may be set up, and although no arcing is supposed to take place, yet it does in actual practice." Such criticisms are worth much in a hand-book for specialists. The conclusion on all surface contacts is that "no engineer who values his peace of mind would willingly put down a system which means the use of probably 1,000 switches per mile of roadway, the failure of any one of which may have fatal results." The conduit systems suffer, as the author states, from the high cost of construction, and also from the fact that the upkeep charges are higher than with the overhead trolley system. Actual figures of cost are given, and also many valuable points on how not to construct conduits. The details of recent conduit construction in London are the more valuable from the fact that the author is describing work carried out under his own supervision.

The volume concludes with a chapter on electric railways, in which what has been done in this line is briefly summarised. More space is given to the greater problems before us, and to the various systems proposed or actually tried for dealing with main-line traffic Here, again, the author's opinion for and against certain schemes for working is freely given. The "cascade" connections for two alternate-current motors are described and compared with the series-parallel system of controlling direct-current motors. This comparison fails after half-speed has been reached, as then only the first alternate-current motor can be used to complete the acceleration and to drive the train. The author concludes that "the electrification of suburban lines must be carried out within the next few years, or the lines as we now know them must cease to exist. With regard, however, to main lines it is a different matter, and while one or other of the systems described may prove to be the right one, there is not at the moment enough experience to warrant any railway company in throwing on one side its large and expensive stock of steam locomotives in order to equip with electricity. But that it will come in time there can be no doubt. Meanwhile, whatever may be said of main lines, there is no excuse for delay in the electrification of suburban lines."

This book is one which will be found most useful to all engaged in traction work, and we know of no better medium for a young engineer to read when taking up the subject for the first time. It will be easily followed by anyone with a knowledge of general electrical work, and the practical conclusions given in every section may be safely accepted. In fact, the subject is treated critically, and it is this which gives great value to Mr. Rider's work.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

### QUESTIONS.

651. Describe some form of transmission dynamometer suitable for measuring the power supplied to a pump.—H. E. H.

652. I wish to run a 100-volt 10-h.p. dynamo as a motor for starting an oil-engine. Energy would be supplied from a battery. Give sketch of connections showing how this can be done.—H. H. R.

### ANSWERS.

*Question No.* 643.—A country town of about 5,000 inhabitants has a power company's high-tension mains passing through it from which it could obtain power—high-tension three-phase—in bulk at a fixed rate. State the advantages and disadvantages and compare the costs of distributing energy on (*a*) direct-current, three-wire system and (*b*) low-tension, three-phase, four-wire system, the lamp voltage being same in both cases.

*Best Answer to No.* 643 (*awarded* 10*s.*).—The most satisfactory form of electricity supply for a particular town is so dependent on local conditions, that the best one can hope to do, when asked such a question as this, is to lay down the broad principles on which the decision should be based, and to assume probable circumstances in order to give comparative figures and reduce abstract reasoning to concrete example; and it is impossible in considering this question fully to leave out of consideration the question of supply on the two-wire direct-current and single-phase systems, as these with suitable conditions may prove better than either of those suggested.

In the first place, a "power company" exists to supply power, and does so, wherever possible, direct from its high-

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tension mains, save only for static transformation. The mains are laid down with a view to economy of copper, and pressure drop is absolutely disregarded so long as it is not sufficient to throw motors out of step. It is hence certain that in nine cases out of ten such a town could not take current for lighting either from static transformers or rotary converters, since these transmit in full all pressure fluctuations, but *must* adopt motor-generators of some form. The low periodicity—probably 25 ⁓—is another factor that would prevent a satisfactory supply being taken from static transformers.

The power company's mains will probably be 10,000 or 6,000 volts, and they will probably prefer to have the high-tension transformers entirely in their charge, and to meter and sell the current at such low voltage as is wanted, 220 or 440 volts perhaps; and as it is not safe to put even 6,000 volts on to a small motor without very special precautions, it may be taken as certain that transformers will be installed by the town if not by the company. Considering the motor-generators, as a synchronous motor's speed is dependent solely on the periodicity — *i.e.*, on the engine speed at the generating station—it is absolutely unaffected by load or pressure variations short of falling out of step, while an induction motor slackens its speed from 3 to 5 per cent. as full load comes on, and also varies a per cent. or two with fluctuations in voltage, it will be preferable, in spite of the necessity of special starting apparatus, to instal synchronous motors. The fact that these have a better power factor than induction motors is a benefit to the power company, but, of course, does not affect the town. The question as to whether direct-current generators or alternators, and if the latter whether single or polyphase, should be used, will be taken later.

We must now consider the town, as this will have large bearing on the system. Its population is 5,000, and a guess at the connections to be provided for initially will put these at 3,000 8-c.p. lamps, equivalent to, say, 100 kw. It may be noted that the load will be almost entirely lighting, since if the demand for motors in the town is at all large, the power company will supply three-phase current "in the rough" for this purpose at a much lower rate than the town can touch. Next allowing for the diversity factor of the load, and remembering that a good motor-generator will easily deal with an overload of 50 per cent. for the short duration of the peak, we shall probably be quite safe in calculating upon a maximum load of not above 75 kw., and upon a motor-generator rated at 50 kw. being quite able to see this through. Of course, we must have spare, and it will be best to put in two 50-kw. sets, as these with switchgear will cost less than three sets of 25 kw., and though initially not so economical, perhaps, in working, will give a better plant when extensions become necessary. The system of distribution must be dealt with in conjunction with the size of the town. And here, also, the personal element of the consulting engineer comes in, as one has to set a monetary advantage in one respect against ease of handling in another, or certain capital expenditure *now* against probable expenditure at a later date; so that on the same data two men may give very different advice, and one can, therefore, do little more than generalise and approximate.

Supposing the town to be compact, consisting of one main street about a mile long, with cross streets off this, then it will be possible to locate our station in a side street just off the centre of the town, so as to be within about 1,000 yards of the most remote customer—and be it noted that having but motor-generators, with, perhaps, a battery, in the station, requiring but little space, it will pay to locate it near the centre of gravity of the load. In this case a direct-current system will undoubtedly be best, and it is simply a question of two or three wires. If, on the other hand, the town is scattered, with shops at one end and with the largest residential houses a mile or so out in various directions, singly or in small clumps, then one would naturally look to an alternating system to give the best results; and it would certainly seem that the simplicity of the single-phase system will quite outweigh the saving of copper of a three-phase supply. Generating single-phase currents, we would have alternators of a periodicity of 50 or 60 ⁓, with one pole earthed, and, therefore, a simple switchboard, with a voltage of 2,200 or so. Our high-tension feeders would be concentric cables (with light insulation on the outer), lead sheathed and armoured, and laid direct in the ground. With conductors of ·025 square inch the feeders would each allow of 50 kw. of transformers being installed, and would cost in average ground 5s. 9d. per yard, including a pilot wire, the transformers being installed in street boxes or on customers' premises according to circumstances. A four-core wire for three-phase transmission would undoubtedly cost more, since with cables of this size it is handling and labour, and not materials, that is the prominent factor of cost. And there would be no economy in distribution with the three-phase system, since one would undoubtedly put down for a scattered load single-phase transformers of 5 kw. or 10 kw., or smaller where on customers' premises, whether three or single phase generation and transmission are used.

To turn now to the comparative cost of the station plant, we would require on the continuous-current two-wire system two 50-kw. sets, each consisting of a synchronous motor, direct-current 220-volt generator, and induction motor starter. For the three-wire system we would replace the direct-current machine by a pair of 25-kw. dynamos, direct-coupled to the one motor, so that the circuits should be self-balancing, and with the alternating supply our sets would consist of the synchronous motor, an alternator, an induction motor starter, and an exciter. The relative cost per set would be approximately:

| | |
|---|---|
| Two-wire, direct current | £450 |
| Three-wire, direct current | 500 |
| Alternating current (single phase) | 525 |
| Alternating current (three phase) | 500 |

The cost of the switchgear may vary over wide limits, according to the number of feeder panels and the degree of complexity of the instruments, but assuming equally complete and serviceable arrangements, the comparative cost of the switchboards erected complete and with all cable connections will be approximately:

| | |
|---|---|
| Two-wire, direct current | £400 |
| Three-wire, direct current | 475 |
| Single-phase, alternating, 2,200 volts | 550 |
| Three-phase, four wire, 3,800 volts | 700 |
| Ditto, 380 volts | 550 |

The three-phase board becomes very expensive owing to having three live poles, the centre point of the star being earthed. The single-phase board is less complex, as one pole only is alive.

It is well to point out that one customary trouble of an alternating station does not have to be considered in this case—viz., synchronising the generators. For in all systems with synchronous motors these must be synchronised on to the 'bus bars, and as soon as this is done, since the motors will have fewer poles than the generators, the latter are bound to be held firmly in correct phase, and can be thrown in parallel with as much readiness as direct-current machines. The attendance necessary at the station would be one man on each shift to see that things ran smoothly, keep the voltage steady at time of varying load, and to comply with the Board of Trade requirements as to keeping someone in charge where there is running machinery. These at £65 each would come to £195 per annum. If, however, on the continuous system we put down a battery of 80 kilowatt-hour capacity on a nine hour basis, and capable of giving 25 kw. for short periods, we will incur a capital expenditure, including switchgear, cable connections, and accessories, of about £750; and by charging this during the whole of one shift, except just when the peak required the full power of the motor-generator, it would be possible to close down the station for nine months in the year from midnight to 4 p.m., leaving such load as there might be on the battery, for with a maximum load of 75 kw., and a load factor of 12 per cent., the daily output will average but 216 kilowatt-hours, of which the 16 hours of light load, except just in the depth of winter, will certainly not total more than 60 per diem. This will enable two attendants to be dispensed with, the "outside man" giving a look in during the course of each day to make sure there has been no abnormal demand on the battery. The saving in labour

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will thus amount to quite 12½ per cent. of the cost of the battery, while the efficiency of this, with the low charge and discharge, will be higher than that of the motor-generator at low load.

Reverting to the case of the compact town above mentioned, we may briefly consider the cost of cables on the various systems, and more especially two-wire and three-wire direct-current. We may assume for comparison that current is to be transmitted 1,000 yards in three directions, with a maximum load of 30 kw. on each feeder. On the two-wire, 220-volt system we have 137 amperes on each feeder, and may make these 300 yards in length, laying pilot wires, and raising the 'bus-bar voltage according to the mean voltage at the feeding centres. The feeders may be ·20 square inch concentric cables, lead sheathed and armoured, and costing, laid complete with pilots, 11s. per yard (in average roads) or £165 each, and dropping as a maximum about 10½ volts. The distributors would run outward 700 yards, and back towards the station 300 yards, and as the latter will in general be the more heavily loaded per yard run, we may allow on the outward branch a maximum load of 18 kw., or 82 amperes, and the sectional area may be ·2 square inch for the first 350 yards, and ·1 square inch for the last 350 yards, the cost being respectively about 10s. and 6s. 9d. per yard. The distributor running towards the station may be ·10 square inch. These sizes will keep the voltage drop at all parts within a reasonable limit even at heaviest load, and will allow of some extensions before extra cables are needed. The total cost of each feeder with its distributors (ignoring branches and house connections) will be then about £560—a figure by no means excessive.

With the three-wire system, at 440 volts on the outers our feeders will each take 68 amperes, and may be 200 yards in length, consisting of ·10, ·10, ·05 triple-concentric, costing with pilot 10s. 6d. per yard. The distributors may be three-core cable, ·075, ·075, ·04 square inch for the first 300 yards outwards, and ·05, ·05, ·025 square inch for the remaining 500 yards, and 200 yards of this latter size towards the station, the cost being respectively 7s. 9d. and 6s. 6d. per yard laid complete, and the total cost will be feeders, £105 each; distributors, £345; or £440 total, as against £560 on the two-wire system. And as the three-wire system will permit of greater extensions before further cables are added, and will show increased economy with every extension order, it will in this case just about pay to incur the greater cost and complexity entailed by the three-wire system over the simple two-wire.

As to the use of alternating current in this case, the cost of a 30-kw. transformer in a road box would be about £100, and about £70 for one of 15 kw. The high-tension feeders we saw cost 5s. 9d. per yard, so that a 300-yard feeder and 30 kw. transformer would cost in all £186, against £155 for the two-wire direct-current feeder they would displace. And though by multiplying feeding points we could cut down very largely the cost of the distributors, still it is quite safe to say that in such a case as this the cost of the transformers required, plus the capitalised cost of their losses, would much more than counterbalance the saving in copper. And, moreover, the alternating-current system prevents the use of a battery, which, as shown above, is likely to be very useful in a case such as this. If a four-wire, three-phase system were to be adopted in a case such as this, it would be best to make it low tension throughout, except, perhaps, for a special feeder to an outlying part, but one would hardly adopt an alternating system in preference to a direct-current one, unless one wished to transmit at high pressure.

For transmitting 30 kw. on a three-phase, four-wire system with 220 volts at the lamps, we shall have 10 kw. per phase, or 45·5 amperes per wire. The drop in voltage at the lamps will be that due to the drop in one wire (assuming balance), just as is the case in a three-wire, direct-current system. Hence, in comparing these two systems, we may allow an equal current density to obtain equal results as to drop. Thus, having put feeders of ·10 square inches on the three-wire system to carry 68 amperes, we must, on the polyphase system, put in feeders of ·066 square inch, with the fourth wire, say, half this, or ·033. The total copper in the direct-current system is ·10 + ·10 + ·05 = ·25 square inch, and in the polyphase system, ·066 + ·066 + ·066 + ·033 = ·231 square inch, or but 7½ per cent. less, and this would be much more than counterbalanced by the additional labour necessary in the wire having four conductors instead of three. The polyphase voltage would be only 380 instead of 440 volts, but this will make no difference in the cost.

In conclusion, I should suggest that (*a*) synchronous motor-generators should be adopted; (*b*) if the town is fairly compact and likely to give a reasonable load, a three-wire, direct current system with battery should be adopted; (*c*) if very compact, and a poor town, where private houses will take very little current, then a two-wire, direct-current system with battery; (*d*) if a scattered area, a single-phase system; (*e*) should it happen that the periodicity of the power supply is 40 ⌒⌣ or over, and that the power company will guarantee to maintain a reasonably steady pressure, then use static transformers, but the question of three-phase distribution or two-phase upon the Scott three-to-two-phase transformer connection must be closely looked into; and (*f*) in particular study the town carefully before coming to any decision on these points.—C. E. C.

*Answer to No.* 643 (*awarded* 7*s.* 6*d.*).—The wants of a town of 5,000 inhabitants would be met by an installation of about 150 kw., with a load factor of 12 per cent. The maximum output may be taken as 120 kw., and this should last for an average of one hour per day taken all the year round. Part of the load would be street-lighting, say 15 kw., and the probable motor load can be taken at the same figure.

*Cables.*—The power factor under the above conditions of load should never be less than ·9 at full load. For the same voltage drop the weight of copper in the feeders will be the same for both systems when the lamp voltage is the same. A polyphase system with a power factor of 9 will, therefore, require 10 per cent. more copper than the corresponding continuous-current, three-wire system. The fourth wire of the three-phase and the balancing wire of the three-wire systems will be the same size. The insulation of the polyphase cables will also cost more, as the maximum strain of voltage to earth will be 1·4 times the direct-current cables. The three mains will also be relatively more expensive than the two equivalent ones.

*Station Equipment.*—The polyphase plant for distribution should consist of three 50-kw. three-phase, star-connected transformers. In the ordinary way, mesh connection is preferable, as if one phase of the winding burns out, the transformer would still furnish three-phase current. This would necessitate a star-connected balancer, the fourth wire being connected to the middle of its winding. The direct-current station should have three 40-kw. asynchronous motor-generators, with a battery of 120 kilowatt-hours capacity, and a safe maximum discharge of 40 kw. For an asynchronous motor of this size step-down transformers would have to be used if the supply pressure was more than 5,000 volts. Rotary converters give a better efficiency—about 87 per cent., including static transformers in this size—but are not suitable for use with accumulators. If it was decided to do without a battery, and always to have an attendant on duty, it would pay to use them. The rotary has also the advantage over the asynchronous or synchronous motor-generator without accumulators, that balancing can be done automatically by connecting the middle wire of the three-wire continuous-current system to the mid-point of connection of the secondary of the transformers operating the rotary. The starting would have to be done on the direct-current side, as in a small machine like this it would not pay to put in a special starting motor. This also applies to the synchronous motor-generator. An asynchronous motor-generator or a small battery would have to be used. This would entail many complications, and, in addition, the necessary synchronising of machines requires a more costly class of attendant. For these reasons the first scheme, with its easily started machines and simpler switchgear, would be preferable. When a battery is used no other balancer need be supplied.

*Operating Costs.*—Taking 450 units as the average output per day (the peak as above), and estimating the street-

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lighting as lasting on an average 10 hours per day, we would have an average output of one hour at 120 kw., nine hours at 23 kw., 14 hours at 9 kw. On the direct-current system this would entail the three sets running together for one hour. The battery would be the reserve. The efficiency of each set is 80 per cent., and the power taken from supply is 150 units. During the next nine hours there would be an external load of 23 kw., allowing 17 kw. for charging battery. The power for this would be $9 \times 50 = 450$ units. The next 14 hours would be done on the battery giving a total discharge of $14 \times 9 = 126$ units. The efficiency of the battery will be about 70 per cent., and this means a total charge of 180 units. An extra half-hour's run would be required for the $180 - 9 \times 17 = 27$ units, and the power required would be 33 kw. The total daily units $= 150 + 450 + 33 = 633$.

The alternating-current station would have three transformers on for one hour, and at a load of 40 kw. each (80 per cent. of full load) the efficiency is about 96 per cent. The power taken from supply is 125 units. For nine hours with two transformers on, the load being 23 kw., the efficiency 93 per cent., and the power is 220 units. The remaining 14 hours at 9 kw. per hour, taking the efficiency at 90 per cent., would require 140 units. The total supply would be $125 + 220 + 140 = 485$ units. The comparative efficiencies of alternating current and direct current are therefore 93 per cent. and 71·5 per cent. The cost of the transformers for polyphase distribution would be under half that of the running machinery for the direct-current system, and the switching arrangements would be simplicity itself. Then the cost of the battery with its auxiliaries and more complicated switchboard for balancing would tell strongly in favour of the polyphase system.

If the periodicity is below 25 ⁓ incandescent lighting is not satisfactory, but at this figure the flickering will not be very noticeable, and practically disappears at any higher periods. Arc lighting is impossible below 42 ⁓, but in every way it compares very well with continuous current. Three-phase motors can now be got with an efficiency equal to continuous current. They are more mechanical in construction, and have no moving part carrying supply current. Two attendants in the station will be required for the direct-current system and one for the alternating-current. This implies that an attendant must always be present when machinery is running for direct current and in the alternating-current station only at the busiest times. The saving in lubricating oils, stores, repairs to battery, and the increased wear and tear of moving machinery would also be considerable.—K. M. E.

*Answer to No.* 643 (*awarded* 5*s.*).—To distribute with direct current, the high-tension three-phase supply must be changed into continuous by means of rotary converters, synchronous motor-generators, or asynchronous motor-generators. Rotary converters, though the most efficient of the three, are complicated machines, requiring careful attention; they have, moreover, the disadvantage that the relative pressure between the alternating and the direct side is a fixed quantity. The starting of rotary converters is also a troublesome matter. Synchronous motor-generators must be run up to speed by an outside source before being switched on. They are also liable to hunt badly under changes from the normal conditions. The last mentioned—viz, asynchronous motor-generators—are, all things considered, much to be preferred for the purpose mentioned in the question. With resistances in the rotor circuits they may be at once started up, and the direct-current side adjusted for voltage in the ordinary way. An asynchronous motor-generator of 100 units will have an efficiency of from 82 84 per cent. Asynchronous motor-generators will be more expensive in first cost than either of the others, but this will be somewhat balanced by the greater ease and convenience in working. Synchronous motor-generators are generally employed in large plants, as although they require more skilful attention, they are lower in first cost, and have a greater efficiency. In a plant where the maximum load would probably be 100 kw. to 150 kw., asynchronous motor-generators would undoubtedly be the most suitable. To distribute by means of three-phase alternating, less first cost would be incurred, and the necessary transformers and apparatus would have a considerably higher efficiency than the asynchronous system. There would also be little demand for skilled attention at the transformer stations. As to whether the distribution should be by alternating or by direct current is largely a question of position. If the town is closely built and the anticipated consumers fairly placed round the station, most engineers would prefer a direct-current, three-wire system. On the other hand, if the consumers are situated at considerable distances, it might be better to provide an alternating-current supply, having feeders at a high potential running to outlying sub-stations, where step-down transformers could be placed. A few years ago the answer would have been, By all means use direct current: it is better understood, there is less difficulty with wiring, it is more suitable for motors, and is the only practical method for arc lighting. Each year, however, finds an increasing number of engineers who advocate the use of polyphase currents, the methods of wiring are now within the ken of the average wireman; and polyphase motors, with their simple starting arrangements and freedom from brush and commutator trouble, are becoming more appreciated. Polyphase motors also compare favourably, as regards price, with direct-current motors of equal power. Cost of leads is in either case about on a par; if, however, the polyphase mains are increased in area to allow for wattless current, they may become more expensive than the necessary direct-current cables.—M. M.

*Question No.* 644.—What are the methods of regulating the voltage on each leg of a three-phase, four-wire distribution, and also of balancing the same?

*Best Answer to No.* 644 (*awarded* 10*s.*).—With the three-phase, four-wire system particular care must be taken with regard to balancing, not only to secure equal potentials in the three phases, but also to obtain the advantage of

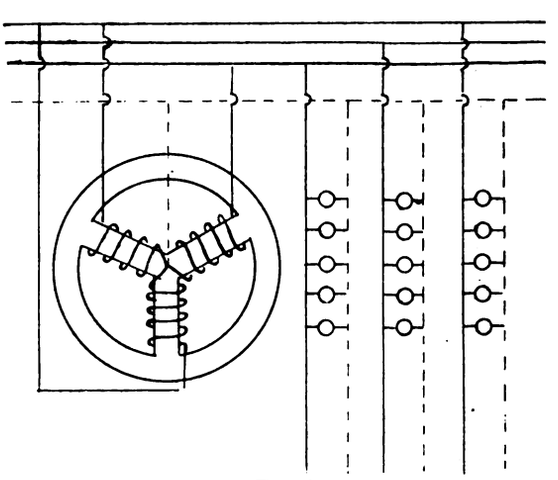

FIG. 1.

balance on the generator load. Thus, where there is a large number of motors or arc lamps, the inductive effects from these may so affect the balance as to destroy the advantages peculiar to this system. In order to get a good balance, with freedom from fluctuations of the voltage, small motors that are started by simply switching direct on the mains should have a high armature resistance; the starting current will then be brought down to a minimum. Large motors should have starting resistances in the rotor circuits. A method of balancing distributing circuits is shown in Fig. 1. A three-phase choking coil is connected up in "star" at places where found necessary. The neutral wire, shown as a dotted line, is connected up to the middle point of the windings of this equaliser. To regulate the pressure on feeders, some form of apparatus as shown diagrammatically in Fig. 2 is usually employed. The secondary winding is formed by one of the feeder wires, the core on which this is wound being fixed. The movable core is energised direct from the mains. By means of a handwheel this movable core may be turned round as required. In position shown in sketch the volts generated in the secondary winding are zero, as one part of the secondary winding is neutralised by the other;

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there is then no alteration to the potential on the feeders. By turning round the core, volts may be added to or subtracted from the feeders as desired. Voltage due to the secondary winding is at a maximum when the movable core is at right angles to the position shown in diagram.

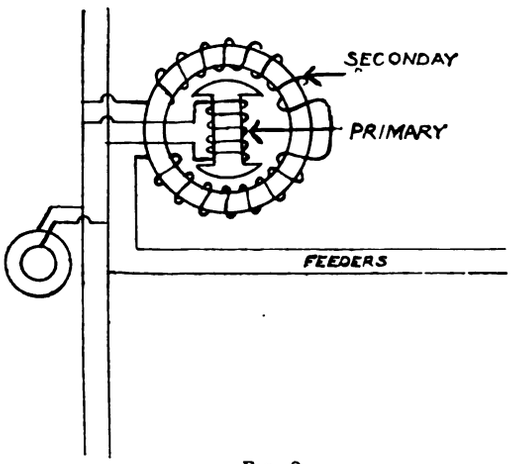
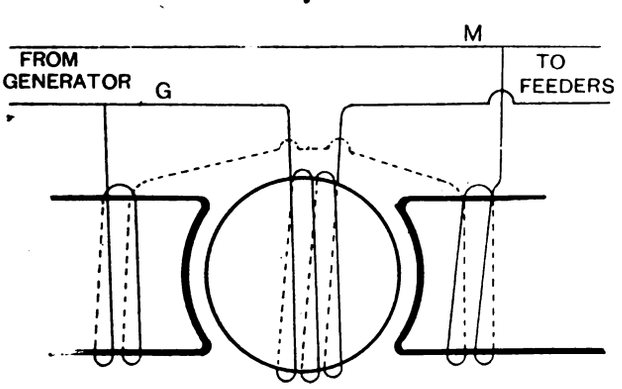



FIG. 2.

A number of automatic regulators have been devised, also patented methods by means of transformers.—M. M.

*Answer to No.* 644 *(awarded* 5s.).—If the load on a four-wire, three-phase system is supplied from a star-connected transformer, the voltage on each leg will practically be balanced perfectly if care is taken in the distribution of the load on each circuit. To do this, the middle wire must be connected to the centre of the star. Even if the whole load is switched off one leg and left on the two others, the difference in voltage between the unloaded and loaded circuits will not exceed the amount of the normal full-load voltage drop on an inductive circuit. If $\cos \phi = 1$, it will be less than this. Three-phase induction motors have also an equalising effect on the circuits. When the load is supplied from mesh-connected transformers or generators, or if for any other reason it is not desirable to take the middle wire into the station, an auto-transformer or choking coil may be used. This is practically a three-phase star-connected transformer with only one winding connected across the mains to be balanced. The middle wire is taken to the common junction of the three coils.




To raise or lower the voltage, a booster of a construction similar to an ordinary two-pole dynamo may be used. The field magnet is built up of laminated plates, and carries the primary winding. The coil on this is connected across from one of the mains to the middle wire. The armature core has a coil on it resembling a shuttle winding. This is connected in series with the main to be boosted. Three of these—one for each main—will be required. The sketch shows connections. G and M are respectively the outside and middle wire of one of the legs. In the position shown the coil will give its maximum boost. When turned through 45 deg. it will have no effect, and if given half a complete turn it will reduce the voltage. The regulating can also be done by means of an auxiliary transformer, the primary of which is connected across G and M, and the secondary between G and the feeder. By varying the number of turns in the secondary the voltage is raised or lowered as desired.—K. M. E.

## CHARGES FOR GAS, WATER, AND ELECTRICITY.

The following information has been compiled by Mr. James Carter, the borough treasurer of Preston.

Water.—Charges in the £ for domestic purposes on house £15 rateable value.

Gas.—Net charge 1,000 cubic feet.

Electricity.—Maximum charge per Board of Trade unit.

| | Water. s. d. | Gas. s. d. | Electricity. s. d. |
|---|---|---|---|
| Accrington | 1 6 | 2 9½ | 0 4 |
| Ashton-under-Lyne | 1 11 | 2 4 | 0 4 |
| Bacup* | 1 10½ | (a) — | — |
| Barrow-in-Furness | 1 0 | 2 6 | 0 6 |
| Bath | 1 0 | (a)2 3 | 0 5 |
| Belfast | 1 4 | 2 3 | 0 6 |
| Birkenhead | 0 10 | 2 6 | 0 5 |
| Blackburn | 1 7½ | 3 1 | 0 6 |
| Blackpool | 1 6 | 2 4 | 0 7 |
| Bolton | 1 3½ | 2 6 | 0 6 |
| Bootle | 0 10½ | 2 8 | 0 5 |
| Bournemouth | (a)0 10½ | (a)3 0 | 0 6 |
| Bradford | 1 6 | †2 3 | 0 4 |
| Brighouse | 1 0 | 2 9 | 0 6 |
| Brighton | 0 9 | 3 0 | 0 7 |
| Bristol | — | 2 1 | 0 5 |
| Burnley | 1 0 | 2 3 | 0 4 |
| Burton-on-Trent | 1 5½ | 2 8 | 0 6 |
| Bury | 2 0 | 1 11 | 0 6 |
| Carlisle | 1 0 | 2 3 | 0 5 |
| Cheltenham | 1 0 | (a)2 3½ | 0 6 |
| Chester | 1 8 | 3 0 | 0 4½ |
| Coventry | 1 2½ | 2 6 | 0 6 |
| Croydon | 1 2½ | (a)2 8 | 0 7 |
| Darlington | 1 3½ | 2 1 | 0 8 |
| Darwen | 1 6 | 2 8⅛ | 0 4⅜ |
| Derby | 1 3 | 2 8 | 0 6 |
| Devonport | 1 2 | 2 6 | 0 5 |
| Dewsbury | 1 2½ | (b)2 11 | 0 6 |
| Eastbourne | 1 0 | 2 10 | 0 6½ |
| East Ham | (a)1 1½ | (a)2 11 | 0 7 |
| Gateshead | 1 3† | 1 10½ | 0 7 |
| Halifax | 1 5½ | 2 2½ | 0 4 |
| Hastings | 1 3 | 3 0 | 0 6 |
| Huddersfield | 1 8 | 2 7½ | 0 4½ |
| Islington | 1 0† | (b)2 8½ | 0 7 |
| Kensington | (a)0 9½ | 3 0 | 0 6 |
| King's Lynn | 0 6½ | (a)3 6 | 0 5 |
| Kingston-upon-Hull | 1 0 | (a)2 6 | 0 5 |
| Lancaster | 1 4 | 2 3 | 0 5 |
| Leamington | 0 8½ | 2 7 | 0 6 |
| Leeds | 1 0 | 2 3 | 0 4 |
| Leicester | 1 2 | 2 4 | 0 4 |
| Lincoln | 0 9½ | 2 3 | 0 6 |
| Liverpool | 0 7½ | (a) — | 0 3¾ |
| Macclesfield | 1 3 | 2 6 | — |
| Manchester | 0 8 | (b)2 7½ | 0 5½ |
| Middlesbrough | 1 3 | 2 5 | 0 6 |
| Newcastle | (a) — | 1 7½ | — |
| Northampton | (b)1 6 | 2 2 | 0 6½ |
| Norwich | 1 5½ | 3 3 | 0 5 |
| Nottingham | 1 1 | 2 8 | 0 5 |
| Oldham | 1 6 | 2 3 | 0 4 |
| Oxford | 0 10 | — | — |
| Portsmouth | 1 0½ | 2 4 | 0 4½ |
| Plymouth | 0 9½ | (a)1 9 | 0 4½ |
| Preston | 1 0 | (a)2 11½ | 0 7 |
| Reading | 0 10½ | 2 10 | 0 6 |
| Rochdale | 2 0 | (b)2 6½ | 0 6 |
| Rotherham | 1 7 | (b)2 6 | 0 4½ |
| St. Helens | 1 0½ | 2 3 | 0 4½ |
| Salford | 0 9 | 2 2½ | 0 4 |
| Southampton | 0 6 | (a)2 10½ | 0 5 |
| Southport | 1 4 | 2 6½ | 0 6 |
| South Shields | 1 0⅜ | 2 10 | 0 7 |
| Stafford | 1 0 | 2 5 | 0 5 |
| Stalybridge | 1 7⅜ | 2 4 | — |
| Stockport | 1 6 | 2 9 | 0 5 |
| Stockton-on-Tees | 1 4½ | 2 3 | 0 6 |
| Sunderland | 1 0 | 1 11 | 0 5 |
| Swansea | 1 1½ | 3 0 | 0 6 |
| Tunbridge Wells | 1 2 | 3 0 | 0 6 |
| Tynemouth | 1 3 | 2 3 | 0 5 |
| Wakefield | 1 5½ | 2 6 | 0 4½ |
| Warrington | 1 2½ | 2 6 | 0 6 |
| West Bromwich | 1 2½ | 2 6 | 0 4½ |
| West Ham | 1 2 | (a)2 9½(b) | 0 7 |
| West Hartlepool | 1 6 | 2 0½ | 0 4 |
| Westminster | 0 9½ | 3 0 | 0 6 |
| Widnes | 0 11† | (b)1 4 | — |
| Wigan | 1 1 | 2 9 | 0 5 |
| Wolverhampton | 1 3 | (a)2 9 | 0 6 |
| York | (a)0 11½ | (a)2 2 | 0 7 |

* Charged on gross rental. † Gross charge. (a) Private company. (b) Average charge.

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## TRADE NOTICES AND NOVELTIES.

### Lundell and Castle Motors.

We have recently received from Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, a copy of their revised catalogue of Lundell and Castle motors. A new feature of the Lundell two-pole single field-coil type motor is the extension upwards of the commutator end casing to form a protection to the terminal blocks, which are thus completely enclosed. Messrs. Holmes and Co. have introduced a new series of multipolar Castle motors from 10 h.p. to 40 h.p., which embody the latest principles in construction. They are designed to stand very great fluctuations of load with perfect working at the brushes, so that the temporary overloads up to about 100 per cent. will not injure the commutator. They are also wound for the greatest possible efficiency at small loads. Further particulars of these motors are given on pp. 20 to 25 of the catalogue under notice. Several interesting applications of the firm's motors are illustrated and directions for fixing and for the motor attendant are included.

### A Useful Gift.

We have to acknowledge the receipt of a useful gift from Messrs. Stegmann and Co., electrical engineers, Brighton Railway-approach, Clapham Junction, S.W., in the shape of a combined barometer and thermometer of small dimensions. In this article Messrs. Stegmann and Co. have certainly hit upon a good means of keeping their name prominently before customers.

### Electric Lighting Boards.

We have received from Electric Lighting Boards, Limited, 80, York-road, King's Cross, London, N., a copy of their new price-list. Several additions are included, and incandescent lamps of the different patterns, supplied complete with the special terminals adapting them for the company's system, are illustrated. The company inform us that their system continues to meet with considerable success, and during the past 18 months they have carried out a large number of temporary lighting installations for exhibitions, etc., up to 5,000 lights, being busily employed at the present time. They are making a speciality of electric signs of various forms.

### Walsall Specialities.

The Walsall Electrical Company, Limited, have sent us a copy of their latest list of arc lamps and accessories; also a number of sheets, etc., dealing with their open, semi-enclosed, and enclosed types of dynamos and motors, ranging in output from 1/20 h.p. to 75 h.p., besides various other specialities, including measuring instruments and switchgears. We may add that the London office of the above firm is situated at 115-117, Cannon-street, E.C.

### Catalogues and Pamphlets, Etc.

TURBINES. — Trump high-grade water-turbines, for heads ranging from 30ft. to 300ft., are dealt with in a well illustrated catalogue which we have received from the Trump Manufacturing Company, Springfield, Ohio, U.S.A.

CALENDARS.—Coalbrookdale Company, Limited (works, Coalbrookdale, Shropshire; London house, 141, Queen Victoria-street, E.C.; Glasgow house, 221, St. Vincent-street), iron-founders, engineers, roofing tile makers. The British Prometheus Company, Limited, electric heating specialists, Kingston-on-Thames. The Cape Asbestos Company, Limited, 8, Minories, E.C., and Kimberley and Turin, makers of blue asbestos, removable coverings for boilers, valves, etc., and blue and white asbestos goods of every description, have issued elegant blotting-pads, aluminium desk calendars, and wall calendars; capyt for electrical installations is especially mentioned amongst their announcements. We also beg to acknowledge the compliments and best wishes for 1904 from Frederick T. Smith and Co., electricians and engineers' brokers, 2, Ranelagh-road, East Ham, London, E.; and of the British Insulated and Helsby Cables, Limited, Prescot and Helsby. Hart Accumulator Company, Limited Stratford-lane, London, E., have issued their usual useful blotting-pad. The Year-Book of New South Wales (By authority of the Government of New South Wales. Compiled by the editor of the "Year-Book of Australia" for circulation by the Agent-General in London) contains an excellent map and 168 pp. of closely-printed and fairly detailed information about everything to be seen, found, manufactured, etc., in the colony.

## PERSONAL.

Mr. Charles J. Hall has resigned as manager of the electrical department of Messrs. John Fowler and Co. (Leeds), Limited, Leeds, which was commenced by him for the firm in the year 1891.

We are informed that Mr. Robert Mitchell, formerly demonstrator in the physical laboratory of the Royal College of Science, South Kensington, and latterly with Sir George Bullough (of Messrs. Howard and Bullough, of Accrington), has joined the directorate of the Phœnix Dynamo Manufacturing Company, Limited, Bradford.

The salary of Mr. H. N. Nugent, assistant at the electricity works, Colne, has been increased to £100 per annum.

The Worksop Urban District Council have increased the salary of Mr. Best, the assistant electrical engineer, to 35s. per week.

The salary of Mr. Milton, the resident engineer at the Maidenhead station, has been increased by £30 per annum.

## ELECTRIC LIGHTING PROVISIONAL ORDERS (SESSION 1904).

The following is the complete list of the applications for provisional orders deposited with the Board of Trade on or before Dec. 21, 1903, under the provisions of the Electric Lighting Acts, 1882 to 1890:

| Title of Order and Description of Area. | Name of Promoters. |
|---|---|
| Acton Electric Lighting Order.—The Urban District of Acton. | The Metropolitan Electric Supply Company, Limited. |
| Ashford (Kent) Electric Lighting Order. — The Urban District of Ashford. | The Ashford and District Electric Supply Company, Limited. |
| Barrhead Electric Lighting Order.—The Burgh of Barrhead. | The Clyde Valley Electrical Power Company. |
| Barry Electric Lighting Order (Amendment Order). | The Urban District Council. |
| Bath Rural District Electric Lighting Order.—The Rural District of Bath. | The Rural District Council. |
| Beddington, Coulsdon, and Sanderstead Electric Lighting Order.—The parishes of Beddington, Coulsdon, and Sandstead, in the Rural District of Croydon. | The Rural District Council of Croydon. |
| Birkenhead Corporation Electric Lighting (Extension) Order.—The Townships of Prenton and Upton, in the Rural District of Wirral. | The Corporation of Birkenhead. |
| Bishop Auckland Electric Lighting (Amendment) Order. | The Urban Electric Supply Company, Limited. |
| Bothwell Electric Lighting Order.—Portion of the Parish of Bothwell. | The Clyde Valley Electrical Power Company. |
| Brynmawr Electric Lighting Order.—The Urban District of Brynmawr. | The Urban District Council. |
| Caerphilly Electric Lighting Order.—The Urban District of Caerphilly. | The Urban District Council. |
| Cannock and District Electric Lighting Order.—The Urban District of Cannock and the Parishes of Cheslyn Hay and Great Wyrley, in the Rural District of Cannock. | Messrs. Whittaker Bros., Limited. |
| Chippenham Corporation Electric Lighting Order.—The Borough of Chippenham and portions of the Parishes of Chippenham Without Langley, Burrell Without, and Hardenhuish, in the Rural District of Chippenham. | The Corporation. |
| Clevedon, Portishead, and Long Ashton Electric Lighting Order.—The Urban Districts of Clevedon and Portishead, and the Rural District of Long Ashton. | The Western Electric Distributing Corporation, Limited. |
| Clitheroe Electric Lighting Order.—The Borough of Clitheroe. | The Corporation. |
| Crediton Electric Lighting Order.—The Urban District of Crediton. | Messrs. Christy Bros. and Middleton. |
| Devizes Electric Lighting Order.—The Borough of Devizes. | The Corporation. |
| Eastleigh and Bishopstoke Electric Lighting Order.—The Urban District of Eastleigh and Bishopstoke. | The Urban District Council. |
| Eastwood and Cathcart Electric Lighting Order.—The Burgh of Pollokshaws and portions of the Parishes of Eastwood and Cathcart. | The Clyde Valley Electrical Power Company. |
| Ely Electric Lighting Order.—The Urban District of Ely. | The Southern District Electricity Corporation. |
| Epsom Rural District Electric Lighting Order.—The Parishes of Cheam, Cuddington, and Ewell, in the Rural District of Epsom. | The County of Surrey Electrical Power Distribution Company, Limited. |
| Gainsborough Electric Lighting Order. The Urban District of Gainsborough. | The Urban District Council. |
| Glastonbury Corporation Electric Lighting Order.—The Borough of Glastonbury. | The Corporation. |
| Hampton Wick and District Electric Lighting Order.—The Urban Districts of Hampton Wick, Esher, and the Dittons, East and West Molesey, and Sunbury; and the Parishes of Hanworth, Feltham, Ashford, Shepperton, Littleton, and Laleham, in the Rural District of Staines. | The Twickenham and Teddington Electric Supply Company, Limited. |

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| Title of Order and Description of Area. | Name of Promoters. |
|---|---|
| Hanwell Electric Lighting Order — The Urban District of Hanwell. | The Urban District Council. |
| Hexham Electric Lighting Order.— The Parishes of Hexham, Acomb, Sandhoe, Hexham, West Quarter, and Warden, in the Rural District of Hexham. | Edwin Percy Harvey, Esq. |
| Heysham Electric Lighting Order.— The Urban District of Heysham. | The Urban District Council. |
| Horley Electric Lighting Order.—The Parish of Horley, in the Rural District of Reigate. | Marshall Handyside Bennett and Robert Cornelius Quin, Esqs. |
| Houghton-le-Spring and District Electric Lighting Order.—The Urban Districts of Houghton-le-Spring, Hetton-le-Hole, and Seaham Harbour, and the Rural District of Easington. | Harry James Almond, Esq. |
| Huddersfield (Extension to Golcar) Electric Lighting Order.—The Urban District of Golcar. | The Corporation of Huddersfield. |
| Johnstone Electric Lighting Order.— The Burgh of Johnstone and portion of the Parish of Paisley. | The Clyde Valley Electrical Power Company. |
| Keynsham (Somerset) Electric Lighting Order.—The Rural District of Keynsham. | The Keynsham Electric Light and Power Company, Limited. |
| Kilpatrick Electric Lighting Order.— The Burgh of Milngavie and portions of the Parishes of Old and New Kilpatrick. | The Clyde Valley Electrical Power Company. |
| Kingswood Electric Lighting Order.— The Urban District of Kingswood. | The Kingswood Electric Supply Company, Limited. |
| Kirkby-in-Ashfield Electric Lighting Order. — The Urban District of Kirkby-in-Ashfield. | The Urban District Council. |
| Lanark Electric Lighting Order.—The Burgh of Lanark. | The Clyde Valley Electrical Power Company. |
| Lichfield Electric Lighting Order, 1901, Amendment and Extension Order.— The Parishes or Townships of Whittington, Shenstone, Swinfen, Packington, Weeford Wall, Longdon, Fisherwick, King's Bromley, Farewell, Cudborough and Elmhurst, Pipe Hill, and portions of the Parishes of Burntwood and Hammerwich, and of St. Chad and St. Michael, Lichfield, all in the Rural District of Lichfield. | The Corporation. |
| Maidenhead Electric Lighting (Extensions) Order.—The Parishes of Taplow, Hitcham, and Burnham, in the Rural District of Eton; and the Parishes of Cookham and Bray, in the Rural District of Cookham. | The Corporation of Maidenhead. |
| Maldens (The) and Coombe Electric Lighting Order.—The Urban District of The Maldens and Combe. | The Urban District Council. |
| Maldens and Coombe and Ham Electric Lighting Order.—The Urban Districts of The Maldens and Coombe and Ham. | The Twickenham and Teddington Electric Supply Company, Limited. |
| Mansfield Woodhouse Electric Lighting Order.—The Urban District of Mansfield Woodhouse. | The Urban District Council. |
| Melksham Electric Lighting Order.— The Urban District of Melksham. | The Urban District Council. |
| Mid-Shropshire Electric Lighting Order.—The Boroughs of Bridgnorth and Wenlock, the Urban Districts of Okengates and Dawley, and the Parishes of Acton Round, Astley Abbotts, Chetton, Eardington, Morville, Oldbury, and Tasley, in the Rural District of Bridgnorth. | The Shropshire and Worcestershire Electric Power Company. |
| Milford-on-Sea Electric Lighting Order.—The Parishes of Milford Hordle and Hordle Detached, in the Rural District of Lymington. | The Milford-on-Sea Electric Supply Company, Limited. |
| Musselburgh Electric Lighting Order.— The Burgh of Musselburgh. | The National Electric Construction Company, Limited |
| Newquay Electric Lighting Order.— The Urban District of Newquay. | The Southern District Electricity Corporation. |
| Newton Abbot (Extension) Electric Lighting Order. — Portion of the Urban District of Newton Abbot, and the Parish of Kingsteignton, in the Rural District of Newton Abbot. | The Urban Electric Supply Company, Limited. |
| North Worcestershire Electric Lighting Order.—The Urban Districts of Bromsgrove and Stourbridge, and the Parishes of Belbroughton, Clent, Frankley, Grafton Manor, Hagley, Hunnington, Pedmore, and Romsley, in the Rural District of Bromsgrove. | The Shropshire and Worcestershire Electric Power Company. |
| Northampton and District Electric Lighting Order.—Portions of the County Borough of Northampton and of the Parishes of Moulton, Moulton Park, Boughton, Church Brampton, Chapel Brampton, Hardingstone, Wootton, Great Houghton, Little Houghton, Milton, Collingtree, Rothersthorpe, Weston Favell, Great Billing, Little Billing, Dallington, Duston, Upton and Kislingbury, in the Rural Districts of Brixworth, Hardingstone, and Northampton. | The Northampton Electric Light and Power Company Limited. |
| Penzance Electric Lighting Order.— The Borough of Penzance. | The Penzance and District Electric Supply Company, Limited. |
| Portpatrick Electric Lighting Order.— Portion of the Parish of Portpatrick. | The Portpatrick Electric Supply Company, Limited. |
| Ramsgate Electric Lighting Order.— The Borough of Ramsgate. | The Ramsgate and District Electric Supply Company, Limited |
| Renfrew Electric Lighting Order.— The Burgh of Renfrew and portions of the Parishes of Renfrew and Govan. | The Clyde Valley Electrical Power Company. |
| Saffron Walden Electric Lighting Order.—The Borough of Saffron Walden. | The Corporation. |
| Shettleston Electric Lighting Order.— Portions of the Parishes of Glasgow and Old Monkland. | The Clyde Valley Electrical Power Company. |
| Southgate Urban District Council Electric Lighting Order.—The Urban District of Southgate. | The Urban District Council. |
| Stroud, Nailsworth, and Dursley Electric Lighting Order. The Rural District of Stroud, the Urban District of Nailsworth, and the Parish of Dursley in the Rural District of Dursley. | The Gloucestershire Electric Power Company. |
| Sunderland Districts Electric Lighting Order.—The Urban District of Southwick-on-Wear and the Rural Districts of Sunderland and Houghton-le-Spring. | The County of Durham Electrical Power Distribution Company, Limited. |
| Sutton-in-Ashfield Urban District Electric Lighting Order.—The Urban District of Sutton in-Ashfield. | The Urban District Council. |
| Tamworth Corporation Electric Lighting Order.—The Borough of Tamworth and portions of the Parishes of Wigginton and Bolehall and Glascote, in the Rural District of Tamworth. | The Corporation. |
| Tavistock Electric Lighting Order.— The Urban District of Tavistock. | The Tavistock and District Electric Supply Company, Limited. |
| Teignmouth Electric Lighting (Amendment) Order. | The Urban District Council. |
| Thornbury Rural District Council Electric Powers Order.—The Rural District of Thornbury. | The Rural District Council. |
| Trowbridge Urban, Bradford-on-Avon Urban, and Bradford on-Avon Rural Electric Lighting Order.—The Urban Districts of Trowbridge and Bradford-on-Avon and the Rural District of Bradford-on-Avon. | The Western Electric Distributing Corporation, Limited. |
| Uddingston District Electric Lighting Order.—The Parish of Bothwell. | The Uddingston District Electric Lighting Company, Limited. |
| Vale of Leven Electric Lighting Order. Portions of the Parishes of Bonhill, Cardross, and Dumbarton. | The Clyde Valley Electrical Power Company. |
| Walmer Electric Lighting Order.—The Urban District of Walmer. | The Urban District Council. |
| Walton-le-Dale Electric Lighting Order. — The Urban District of Walton-le-Dale. | The Urban District Council. |
| Walton-upon-Thames Electric Lighting Order.—The Urban District of Walton-upon-Thames. | The Urban Electric Supply Company, Limited. |
| Watford Electric Lighting Order.— Portion of the Urban District of Watford, and portion of the Parish of Watford Rural and the Parish of Bushey Rural, in the Rural District of Watford. | The Urban District Council. |
| Whickham Electric Lighting (Transfer of Powers) Order. | The Urban District Council. |
| Widnes Electric Lighting Order (Amendment Order). | The Corporation. |
| Wishaw Electric Lighting Order.— The Burgh of Wishaw. | The Corporation. |
| Yardley Rural District Electric Lighting Order.—The Rural District of Yardley. | The Rural District Council. |

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# LEGAL INTELLIGENCE.

## THE CARDIFF BREAKDOWN.

At Cardiff on Monday Frederick Parks (32) was charged with that he did "feloniously, unlawfully, and maliciously injure certain electric lines at the Roath power station, with intent to cut off a certain supply of electricity," on Dec. 24.

**Frank Hicks,** pointsman, said he saw the prisoner at the power station at nine o'clock on Christmas Eve.

"Have you any questions?" asked the clerk, and the prisoner replied, "I don't remember going to the station, sir."

**Walter Ashford,** switchboard attendant at Roath power station, said that about 9.30 on Christmas Eve he heard a heavy thud, and looking over the back switchboard saw the feet and legs of a man. The instrument had gone back to zero, and the power driving the trams had been cut off.

**Prisoner:** I never saw this gentleman.

**Wm. George Gregory,** assistant to the last witness, gave corroborative evidence. He went to the chamber beneath the switchboard immediately after the power was cut off. Prisoner, who was lying full length across the floor, seemed delirious. Witness recognised prisoner as a wireman who had been engaged at the power station.

**Kenneth Cramp,** electrical engineer at the power station, deposed that he assisted to carry prisoner out into the hall. Underneath the switchboard witness found that two shunt leads belonging to the regulating rheostats of Nos. 5 and 6 machines had been disconnected. The effect of this was to cut off the traction current from the mains and to stop the tram service.

**Mr. Ellis,** electrical engineer and manager, said that at 9.30 on Christmas Eve he was standing on the Hayes Bridge and noticed that the current was cut off from the tramway system in that district. Believing, naturally, that it was only a local fault, he waited a few minutes for the current to come on again. As it did not, he hurried to the sub-station under the fish market and got into telephonic communication with the power station, to which he afterwards drove in a cab. After examining what had been done, he gave the prisoner into custody. The damage inflicted was estimated at £100, but in addition there was the loss of traffic during the stoppage for 20 minutes of the tram service. In a case of this sort, however, internal troubles might have been set up inside, which would have taken some time to develop, and which might result in an occurrence similar to that caused by the prisoner's interference. Prisoner had been employed at the station as a wireman, but was discharged on the morning of Dec. 24 so that he had no right whatever at the station in the evening. Witness did not think Parks received an electric shock. He was probably injured by falling off the platform. Having regard to what happened at Bristol the previous night, witness, finding there was a heavy load, gave orders for a transfer from one of the big machines to four smaller ones. But for these instructions Cardiff would have had a similar experience to Bristol. The big machine might have been ruined, to say nothing of the town being launched into darkness, the stoppage of the trams, and the inconvenience to shopkeepers and the public generally. It was not every man in the station who knew how to disconnect the cables. Prisoner's ability to find them was explained by the fact that he actually fixed them in position.

**Detective Davey** deposed that in reply to the charge Parks said, "I am nearly innocent. I met a man in Broadway coming from the office in town. He asked me if my name was Parks. I said 'Yes.' He said, 'I was coming down to your house for you to do some work at the power station,' and then I had a drink out of a flask with him, and must have been drugged, and I don't remember anything else until Christmas night."

**Prisoner** now said: Under the circumstances I should never have attempted to go to the place unless I had work to do there that night.

Prisoner was committed to the Quarter Sessions, bail being refused.

## TAMPERING WITH AN ELECTRICITY METER.

At the Durham County Police Court on Wednesday, Dec. 30, Mary O'Hara was charged by the Northern Counties Electric Supply Company with fraudently obtaining electricity on the 11th ult.

**Mr. Marquiss** stated that the company put meters in the houses on the penny-in-the-slot principle. In this case, when the collector went round, he found that a hatpin had been inserted in the meter, the effect of which was that instead of the supply being cut off after 5½ hours, which was the amount supplied for 1d., the connection was allowed to continue, and the electric light was thus obtained for nothing. The company were very reluctant to bring the case forward, and did not press for a heavy penalty. Still, they felt they must protect themselves. As the Bench would know, the penalty under the Act for this offence was £5.

Evidence having been given in support of the charge, a fine of 10s., including costs, was imposed.

## IN BANKRUPTCY.

*In re* John Webster Michelson Starr, electrical engineer, 29, Grange-road, Dudley. Gross liabilities, £319. 10s. 1d.; assets, nil. Alleged causes of failure, bad debts, losses on contracts, and profits from the business being insufficient to meet business and personal expenses.

The Official Receiver reports as follows: The bankrupt is 53 years of age, and states that he commenced business about 10 years ago as an electrical engineer, under the style of Webster, Nicholson, and Co., at Stone-street, Dudley, with a capital of £90, which he saved from his earnings as manager for a firm in Wolverhampton. About five years ago he moved from Stone-street to Snow-hill, Dudley, where he traded till November, 1902, when he disposed of the whole of his business to a limited liability company, and he has since been engaged as traveller for the company, at a weekly salary of 30s. He states that he received no cash payment for his interest in the business, but only 1,000 £1 shares in the company. These shares, which he now values at £50, have been deposited with his solicitor as security for costs to the amount of £70. The receiving order was made on the petition of the debtor's bankers, to whom he owed £73. His books, he says, are in the hands of the company. There are five creditors whose debts exceed £10, and at the date of the receiving order seven creditors had obtained judgment against him.

# NEW COMPANIES REGISTERED.

**Town End Foundry, Limited.**—Capital, £1,000. Object: to carry on the business of iron and brass founders, miners, smelters, mechanical and electrical engineers, etc.

**Willey and Co., Limited.**—Capital, £100,000. Object: to acquire and carry on the business of gas, electrical, and mechanical engineers at Exeter and London under the style of Willey and Co.

**Lacoste and Battman, Limited.**—Capital, £160,000. Object: to acquire and carry on the business of autocar manufacturers at 16, Rue Chaptal, Levallois, Perret, near Paris, of Messrs. Lacoste and Battman.

**"Kno-Wet" Patent Dry Seat Company, Limited.**—Capital, £5,000. Objects: to acquire from W. Cuthbertson the benefit of an invention relating to an improved means for providing a dry outdoor seat, and to carry on the business of tramcar, garden, deck, pier, and other seat manufacturers, etc.

**S. R. Bailey and Lambert, Limited (79,615).**—Capital, £5,000. Objects: to adopt an agreement with S. R. Bailey and L. Lambert, and to carry on the business of manufacturers of, dealers in, and agents for motorcars, carriages, omnibuses, vans, cycles, and other mechanically-propelled vehicles, etc. Registered office: 217, Piccadilly, W.

**George Neill and Co, Limited (79,606).**—Capital, £10,000. Objects: to acquire and carry on the business of an engineer, manufacturers' agent, and contractor of G. Neill at 38, Fenchurch-street, E.C., and Burnham-on-Crouch, Essex, as George Neill and Co.; to adopt an agreement with the said G. Neill, G. F. Metzger, and A. E. Rooke, and to carry on the business of iron and steel founders and workers, tool makers, mechanical, electrical, and general engineers, machinists, etc. Registered office: 38, Fenchurch-street, E.C.

**Zone Dynamo and Motor Patents Company, Limited.**—Capital, £2,700. Objects: to adopt agreements with H. Edmunds, L. W. Holmes, H. F. Joel, J. H. St. H. Mawdsley, and A. Pratt, to undertake and execute any contracts for works involving the supply, application, or use of dynamos, motors, and dynamo-electric machinery, and to carry on the business of electrical engineers and experts, technical advisers, consulting, mechanical, and general engineers, manufacturers of electric dynamos, motors, magnets, machines, generators, exciters, boosters, motor-generators and transformers, and electric regulators, etc. Registered office: 10, Serjeants'-inn, E.C.

# CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cuba.**—The Insular Railway Company will shortly require material for installing an electric tramway in Marianas.

**Warsaw.**—The Municipality are open to receive tenders for electric tramways. Particulars may be obtained on application.

**Rome.**—The Admiralty require tenders for electric lamps, estimated at £6,000, by Jan. 23. Foreign competitors are invited.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Kettering.**—The Urban District Council invite tenders for the supply and delivery of electricity meters. Particulars from Mr. John Bond, clerk. Tenders by Jan. 9.

**Peteringa (Croatia).**—The Municipality require tenders for installation and working of electric lighting; 6 to 8 arc and 160 to 180 incandescent lamps are required for the street-lighting.

**St. George's (Hanover-square).**—The Guardians invite tenders for electric wiring and mains at their workhouse in Fulham-road, West Brompton, S.W. Tenders by Jan. 13. See advertisement in last issue.

**Greenwich.**—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Whitby.**—The Urban District Council invite tenders for the supply and delivery of feeding and distributing mains. Specifications, etc., from the Electrical Engineer. Tenders by 10 a.m. on 25th inst. See advertisement.

**Camberwell.**—The Borough Council invite tenders for the maintenance of electric bells and private telephones. Forms of tender from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Tenders by 5.30 p.m. on Jan. 18.

**Sydney (N.S.W.).**—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W. Tenders by Jan. 12.

**Manchester.**—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes (Contract No. 9),

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with other appurtenant works. Specifications, etc., from City Surveyor's Office, Town Hall. Tenders by 10 a.m. on Jan. 11.

**Avila.**—Tenders will be received by the Municipal Council (Ayunta miento Constitucional) for installation and working of electric lighting until Jan. 22, 1904. The estimate for the total work is 1,739,539·42 pesetas, and specifications, etc., may be seen at this office.

**Manchester.**—The Tramways Committee invite tenders for the supply of electric tramcar bodies, electrical equipments of cars, and tramcar trucks. Specifications, etc., from Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 5 p.m. on 18th inst.

**Pontypridd.**—The Urban District Council invite tenders for Section D (pipework) and Section T (supply of meters). Specifications, etc., from Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on Friday, Jan. 15, 1904. See advertisement in last issue.

**Wallasey.**—The Urban District Council invite tenders for the supply and delivery of about 7,100 yards concentric armoured cables, together with joint boxes and section boxes. Specifications from Mr. J. A. Crowther. Electric Supply Works, Sea View-road, Liscard. Tenders by Jan. 16.

**Christchurch (New Zealand).**—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement in former issue.

**Southend-on-Sea.**—The Corporation invite tenders for the extension of the car shed at their electricity works, comprising the erection of workshop, etc., the construction of storage tank and reservoir, and other works. Specifications, etc., from Mr. E. J. Elford, M.I.M.E., borough engineer, Southend. Tenders by 12th inst.

**Enniscorthy (Ireland).**—The District Lunatic Asylum Committee invite tenders for the following works: generator and motor-generator converter; motor and motor pumps; accumulators; main switchboards; overhead conductors and telephone; gearing and shafting; wiring asylum. Specifications, etc., at the Asylum Office. Tenders by Jan. 20.

**London, N.**—The Hornsey Borough Council invite tenders for (Section A) two dry-back or water-tube boilers; (B) smoke-consuming apparatus; (C) two 300-kw. steam dynamos, one 100-kw. steam dynamo, two motor-generators. Specifications, etc., may be obtained of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by 10.30 a.m. on Feb. 8. See advertisement.

**Brighton.**—The Town Council invite tenders for the supply and delivery of steel poles, trolley wire, bases and section pillars, cast-iron fittings, pole brackets, overhead line fittings, span and guard wire, switchgear, feeder, distributing, and telephone cables, bonds, etc. Specifications, etc, from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by 10 a.m. on 18th inst.

**Glasgow.**—The Corporation invite tenders for providing and erecting at their generating stations in the city two 3,000 kw. 6,500-volt three-phase turbo-alternators and condensing plant, one 2,200-h.p. engine coupled to a double-current generator and transformers, and six 500-kw. motor generators or rotary converters. Specifications from Mr. W. A Chamen, 75, Waterloo-street. Tenders by Jan. 11.

**Erith.**—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings, and steam feed pump; steam, exhaust, feed, air and circulating, blow-off, and drain pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam-engine of 500 kw. capacity; extensions to main switchboard and cable connections. Tenders by Jan. 18. See advertisement in former issue.

## RESULTS OF TENDERS.

**Derby.**—The tender of Mr. Henry Vernon, amounting to £135 5s., has been accepted for extensions to the switchboard gallery at the electric lighting station.

**Hackney.**—The Council have accepted the tender of the Westinghouse Company for supply of the necessary oil-tank pipes for dealing with the waste oil at the electricity station for the sum of £60. 10s., plus their man's time in fitting the pipes at the rate of 15s. per day; and that of Ferranti Limited for supply of a small switchboard for the boiler-house at £28.

# BUSINESS NOTES.

## TRACTION.

**Rolleshy.**—The Corporation tramways are to be extended to this district.

**Southend.**—The Town Council are being petitioned to extend the tramways to Hadleigh.

**Cardiff.**—The Board of Trade have sanctioned a loan of £70,500 by the Corporation for tramway purposes.

**Chesterfield.**—A public meeting held on Tuesday approved the scheme for an electric tramway system.

**Madras (India).**—The city of Madras is considering the installation of an electric tramway service in the near future.

**Carnarvon.**—The Harbour Board have decided to support the scheme for a light railway from Dinas to Carnarvon.

**Accrington.**—The Town Council have decided to apply to Parliament for powers to convert the tramways to electric traction.

**Surbiton.**—The London United Tramways Company propose to delay the extension of the tramways to this district until 1905.

**Dalton.**—The extension of the Barrow tramways to this district is under consideration by the British Electric Traction Company.

**Rotherham.**—In view of overtures from the Post Office, the Tramways Committee have agreed to the fixing of letter boxes inside the tramcars.

**Mid-Yorks.**—The Mid-Yorkshire Tramways Company are asking £75 000 for the transfer of their lease of their trams at Shipley to the Bradford Corporation.

**Saddleworth.**—The Saddleworth and Springhead Tramways Company have decided to abandon their proposal to construct tramways in Saddleworth and Springhead.

**Guildford.**—The local enquiry into the application for sanction to construct light railways from Guildford to Stoughton has been fixed to take place on Monday, Jan. 18.

**Liverpool.**—At the meeting of the Town Council on Wednesday the proposal of the committee to discontinue the Everton experimental routes was rejected by 58 votes to 22.

**Tynemouth.**—The estimated cost of the extension of their tramways, for which the Tyneside Tramways and Tramroads Company are seeking parliamentary sanction, is £3,374.

**Worcester.**—The Board of Trade propose to grant an extension of three months to the tramways company in respect of the construction of the city lines, and 12 months for those outside.

**Logiealmond.**—The Earl of Mansfield has promulgated a scheme for an electric light railway for the purpose of developing the Craiglea slate quarries. It will be laid entirely on the Earl's estate.

**King's Norton.**—The Tramways Committee are considering a petition for further facilities for workmen on the tramways, and will probably communicate with the tramways company on the subject.

**Cardiff and Penarth Tramway Scheme.**—The Cardiff Town Council are recommended to oppose the granting of a provisional order for the construction by a company of tramways between Cardiff and Penarth.

**Stourbridge.**—The Dudley, Stourbridge, and District Electric Traction Company, Limited, propose to substitute the present single line by a double line construction along the route from Coalbournbrook to the Ridge.

**Mangotsfield.**—The Parochial Committee have requested the Warmley Rural District Council to agree to the proposed tramways extension in the parish, subject to the purchase and general clause being satisfactory.

**Wellington (N.Z.).**—According to the *New Zealand Mining Journal*, the construction of the Wellington electric tramway track is progressing apace. Messrs. Macartney, M'Elroy, and Co. are carrying out the contract.

**Folkestone.**—The Town Council have decided to give the contract for the proposed tramways to the owners of the G.B. surface-contact system, subject to an agreement being drawn up between them by a consulting engineer to be appointed by the Council.

**Colchester.**—At Wednesday's meeting of the Town Council the engineer reported that the official test of the 11 miles of feeder cables in connection with the tramways was carried out on Dec. 22, and that the result obtained was above that provided for by the specification.

**Lincoln.**—The City Council at their last meeting discussed a recommendation of the members sitting in committee to acquire the tramways for £10,437. 10s., possession to be given on July 1. The proposal was strongly opposed, but the recommendation was eventually agreed to.

**Warrington.**—The Tramways Committee have been requested to prepare plans showing the through tramway routes in the four principal streets, and the turnings and crossings at Market Gate, so as to enable the Streets Committee to prepare plans for the proposed widening of those streets.

**Hyde.**—A start has been made with the scheme of the Corporations of Hyde, Stalybridge, Dukinfield, and Mossley for connecting the four districts with an efficient network of electrically-worked tramways, at a cost of £400,000. The erection of a sub-generating station and a car-shed has been commenced.

**Preston.**—A commencement has been made with the electrification of the tramways, which have to be completed by May 1. The Town Council are opposing the Preston and Lytham and Preston and Blackburn tramway schemes which will be presented for the approval of Parliament in the ensuing session.

**Hull.**—In accordance with a promise made some time ago, the Tramways Committee have reduced the hours of labour on the city system from 60 to 54 hours per week. With respect to indoor men, or carwashers, their wages have been increased from 23s. to 24s. per week, rising 1s. per week each year to 27s.

**Dundee.**—Statistics of the year's working of the tramways undertaking for 1903 show that the total number of passengers who patronised the cars was 11,185,035, being an increase of 1,176,069 on last year. The sum earned in fares was £43,369. 5s. 9d., which is £4,456. 7s. 9d. in advance of last year.

**Vienna.**—The electric tramcars here are now running with a new patent safety guard. The new arrangement consists of an automatic spring affixed to the front of the car, which, when touched by a prostrate body, immediately causes the protecting framework of the wheels to fall to within an inch of the ground.

**Bishop Auckland.**—The Urban District Council have agreed to support the United Kingdom Tramways and Light Railway Syndicate in their application for a provisional order for 42 years. They have also decided to enter into an agreement with the syndicate for the laying of wooden blocks at the side of the rails.

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**Dunedin (N.Z.).**—Excellent progress continues to be made with the Dunedin tramways, and at no very distant date we hope to see the electric cars travelling all over the city. We understand it is the intention of Messrs. Noyes Bros. to have a trial car running in a day or two to test the machinery, tramlines, etc.—*New Zealand Mining Journal* (Nov. 26).

**Erdington.**—At Wednesday's meeting of the District Council it was stated that the delay in starting the construction of the proposed tramways was due to the illness of the engineer to the British Electric Traction Company, whose duty it was to go through the plans. This gentleman, however, was now better, and it was hoped that there would be no further delay.

**Halifax.**—At the meeting of the Town Council on Wednesday a proposition to request the Tramways Committee to consider the advisability of introducing ½d. fares for children between the ages of three and twelve was withdrawn, the mover, however, remarking that if nothing were done within a reasonable time, he would bring the matter forward again in a more direct form.

**Dublin United Tramways Co.**—The directors of the Dublin United Tramways Company, Limited, recommend a dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year ended Dec. 31 last. The sum of £4,000 is set aside for reserve fund, £2,000 towards maintenance during current half-year, and £1,000 to accident insurance fund, leaving £6,775 to be carried forward.

**Musselburgh.**—The company promoting the electric tramway scheme having proposed the adoption of a surface-contact system, the Town Council remitted to the Provost and Law Committee to report on the system before consent could be given. The committee met on Tuesday, and with information before them indicating that the system was very much in the line of experiment, agreed to call in an expert to advise them.

**Metropolitan Railway.**—The Metropolitan Railway Company have deposited a Bill for introduction into Parliament next session "to convert and consolidate their existing capital and to raise additional capital." The total par value of the stocks affected by this scheme amounts to £7,675,924. The Bill also proposes to empower the company to raise £750,000 additional capital, and to borrow in respect of this capital a further sum of £250,000.

**Llanelly.**—The Urban District Council have deposited for next session a Tramways and Improvement Bill to confirm an agreement between the Council and the British Insulated and Helsby Cables, Limited, and to make provision for the transfer of the tramways and of the electrical supply undertaking of the Council and of the undertaking authorised by the Llanelly and District Light Railway Order, 1902, to the company, and other purposes.

**Dunfermline.**—For the proposed electric tramway from Dunfermline to Rosyth, two routes are to be surveyed shortly. The Fife Electric Power Company, in their incorporating Act, provide for acquiring lands for generating or power stations only at Comrie, Cowdenbeath, Cupar, Markinch, and Leven, but one of the sections enacts that lands elsewhere may be obtained by agreement, and the Rosyth naval base has made Dumfermline a more important centre.

**Competition.**—The Great Central Railway Company have inaugurated a system of 6d. weekly tickets between Grimsby town and Cleethorpes, enabling holders to travel when they like and as often as they like between Grimsby, Grimsby Docks, New Clee, and Cleethorpes, from Monday morning to Sunday night. The Grimsby and District Tramway Company have replied by issuing return tickets between Riby-square and Cleethorpes for 2d. Hitherto the return has been 4d.

**Wakefield.**—The Wakefield and District Light Railway Company, whose light railways are now being constructed, and will shortly be opened for public traffic, have deposited a Bill for introduction into Parliament next session, under which power is sought to construct tramways in Wakefield, Pontefract, Normanton, Whitwood, Castleford, Featherstone, and Knottingley. The proposed lines will, taken together, be just over 25 miles in length, and cost £183,918 to construct.

**Light Railways.**—The Board of Trade have confirmed the following orders made by the Light Railway Commissioners: (1) Quarry Bank, Brierley Hill, and Rowley Regis Light Railway Order, 1903, authorising the construction of light railways in the urban districts of Quarry Bank, Brierley Hill, and Rowley Regis, in the county of Stafford; (2) Robertsbridge and Pevensey Light Railway (Extension of Time) Order, 1903, amending the Robertsbridge and Pevensey Light Railway Order, 1900.

**Enfield Light Railway.**—At the Southgate Urban District Council meeting on Wednesday evening, it was reported that the order authorising the construction of a light railway along Green-lanes from Wood Green to Enfield, a distance of about four miles, had been confirmed by the Board of Trade. The scheme is that of the Middlesex County Council, and the cost of road preparation is estimated at £36,000. As far as possible, the road for the entire distance will be made a uniform width of 60ft.

**Glasgow.**—There is a probability that the proposed extensions of the Corporation tramway system to Bearsden and Milngavie in the north-west and Barrhead on the south may not be proceeded with. There has been strong opposition, especially to the former part of the scheme, and there appears to be a decided feeling among the members of the special committee entrusted with the promotion of the provisional order that unless a strong representation is made by the dwellers in these districts in favour of the extensions the Corporation should be advised not to go on with them in the meantime.

**Leith.**—At a meeting of the Tramways Committee on Tuesday it was stated that the National Telephone Company, the Edinburgh and District Water Trust, the Edinburgh and Leith Gas Commission, and the Leith Dock Commission were applying for protection clauses in the Leith tramways provisional order. The town clerk also reported that the Edinburgh Street Tramways Company and the Leith Corporation had respectively applied to the Board of Trade for approval of the tramways purchase agreement, and there was submitted a communication from the Board of Trade stating that the matter would receive attention.

**Stirling and Bridge of Allan.**—At a meeting of the Bridge of Allan Town Council on Tuesday a letter was read from the town clerk, Stirling, with reference to the proposal before the Town Council of Stirling to acquire the existing system of tramways between the two places and convert it to electric traction, extending the line to Bannockburn. The letter enquired whether, in the event of the Stirling Council promoting a provisional order for the purpose, the Bridge of Allan Council would give their consent, and postpone their right of purchase for a period of years. The Council agreed to consider the questions in committee.

**Lambeth.**—A special meeting of the Borough Council was called for last night to consider a motion to rescind a resolution passed by the Council on Dec. 10 to contribute a sum of £20,000 towards the cost of the widenings in connection with the purchase of the London Southern tramways, and asking the Highways and Finance Committees to bring up a recommendation recommending a contribution of one-third, as requested by the London County Council. There is a strong local feeling in favour of the scheme, and petitions to the Borough Council, urging that body to agree to the contribution required by the London County Council, are being circulated.

**Tottenham Court-road.**—Although the St. Pancras Borough Council have consented to the London County Council's project for an electric tramway along Tottenham Court-road, the Holborn Borough Council are opposed to the scheme, "believing that the thoroughfare is not suitable for a surface tramway, and that this view is shared by the whole of the frontagers." The Marylebone Borough Council are asked by the Parliamentary Committee to adhere to their previous resolution in opposition to the proposed tramway, 4 furlongs 1·6 chains of which would be in St. Pancras, 1 6 chains in St. Marylebone, and 1 furlong 5 8 chains in Holborn.

**Eastbourne.**—The Electric Light Committee are still hampered in their motor 'bus scheme by the delay in delivery of 'buses and the difficulty of obtaining new ones in anything like reasonable time. Application is to be made to the County Council to register the motor omnibuses belonging to the Corporation, and to license the drivers and conductors. The general opinion of the committee in respect to the motor 'bus service is well voiced by its resolve that as a sufficient trial has not yet been made of the motor omnibus service, the time is not ripe for the consideration of the question of tramways. This opinion was endorsed by the Town Council on Monday.

**Perth.**—The Tramways Committee have considered the question of appointing an engineer for the reconstruction of the tramways. The following were selected by the committee: Kincaid, Waller, Manville, and Dawson, London; Hawtayne and Zeden, London; Stephen Sellon, London; Handcock and Dykes, London and Glasgow; Hewit and Rhodes, Manchester: Geo. Hooghwinkel, London; and James More, jun., Edinburgh. Of the above the following three are to be asked to send representatives to Perth with a view to the final appointment being made: Messrs. Kincaid, Waller, Manville, and Dawson; Messrs. Hawtayne and Zeden; and Mr. James More, jun.

**Wood Green.**—At the last meeting of the District Council a letter was read from the engineer to the Metropolitan Electric Tramways Company with regard to the proposed improvements to Jolly Butcher's-hill from the junction of Lordship-lane to a point opposite Bound's Green-road, offering to carry out such improvements provided the Council would accede to the proposals of doubling the lines of tramway under the Great Eastern Railway bridge at Noel Park Station without widening the roadway. The Council decided not to agree to the proposal. The matter of doubling the lines under the Great Eastern Railway bridge at Noel Park Station is at present under the consideration of the Board of Trade.

**Additional Traffic Returns.**—Anglo-Argentine, £2,104 increase; Barcelona Ensanche y Gracia, £143 increase; Barcelona, £3 increase; Brisbane, £57 decrease (month of December, £11,915, increase £371), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £300 increase (month of December, £15,057, increase £1,099); Calcutta, £573 increase; Cape Town (month of November), receipts £16,785, expenditure £8 673; Isle of Thanet Electric, £26 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of November), receipts £47,350, expenses £27,600; Perth Electric, £266 increase; Port Elizabeth (month of November), receipts £4,073, expenditure £2,989.

**Brighton.**—Mr. T. B Holliday, the Corporation's tramway engineer, has reported to the Tramways Committee giving a number of reasons why he considers it unwise to make any change in the working of the cars on Elm grove and Queen's Park-road routes, and strongly advising them to maintain the present method of operating the cars, although it may appear to be slightly inconvenient, until such times as they are able to connect the Queen's Park-road line with the Aquarium terminus. This report has been approved by the committee. Mr. Holliday has also reported the result of his enquiries as to the systems of interchangeable tickets in other boroughs. With one exception the verdict of each town was adverse to the transfer system. The committee have therefore resolved not to adopt the transfer system.

**Derby.**—The Town Council having decided not to proceed with a portion of the tramway route in Burton-road, the committee have been in communication with the contractors who are willing to construct other lines in lieu thereof at the schedule of prices contained in their

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contract, which will obviate any charge on the Council for materials, etc., which would otherwise not at present be utilised. The committee are of opinion that it is desirable that the undermentioned routes included in the complete scheme should be proceeded with—viz., Bateman-street to Osborne-street, at a cost of £2,414. 10s.; Douglas-street and Dairy House-road, at a cost of £4,740. 18s. — total, £7,155. 8s. The committee have now decided, subject to the approval of the Council, to substitute wood paving for granite paving on the Normanton-road, from Loudoun-street to Leonard-street, at a cost of £605. 6s. 8d.

**Leeds.**—The Town Council have approved a resolution in favour of promoting a Bill for empowering the Corporation to construct certain temporary railways and works to facilitate the construction of their authorised waterworks in the valley of the Burn, and to authorise the placing of electric lines in certain highways, and for other purposes. The tramway men employed by the Corporation threaten to strike. About 1,000 of them held a midnight meeting on Monday to protest against the proposed split-turn system of working. Under this scheme the routes of the men will be changed, and this is objected to on the grounds that it is likely to entail accidents, that the drivers would necessarily be unemployed at intervals during the day, when they would be subject to special temptations, and that the wives and children of the men would be sufferers in the end. The Town Council, however, on Wednesday decided to give the system a trial.

**Newcastle.**—From the official report of the professional auditor to the Corporation, it appears that during the half-year from March 26 to Sept. 29, 1903, the receipts from the tramways amounted to £120,697. 17s 2d. This sum was made up as follows: balance at March 25, 1903, £22,380. 14s. 3d.; traffic receipts, £89,969. 1s. 1d.; capital expenditure repaid, £7,856. 0s. 5d.; and sundry receipts, £492. 1s. 5d. The total payments were £102,627. 8s. 7d., comprising, among others, the following items: traffic expenses, maintenance, etc., £62,732. 12s. 5d.; capital suspense account, payments chargeable against capital, £10,809. 1s. 8d.; interest on loans, £11,080. 8s. 5d.; city fund on account of advance, £10,000; and loans repaid, £7,489. 2s. 3d. The credit balance as at Sept. 29 amounted to £18,070. 8s 7d. The total cost of the tramways proposed to be constructed under the Newcastle Corporation Bill, to be promoted in the ensuing session, is estimated at £129,740.

**Reading.**—A scheme by Mr. Binns, engineer and manager, has been approved in favour of issuing cheap tickets for school children, and books of tickets to adults. On the question of the fractured axles, the engineers, Messrs. John Bowen and I. E. Winslow, at the last meeting reported the outcome of a conference between representatives of the Corporation and of the contractors (Messrs. Dick, Kerr, and Co., Limited), the general effect of which was that the contractors having called for the engineers' lists and inspected the same, promptly admitted the low quality of the steel, which came as a great surprise to them, although such cases occasionally occurred in manufacture. They stated they were not the makers of the steel, and would have to take the matter up with their sub-contractors. The contractors' representatives thereupon freely agreed to cancel all existing claims for replacements of axles, to supply new axles, to put new wheels (to be supplied by the Corporation) on to the new axles, and to fix the same under the cars at Reading.

**The Thames Valley.**—The London United Tramways Company contemplate further operations in the Thames Valley. Finding the extension to Hampton Court successful and popular, they purpose seeking parliamentary authority to carry their lines onward to Taplow and Maidenhead. Their scheme is to lay down a tramway from Hounslow on to Colnbrook and Slough, and thence to Skindle's Hotel at the Taplow end of Maidenhead Bridge. This is a very ambitious project, and in some directions it is objected to on the ground that tramlines will be prejudicial to much of the charming scenery through which it will necessarily pass; but there is little doubt that the intended extension will be of great public advantage, and will provide a delightful alternative route to that by railway for pleasure seekers making for Upper Thames resorts in the summer. Another and a similar, but much shorter, extension projected is from Hounslow to Staines, and that likewise will tempt many people to journey to the river-side by road rather than by rail. All these developments are calculated to render a much-needed benefit on the various Thames-side towns.

**North Yorks.**—A Bill for the construction of railways from Hellifield to Scorton has been deposited for next session in the Private Bill Office of the House of Commons. It is proposed to confer upon a company powers to construct 12 sections of railways, which, taken together, comprise just over 51 miles of lines, commencing at Hellifield by a junction with the Lancashire and Yorkshire Railway Company line from Blackburn, and terminating at Scorton by a junction with the Richmond branch of the North-Eastern Railway. The total length of this main line will be 48 miles 1 furlong, and in connection with it branch lines are sought to be constructed so as to obtain access by means of running powers into the Hellifield Station of the Midland Railway, into the Darlington, Middlesbrough, and Northallerton Stations of the North-Eastern Railway, and into the Colne and Skipton Stations of the Midland Company's system. Junction lines are also proposed with the Yorkshire Dales Railway, over the whole of which it is proposed to exercise running powers. The period required for the construction of this railway is five years, and it is proposed to adopt electric traction, provision being made for the acquisition of land for the erection of three generating stations. The capital of the company is proposed to be fixed at £960,000, with the right to borrow by the creation of debenture stock a further sum of £450,000.

**Bingley.**—On Tuesday a special meeting of the District Council was held in committee for the purpose of discussing the question of the Mid-Yorkshire tramways scheme with Mr. Balfour, the representative of the owners of the system and rights. Mr. Balfour's principal object was to obtain a concession from the Council as to the term for which the tramways scheme should be worked as a private undertaking before its transference to the Council. The period fixed with the original promoters was 30 years, but recently the Council were asked to extend the period to 42 years. At that time an extension of five years was granted by the Council, but now Mr. Balfour has put forward once more the request for an extension of 12 years beyond the original 30 years, and made certain suggestions of a financial nature as an inducement. Before going into the question members of the Council sought information respecting the reported offer of the undertaking to the Bradford Corporation. Mr. Balfour assured them that this was not correct, at any rate so far as the Bingley portion of the scheme was concerned. In the end the Council offered to extend the term to 42 years, on the condition that during the extra seven years a certain sum of money should be annually paid to the Council. The proposal of the promoters is to extend the tramway from its present terminus in Nab Wood to Morton-lane, just beyond Crossflats, but not to go further in the direction of Keighley.

**Bath.**—On Saturday the system of electric tramways which has been laid down by the Bath Electric Tramways Company was formally opened for traffic, thus displacing an antiquated horse-drawn combined 'bus and tram service. The chief feature of the change from the point of view of the public, apart from the quicker service, is the substitution of double-deck for single-deck cars, because for some reason the horse trams were never permitted to use the double deck. The lines now put down comprise some 12½ miles of track, mostly single track, with turnouts, owing to the narrowness of the roads. The standard gauge, 4ft. 8½in, has been adopted. The routes traversed are in many places extremely hilly, with very sharp gradients, which necessitate the use of 30-h.p. motors on single-truck cars. The routes in operation are (1) Great Western Railway Station to Weston; (2) Bridge-street to Coombe Down: (3) city to Bathford; (4) city to Twerton. The British Westinghouse Company carried out some quick work in connection with the scheme. On May 1 last ground was broken for the generating station, car-sheds, and office buildings, and these have since been erected and equipped throughout. The generating station, which is situate in Walcot, adjoining the River Avon, has a capacity of 675 kw., and the car-sheds hold 40 cars. The complete electrical equipments for the latter consists of Westinghouse 49 B/90, with Westinghouse magnetic brakes. The overhead trolley system has been adopted. Flexible suspension is in use throughout, chiefly from bracket arms on side poles, but span wires from side poles and rosettes are employed in some of the central streets. The system has been opened just about eight months after the commencement of the work, and the Westinghouse Company, together with the other contractors and the responsible officials entrusted with the charge of the scheme, share the credit for this. The new tramways connect up a number of suburban districts, and serves a population of nearly 80,000 persons. For the present a daily service of 30 cars will be put on.

**Railway Bills in Parliament.**—Last session there was a large number of Bills for making tube railways in all parts of London, but in consequence of the appointment by the Government of the Royal Commission on London Locomotion, practically all these Bills were suspended, and as the Commission is still sitting, enterprise in this direction is to a great extent hung up. There is, however, one interesting tube scheme coming on, which is to connect North and South Woolwich by a tunnel under the Thames. It is noticeable that there is no attempt being made this year to construct an electric railway between London and Brighton either on the Behr or any other system. Altogether, there are 34 Railway Bills to be promoted in the ensuing session, including the following: Metropolitan (Capital Powers), £750,000; Baker-street and Waterloo, £330,000; and Charing Cross, Euston, and Hampstead, £300,000. The North and South Woolwich Electric Railway, which will be carried out, if sanctioned, by a new company, is estimated to cost about £240,000. The London United Tramways Company propose making two pieces of railway to connect with the Hammersmith Station of the Metropolitan District Railway, and the Great Northern Railway Company and the Great Eastern take powers to make widenings and carry out various works on their lines. The North Staffordshire Railway Company are asking for powers to work both the railways and the canal under their control by electricity. The Metropolitan District Railway Bill will undoubtedly be one of the most interesting before Parliament, inasmuch as the whole question of zone fares is raised when the electrification of the line is completed. The Great Northern and City Railway Company is seeking an extension of time for the completion of the undertaking, which, however, is now very far advanced, while the Charing Cross, Euston, and Hampstead Railway want authority to make certain deviations of the authorised line, as well as raise further capital.

**Birmingham.**—The first section of electric tramways to be opened for public traffic under the direct control of the Corporation, and since Mr. Baker assumed the managership of the system, was inaugurated on Monday with the customary ceremonial. It is the line which runs out to the city boundary at Aston-road from the top of Steelhouse-lane. Connection is thus established with the steam trams of the Aston borough, and the through journey is accomplished with one change at the junction of the two systems. At the luncheon which followed the opening of the route, Alderman Cook, in reply to the toast of his health, said that for many years they were compelled by the restrictions of the then Tramways Act to lease the lines to private companies. Their experience in this direction had been long and peculiar, and he thought the unsightly, dirty, and antiquated steam engines at present running were sufficient justification for the refusal to continue the old order of things. The lease of the Aston lines expired last Wednesday, and that day, for the first time, the citizens of Birmingham were working their own tramways. He ventured to predict that after they had tried the experiment the citizens would be eager to extend the system to the other lines in the city. Referring to the action of the authorities who joined hands with the British Electric Traction Company in promoting the Birmingham District

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Tramways Bill, Alderman Cook said there was no doubt that that action had caused considerable friction, and it was an act of war which in international affairs would have been followed by the breaking off of relations. Birmingham thought they had been misled. It was not a neighbourly nor a dignified position for the local authorities to join with a company to secure compulsory running powers over the Birmingham lines. The committee believed that the public should be the first to be served. They should work in a conciliatory spirit with the Electric Supply Committee to make it a good concern in the interests of both and the finances of the city. He hoped the British Electric Traction Company would recognise that Birmingham had definitely settled on municipalisation, and that, as they must be neighbours, nothing was to be gained on either side by a "dog-in-the-manger" policy. The Corporation desired to give fair and reasonable facilities for the interchange of traffic, and he was glad to add that during the last few days he had heard of some disposition to let bygones be bygones, and to arrive at a fair working arrangement.

**Tramway Bills in Parliament.**—There are fewer Tramway Bills to be promoted in the ensuing session than has been the case for some years. The London United Tramways Company are bringing in a Bill to make a number of extensions in Brentford and Ealing of their system, at a cost of £530,000. The Harrow-road and Paddington Tramways Company seek to transfer their undertaking to the Metropolitan Electric Tramways Company, Limited, which already has secured numerous tramways in Middlesex. The Staddleworth and Springhead Tramways, which had secured sanction to construct tramways in connection with those two towns and the district, have met with difficulties, and ask to be allowed to abandon the undertaking and dissolve the company. The Bristol Tramways and Carriage Company are promoting a Bill to make extensions of their present system in Bristol and the neighbourhood. By the Llanelly Tramways Bill it is sought to transfer the tramway order of the Urban District Council to the British Insulated and Helsby Cable Company. Both the London, Camberwell, and Dulwich Tramways Company and the Southport and Lytham Tramways Company seek further capital. The Tyneside Tramways and Tramroads Company ask to be allowed to make further extensions, and to have running powers over the Newcastle Corporation tramways. By the Preston and Blackburn Tramways Bill a company will be incorporated to construct a line between those two towns. The Preston, Chorley, and Horwich Tramway Company are seeking to make deviations from their authorised line and to raise additional capital, and the Imperial Tramways Company ask for power to make further extensions in the Middlesbrough, Stockton-on-Tees, and Thornaby (Bill. By the Romford and District Tramways Bill the Empire Electric Light and Power Company will be allowed probably to make extensions, and the Watford and District Tramways Company want an extension of time to construct their authorised lines. The Isle of Thanet Light Railways Bill is a small measure dealing principally with deviations. Under the Torquay Bill the Dolter Electric Traction Company wish to construct about 6½ miles of tramway, but seek no capital powers. By the West Riding Tramways Bill the Wakefield and District Tramway Company seek to make considerable extensions of their system; and under the Holyrood Tramways Bill a company will be incorporated to construct tramways in Belfast and County Down. The following are the amounts of new capital sought to be issued under Tramways Bills as given in the *Financial Times*: Preston and Lytham Tramways, £350,000; West Riding Tramways, £156,000; Preston and Blackburn, £200,000; Preston, Chorley, and Horwich, £100,000; London, Camberwell, and Dulwich. £120,000; Holywood, £54,000; Southport and Lytham, £30,000; Mid-Cheshire Tramways, £200,000. Amongst the municipal schemes the Belfast, Great Yarmouth, Newcastle-on-Tyne and Manchester Corporations, the London County Council, and the Urban District Councils of Leyton, Wallasey, Stretford, Ilford, and Radcliffe all have Bills of considerable dimensions.

## LIGHTING AND GENERAL.

**Bombay.**—The Municipality propose to erect an electric lighting plant.

**Eastbourne Electrical Exhibition.**—Sixty-one persons paid 6d. for admission and 1,848 paid 3d.

**Reigate.**—The Town Council have received sanction to a loan of £7,000 for electric supply purposes.

**Dukinfield.**—The Town Council have decided to oppose the Cheshire Electricity and Power-Gas Bill.

**Wood Green.**—Formal sanction to the Council's electricity scheme has been received from the Board of Trade.

**Dorking.**—The Urban District Council have decided to extend the electricity distributing mains at a cost of £670.

**Hartlepool.**—The Northern Counties Electricity Supply Company are to start to-morrow with the electric lighting.

**Stepney.**—The Council on Wednesday decided to borrow £78,000 from the London County Council for electric lighting extensions.

**Pontypool.**—The Urban District Council are asking the electric light and power company to reduce their charges for lighting the town hall.

**West Bromwich.**—The Electric Lighting and Power Committee have received sanction to a loan of £12,177 for the purposes of the electricity works.

**Monmouth.**—An extra high-tension cable 790 yards long is to be laid down, at a cost of £207, to meet the increasing demand for electric light in the borough.

**Cable Steamer.**—It is stated that the Eastern Telegraph Company's cable steamer "Chiltern," which sank at Plymouth a few days ago, will probably be refloated.

**Horsham.**—The electric light is now being installed in the eastern part of the district, and recently cables have been laid in Bedford-road, Arthur-road, and New-street.

**Melksham.**—A memorial has been sent to the Board of Trade stating that the terms of the Council's provisional order in regard to electric lighting had been altered to.

**Electric Accumulators.**—The Home Office has issued regulations for the manufacture of electric accumulators in pursuance of Section 79 of the Factory and Workshop Act, 1901.

**Notice of Removal.**—Being compelled to remove into larger offices, Messrs. Manlove, Alliott, and Co., Limited, have removed to 41 and 42, Parliament-street, Westminster, S.W.

**Kingston.**—The architect has been instructed by the Guardians to obtain tenders for the work in connection with the proposed electric lighting and power scheme adopted at the previous Board meeting.

**Electric and General Investment Co.**—Warrants for the interim dividend on the 6 per cent. cumulative preference shares, and the interim dividend at the rate of 10 per cent. per annum on the ordinary shares, have been duly posted.

**New Branch.**—Mr. E. Macgregor Duncan, 27, Old Queen-street, Westminster, has opened an office at St. Lawrence-chambers, Butter Market, Ipswich, for his consulting work in the Eastern Counties, the London office remaining as above.

**Wimbledon.**—The electrical engineer's plans and estimates for additions to the boiler-house, new boilers, etc., at an estimated cost of £12,300, have been adopted by the Rural District Council, and application will be made for a loan.

**Newbury.**—We learn that Messrs. Plenty and Son, Limited, electrical engineers, are now prepared to supply estimates for all the necessary wiring, etc., for lighting and power in the town and for complete installations in country houses.

**Barnstaple.**—The Town Council are corresponding with Mr. Trentham with regard to lighting Cross-street, Bear-street, Newport, and Pilton with arc lamps and Nernst lamps. Steps are being taken to borrow £5,400 for extension of mains.

**Stourbridge.**—We understand that the Urban District Council will oppose the application of the Shropshire and Worcestershire Electric Power Company for parliamentary powers in respect of the urban district and the adjoining parishes.

**Rochdale.**—The consumers of current from the Corporation electricity works are paying a minimum charge of 10s. per quarter. The Gas and Electricity Committee now recommend that this minimum charge should be reduced to about one-half.

**Cheltenham.**—A number of extensions to mains are to be carried out. At the present time there are 749 electric light customers, with the equivalent of about 47,270 8 c.p. lamps, connected to the private supply mains, the large increase in lamps being due to the new town hall.

**Eccles.**—The Gilbert Arc Lamp Company, of Chingford, report that they have during the past year carried out three small street-lighting contracts for Eccles, where some interesting lighting with small-watt open-type 6ft. carbon lamps has been most satisfactorily installed.

**Colchester.**—The Town Council have received the following report of the electrical engineer: output of electricity in units during November, 1903 49 577, 1902 33 034, 1901 29,378; number of consumers at end of November, 394, 311, and 218; total number of 8-c.p. lamps connected, 24,278, 19,482, and 12,499.

**Gateshead.**—The Town Council have agreed to the proposal of the Durham County Electrical Power Distribution Company, Limited, for conditional reduction of prices to consumers on the understanding that the period of 13 years under the provisional order be extended to 14 years, and not 19 as suggested by the company.

**Oban.**—The Town Council have recently converted two street lamps from gas into incandescent 16-c.p. lamps placed inside prism globes, which are put into the existing gas lanterns. The lamps are considered a great improvement upon gas, and the Town Council no doubt will gradually convert the remaining gas lamps in the same way.

**Halifax.**—Alderman Hey, replying to a question at Wednesday's meeting, assured the Council that it was imperative that application be made for powers to borrow £10,000 for the extension of the electricity undertaking, as the money would be required for new works that must be in operation by the autumn to enable them to meet the winter load.

**Pontardulais.**—At a recent parish meeting the Council were authorised to take steps to borrow £1,250 for an electrical plant and £191 for the first year's working. Plans were prepared, but the Local Government Board declined to sanction the scheme. It is now proposed that the streets be lighted with gas. The Parish Council will take the matter up at the meeting to be held to-day.

**Middlesbrough.**—The Corporation have decided to proceed with their arrangements for the work in connection with the proposed extension of the plant and buildings, for which sanction to a loan of £15,000 has been applied for. The electrical engineer's report states that the plant had worked successfully during the past month. They had received 11 applications for 505 additional lights in the future.

**South Wales Electrical Power Co.**—The first 3,000-h.p. engine and electric generator at the Treforest station of the South Wales Electrical Power Distribution Company was started under steam on Christmas morning. Since then it has been regularly at work under test, and this week current will be put on the mains, some 16 miles of which are now completed, and to which many customers are being connected.

**Londonderry.**—Mr. Macrory, electrical engineer, reporting progress of cablework, etc., says that house connections (which are made free to

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consumers) have been commenced and are being proceeded with, and urges intending consumers to apply at once. He further reported that the setting of the first new boiler had now been almost completed, and that the overhead travelling crane would soon be delivered on the site.

**Spennymoor.**—The electricity supply company are putting up some 150-c.p. lamps in certain parts of the district, and these will remain till the end of next month. The Council has been informed that if they desired these new lamps to remain till the end of the season, an extra charge of 27s. 6d. per lamp would be made. It appears that the Council desire that the special lamps should be erected at the expense of the company and not the Council.

**Wrexham.**—The Town Council have accepted an offer of the St. Helens Cable Company of £400 to compound the maintenance covenant respecting the electric cables they laid for the Council. During November 43,678 units were generated at the electric works, as against 21,305 units last November. The question of altering the scale of charges for current has been referred back to the Electricity Supply Committee for further consideration.

**Agency.**—Messrs. Monté Callow and Co., 6, Ludgate-broadway, E.C., have appointed Mr. R. A. Young, of Ward's buildings, High Bridge, Newcastle-on-Tyne, as district representative for the sale of their "Perfecta" motor starters, regulators, and controllers, samples of which may be seen at his office. We are informed that any sectional list of "Perfecta" resistance apparatus will be sent to our readers on application, and that Mr. Young does not propose to sell motors or to interfere in any way with general electrical contractors' work.

**Para Rubber.**—The area planted in Para rubber in Ceylon (says the *Chamber of Commerce Journal*) is estimated at 3,000 acres. The best results have been secured in the South Kaltum district, which is about 100ft. above sea level, and has an average rainfall of over 98·5in. The soil is mostly a sandy loam. Para rubber thrives also at an altitude of 3,000ft., and will endure a variation of rainfall of from 70·9in. to 147·6in. Each tree produces about a pound, worth about 4s. According to the *Deutsche Kolonialzeitung*, the quality of the rubber is often impaired by the use of such acids as lemon juice to hasten the extraction of the juices from the trees.

**Brighton.**—The Lighting Committee of the Town Council have agreed to Mr. Galbraith's recommendation that, in addition to their contract price of £35,760 in connection with the Southwick electricity works and the sum of £12,204 for extra works, the Town Council pay Messrs. Pedrette and Co. the sum of £4,132 additional in full settlement of all demands, bringing up the total cost to £52,096. The sum of £45,500 has already been paid on account, so that the amount now payable to Messrs Pedrette in full satisfaction of all demands is £6,596. Mr. Galbraith also recommends that the Corporation withdraw their claim for damage by reason of non-completion of contract within the specified time.

**Portsmouth.**—It will be remembered that recently two new Parsons turbines and alternatore were installed at the electric lighting station. At the same time there was obtained a spare armature, which could be used on either of the turbines. The new plant got very successfully through the extraordinary demand during the Christmas holidays, but on Thursday night one of the turbine armatures broke down. The spare armature above mentioned was put in, but another mishap occurred on Saturday night, and owing to the works of Messrs. C. A. Parsons at Newcastle being shut down for the New Year holidays some delay necessarily occurred before the matter was put straight again. We are informed that these turbines were taking load again on Tuesday last.

**Aberdeen.**—Mr. J. A Bell recommends the following additional plant be placed in the Ferryhill station: One 740-kw. direct-coupled generating set, with condenser, air pump, steam and exhaust pipes, foundations, and switchboard connections, £10,800; two boilers, each capable of evaporating 15,000lb. of water per hour, with mechanical stokers, steam-pipes, foundations, flues, and brickwork, £4,300; coal bunkers of mild steel of 800 tons capacity, with bucket coal conveyor, electrical driver, weighing machines, and rails, etc., complete, £3,500—£18,860; for contingencies, say, 10 per cent., £1,860—total, £20,460. The committee have decided to recommend the Council to authorise the obtaining of tenders for the plant. They have already in hand applications for 385 h.p. for motor purposes.

**Nottingham.**—A recent report of the Electricity Committee states that, owing to the increased demands for the supply for lighting and power purposes, they find it necessary to make provision for completing the equipment of the first section of the electricity generating station at St. Ann's Well-road, and extending mains, services, etc. The electrical engineer's estimate shows that additional boilers, steam dynamos, pumps, pipes, valves, and connections, etc., will cost £46,695; extensions of mains, house service connections, meters, etc., £53,305—making a total of £100,000. The committee now recommend that application be made for sanction to the borrowing of £100,000, to be raised as required. The proportion required to be expended during the year 1904 to meet the probable requirements of new consumers is estimated at £41,000.

**London Gazette.**—Ebenezer Henry Hawkins has been appointed trustee in the estate of Thomas Hyam, hardware dealer, gas and electric light fitter, 139, Fawcett-road, Southsea, Hants. The petition for the winding-up of the Electric Tramways Construction and Maintenance Company, Limited, which was presented to the High Court of Justice on Dec. 23 by Alfred John Paine, of the Old Cedars, Westhill, Sydenham, will be heard before the Court sitting at the Royal Courts of Justice, Strand, London, on Jan. 12. Any person intending to appear at the hearing of the petition must send in notice to Joseph Davis, 22, Liverpool-street, E.C., by 6 p.m. on Jan. 11. Edwin Leadam Hough has been released from trusteeship in the estate of George Calvert, electrical and motorcar engineer, residing at 12, Woodville-road, Mildmay Park, lately carrying on business at 487, Kingsland-road, London.

**Derby.**—On Wednesday the Town Council adopted a scheme submitted by the Electric Lighting Committee for the lighting of the streets on the tramway routes by electricity. It is proposed to fix an arc lamp on every alternate tramway pole, a distance of about 74 yards apart, and also an incandescent lamp on every pole, about 37 yards apart. The arc lamps would be switched off at 11 p.m. each evening, and the incandescent lamps then switched on until sunrise. The scheme will provide for a large increase of light in the streets referred to, comprising the addition of about 60 arc lamps and 117 incandescent lamps. The charge for public lighting will not be increased by the adoption of the scheme. The consent of the Highways Committee has been obtained. A capital expenditure of £1,250 will, it is estimated, be necessary for the purpose, and the Council will apply for sanction to the borrowing of that amount.

**Borough Theatre, Stratford.**—During the few weeks previous to the production of the annual pantomime at this popular suburban theatre the electrical installation was thoroughly renovated and considerably extended. Consequently the electric light plays an important part in the telling of the old story of "Dick Whittington," not only in the gorgeous transformation scene, in which it is used to its fullest capacity, but with delightful effect in the "Highgate Hill" scene—one of the prettiest ever produced at this house. In the latter the change of light from dusk to moonlight and from moonlight to the first tints of early dawn and subsequent sunrise is very true to Nature, and reflects great credit on those responsible. During the whole performance the electrical effects are cleverly conceived and well executed, and the pantomime, which is capitally staged and mounted, can hardly fail to secure full houses for the remainder of its run.

**Hereford.**—The Electric Lighting Committee have received sanction to the borrowing of £1,500 for the extension of mains. The following return, showing the output of current for the quarter ended Sept. 15, 1903, and Sept. 25, 1902, has been submitted to the Council: Quarter ending Sept. 25, 1903, units sold for lighting 15,161 (Sept. 25, 1902, 11,955); units sold for power, 4,039 (2,828); total units sold, 19,200 (14,793); equivalent number of 8 c.p. lamps at beginning of quarter, 9,698 (3,505); 8-c.p. lamps added, 197 (223); equivalent number of 8 c.p. lamps at end of quarter, 9,835 (8,728); number of arc lamps connected, 20 (16); number of motors connected, 14 (11); horse-power of motors connected, 47 (41). Owing to exceptional pressure of work, the engineer has applied for extra assistance temporarily, and the committee have sanctioned the appointment of Mr. Ronalds for the above purpose at a salary of 30s. per week till the end of February next.

**Brompton and Kensington Electricity Supply Co.**—From January, 1904, the price of electrical energy for lighting has been reduced as follows: Consumption per annum—under 500 units, 5½d. per unit; above 500 units and under 1,000 units, 5½d. per unit for first 500 units, and 5d. per unit for remainder; above 1,000 units and under 2,000 units, 5½d. per unit for first 500 units, 5d. for second 500 units, and 4¾d. for remainder; above 2,000 units and under 3,000 units, 5½d. per unit for first 500 units, 5d. for second 500 units, 4¾d. for next 1,000 units, and 4½d. for remainder; above 3,000 units and under 4,000 units, 5½d. per unit for first 500 units, 5d. for second 500 units, 4¾d. for next 1,000 units, 4½d. for next 1,000 units, and 4¼d. for remainder; above 4,000 units and under 5,000 units, 5½d. per unit for first 500 units, 5d. for second 500 units, 4¾d. for next 1,000 units, 4½d. for next 1,000 units, 4¼d. for next 1,000 units, and 4d. for remainder. The following example is given: consumption per annum, 1,800 units—500 units at 5½d., £11. 9s. 2d.; 500 units at 5d., £10. 8s. 4d.; 800 units at 4¾d., £15. 16s. 8d.—total, £37. 14s. 2d., which, compared with present bill of £43. 2s. 6d., shows a saving of £5. 8s. 4d. The adjustment in the charge will be made each year in the Christmas quarter account. The charge for power and heating, on separate meter, will remain at 3d. per unit, and existing scales of discounts are abolished.

**Maidenhead.**—Councillor Pearce has been chosen chairman of the Electric Lighting Committee for the current year. The resident engineer, Mr. C. O. Milton, in his last report supplies the following figures: A start was made on Dec. 10, 1902, with 39 consumers connected and 2,876 8 c.p. lamps. About the same day in 1903 there were 11,208 lamps applied for, of which 995 were awaiting connection, leaving 10,313 connected, the demand being made up by 150 consumers connected. The load on the station from outside had risen from 96 kw., the maximum last winter, to 150 kw. at the present time, and it is still rapidly increasing. The load is chiefly a lighting one, but several motors are running on the mains, and there seems to be likelihood of a very considerable power load in the near future. This would bring down the cost of production rapidly, although progress has been made in that direction, too. The total works cost per unit sold is now 1·70d., while in January last it was 3·14d. It is purely a matter of output per unit of plant. In January 1,700 units per week were being generated, while last week upwards of 5,600 were turned out. The weekly management sheet shows a margin of profit from week to week now, with the charges for the new capital taken in. Mr. Milton said: "The committee will be gratified to know their station has made a good start, and the engineer craves leave to say a word for the works staff. The assistant, pupils, foreman, and every man inside and outside have stuck fast at nothing in the shape of work or hours in order to keep down costs, and have helped almost as much as the increased output to get units generated at 1·7d. With the better conditions there will be for running with the new engine and condenser in working order, the cost per unit will before another note on a year's work have dropped the 7d." A resolution has been passed to the effect that the Electricity Committee view with pleasure the increase in the electric lighting undertaking as evinced by the facts and figures contained in the foregoing report.

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**Cork.**—The law agent, Mr. Galvin, reported at the last Council meeting that the contract with the electric lighting company provided that if the company failed to light any of the lamps contracted for they should be liable to a penalty of 5s. for each arc lamp and 2s. 6d. for each incandescent lamp which they might fail to light, the penalty to be payable in respect of each night or part of a night during which they should fail. In case any lamp failed to be efficient, the company were bound to at once make renewals or repairs as may be necessary, and in case they failed to do so they were liable to the penalties provided for in respect of unlit lamps. It was decided to request the city engineer to direct the foreman lamplighter to report regularly on the condition of the electric light with a view to the contract being enforced. A letter was read from the electric lighting company stating with respect to some complaints regarding lodgments of water on their lines, that they had on order four drain boxes for dealing with the trouble in William-street, and had effected other improvements, especially with regard to the neighbourhood of the Carmichael Schools. The letter was referred to the city engineer.

**North Wales Electricity Supply.**—In the Bill deposited by the North Wales Power and Traction Company, Limited, for next session power is sought to construct generating stations for the supply of electrical power in North Wales. The area proposed to be covered comprises the whole of the counties of Carnarvon, Merioneth, Anglesey, and Denbigh, with the exception of the borough and rural district of Wrexham, and so much of the county of Flint as comprises the urban districts of Prestatyn and Rhyl and the rural districts of Overton and St. Asaph. The capital proposed to be expended by the company on the works, if authorised, is not, without the consent of the Board of Trade, to exceed the sum of £1,000,000. It is sought to take over on the passing of the Act the powers granted in 1901 to the Portmadoc, Beddgelert, and South Snowdon Railway Company, so far as they relate "to the construction of generating stations and the generation of electricity and the supply thereof within certain parts of the county of Carnarvon." The powers granted under this Bill, which are to cease if within two years of the passing of the Act no substantial progress has been made "for the purpose of carrying out their powers," are to be limited to "authorised undertakers" and "to persons requiring a supply for power," and the profits divisible by the company are limited to 10 per cent., subject to a sliding scale.

**Sturtevant Engineering and Electrical Transmission Co.**—We are informed that from the 1st inst. the business of the Electrical Transmission Company, Albert Works, Hammersmith, has been amalgamated with that of the Sturtevant Engineering Company, Limited, whose works are at 29, Bankside, S.E., and offices, 147, Queen Victoria-street, E.C. By this step the very extensive range of all forms of motor starting and controlling devices manufactured by the Sturtevant Engineering Company, Limited, has been augmented by the addition of the specialities in switchgear manufactured by the Electrical Transmission Company. The Bankside works will be devoted to the manufacture of all apparatus connected with the higher forms of motor control, such as is used for lifts, winches, hoists, haulage, cranes, pumps, etc., and every description of automatic controlling devices. The Hammersmith works will be reserved for the manufacture of the E.T.C. specialities, such as main switches, traction accessories, feeder and section pillars for power and lighting, service switches, motor starters and speed regulators, etc. The whole field of motor control and switch work is thus covered by the standard apparatus of this combination. The commercial management of both concerns will be directed from the head office of the Sturtevant Engineering Company, Limited, at 147, Queen Victoria-street, E.C.

**Hackney.**—Sanction has been obtained from the London County Council in respect of the undermentioned loans in connection with the electricity and destructor undertakings—viz: additional boilers, £6,500; additional mains, £906; paving and roadmaking works in connection with destructor works, £1,560. We understand that Mr. Hammond's terms to act as consulting engineer for the whole of the works necessary for the supply of electricity within the borough have been accepted. A report has been submitted stating that since the termination of the agreement with the National Electric Wiring Company a number of likely consumers had been lost, owing to the inability of the Council to continue the free-wiring system, or to find contractors willing to put their capital into this sort of business. The Council are aware that the London County Council endeavoured to obtain powers for the borough councils to wire consumers' premises, but the Bill was strongly opposed and defeated. It is understood, however, that there is now every probability of the Bill becoming law in consequence of the opponents to the measure having practically intimated their intention of not proceeding with their opposition, should the matter again come before Parliament. With a view of urging the London County Council to again apply for power for the borough councils, a conference of representatives of metropolitan borough councils possessing undertakings is to be held at the Town Hall, Hackney, on Feb. 8 at 7 p.m.

**Underground Telegraph.**—The new underground telegraph system, in continuation of the line from London to Birmingham on to Carlisle, by way of Warrington and Preston, is now nearly completed, and will probably be available for emergencies early this month. The first section of the new system, from London to Birmingham, opened three years ago, was laid at an average depth of 2ft. below the surface of the ground, and contains between 70 and 80 conductors. Iron wires have been superseded by copper wires, from which greater electrical stability is obtained, and it is found that there is no variation in the insulation of the wires during wet weather or fogs. The new cables, too, are an improvement on the original paper-insulated, air-space, lead-covered cables, which, worked at high speed, set up inductive interference between circuits. That has now been got rid of by screening the wires with metallic tape. Copper is dearer than iron, but it lasts longer, and the department express confidence that the change will prove a sound financial success. The new cables are laid *viâ* Warrington and Preston to the North. The expenditure for the current financial year is estimated at £150,000. There are already "pipe" lines underground between Warrington and Manchester and Warrington and Liverpool, and a new cable is being laid from Manchester to Leeds, which will be opened shortly. A short underground cable, 26 miles long, has been laid on the Beattock incline, which is often subject to gales and snowstorms, in the south-west of Scotland, and is now finished, so that direct telegraphic communication is established with the Scotch system

**Cardiff.**—The Electric Lighting Committee on Tuesday adopted a report from Mr. Arthur Ellis, borough electrical engineer and manager, on electrical street-lighting. The total capital expended on street-lighting for the 12 months ending August, 1903, was £4,563, of which amount the sanction of the Local Government Board had been received for the allocation of £3,268 on certain thoroughfares. This left a balance of £1,295 unsanctioned. The total number of lamps fixed was 298, and the capital cost of which was £3,268. Thirty-two lamps had also been fitted up in certain streets at a cost of £417, but for which no specific loans had been obtained. Twenty other lamps were now in course of erection, at a cost of £273. As to the suggestion to lay mains in the streets and roads where there were none at present, solely for the street-lighting, it was stated that the revenue would not pay the loan charges on the capital expended. The amount of capital which would be required would be £7,430. 10s. 8d. if mains were laid in a number of specified thoroughfares. With regard to the roads already provided with mains, more use would be made of the cables by electrically lighting those roads or streets, and the capital cost of erecting lamps, together with the annual charge upon the Lighting Committee, as compared with the present cost of gas lighting, would be as follows: capital cost, £1,561. 12s. 6d.; annual amount, at £14 per lamp, £1,610; present cost of gas, £278. 11s. 10d.; candle-power of electric, 86,250; candle-power of gas, 3,204. This would make a total capital cost for lamps in those roads where mains were already laid of £1,561. 12s. 6d., and an annual cost to the Lighting Committee of £1,610.

**Beeston.**—The District Council in 1902 decided to obtain a provisional order under the Derbyshire and Nottinghamshire Electric Power Company. The question was then deferred for full information, and it is expected that the whole matter will be settled at the next meeting of the Council. The Derbyshire and Nottinghamshire Electric Power Company would bring their high-tension three-phase transmission cable into a proposed sub-station, there transforming down to 345 volts, which would give 200 volts between any phase and neutral for lighting, while the higher voltage would be available for motor work. The company would distribute current over the area by a three-phase four-wire network. The area of supply includes the whole of the district, but the company suggest that operations should be restricted at the present time to the compulsory area only, with one slight extension. The estimated cost to complete the plant is as under: sub-station building, £150; switchboard, £500; two-ton hand crane, £60; three-core cables, laid complete, £2,500; meters and connections for 100 consumers at £8. 10s., £850; contingencies, £190—total, £4,250. The £850 required for meters and connections is for house service connections, including meters, fuses, and service cables, for which a rent from the consumer will be charged sufficient to cover interest on outlay. The company would be willing to enter into an agreement to supply a minimum of 100,000 units per annum at the rate of 1½d. per unit, which quantity it is recommended to apply for, and to distribute at a charge of 4½d. per unit for lighting and 2d. to 2½d. for power purposes, in the generality of cases. The installation could, probably, be made to pay at a very early date, as the preliminary canvass already made shows good prospects of consumers, both light and power. The consumption would soon reach a supply of 2,500 lamps and motor load of 50 b.p., and for these figures the receipts and expenditure for the first year are estimated as follows: Receipts—lighting, 68,000 units at 4½d., £1,275; motors, etc., 28,000 units at 2d., £233—total, £1,508. Expenditure—100,000 units at 1½d., £625; distribution, £150; salaries and office charges, £150; rates and taxes, £25; cost of public lighting compulsory area, £12. 10s.; interest and sinking fund, at 5½ per cent. on £3,400, £187; rent of transformers, £75—£1,224. 10s.; balance, £283. 10s.—total, £1,508. Fifty gas lamps converted to electric lamps show a saving of about £225; 50 gas lamps, at £5 per annum, £250; 50 electric lamps, at 10s. per annum (4,000 units), £25—balance, £225.

**Johannesburg Tenders.**—The following recommendations of the Tramway Committee were adopted by the Town Council on Nov. 27: (*a*) That the tender of Messrs. Bolckow and Vaughan, to supply steel grooved rails and fishplates in accordance with Sections A and B of tramway specification No. 1, at the price of £31,058. 10s. f.o.b. Middlesbrough, be accepted; (*b*) that the tender of Messrs. Bolckow and Vaughan to supply steel Vignoles rails and fishplates, in accordance with Sections C and D of tramway specification No. 1, at the price of £4,808. 15s. f.o.b. Middlesbrough, be accepted; (*c*) that the tender of H. Gielgud to supply tiebars, sole-joints, guard rails, etc., in accordance with Section F of tramway specification No. 1, at the price of £3,519. 14s. 8d. f.o.b. Antwerp and London, be accepted, and that an additional sum of £49. 14s. 8d. be sanctioned to cover the duty on these goods; (*d*) that a sum of £49,000 be sanctioned to cover the charges for freight, railage, etc., on the materials included in the above tenders; (*e*) that the consulting engineers be authorised to order such extras as may be required from the successful tenderers up to an amount not exceeding £6,350. At the same time a report of the Tramway Committee was submitted as follows: "A copy of a cablegram received from Messrs. Mordey and Dawbarn is appended, as well as a tabulated statement of the tenders of which particulars have been cabled. It appears from these that 17 tenders were received for Section A and B, 14 for Section C and D, and 18 for Section F. For Section A and B the lowest tender is a foreign one, that of Messrs. Nye, for rails made by the Ougree Steelworks, Belgium. The amount

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of this tender appears to be £28,685, on certain terms of payment which are not specified. The consulting engineers say that after adjusting this to suit terms of payment the amount is £29,140. The lowest English tender is that of Messrs. Maclellan, but as they appear to depart from the specification, as before, this need hardly be considered. The amount is £29,830. The next English tender is that of Messrs. Bolckow and Vaughan, the amount being £31,058 for rails complying with the specification. If the Council decide to purchase foreign rails, the consulting engineers say that they prefer those offered by Gielgud, and made by La Société d'Angleur. The amount of this tender is £30,049. No reason for preferring it to the lower one is given. The engineers, however, remark that the price of these rails is high, and the tender actually recommended, if foreign rails are taken, is the lowest one. For British rails, Messrs. Bolckow and Vaughan are recommended. Assuming that the freight is the same in both cases, the difference in price between the Belgian andEnglish rails is rather less than 7s. per ton. It is true that both British and foreign rails are made to the same specification ; but even allowing for this, it is thought that, as remarked with reference to former tenders, British rails—especially if manufactured by a firm of such high standing as Bolckow and Vaughan — are probably worth a few shillings more a ton. The specification was, of course, drawn so as not to exclude Belgian rails, but British rails of the composition specified would probably be of a somewhat higher class than the specification absolutely requires. For Sections C and D, the lowest tender is a foreign one—by Gielgud, for rails manufactured by La Société d'Angleur. The amount is £4,530. The two others tenders are English, and of the same amount—£4,804. One of them, that of Messrs. Bolckow and Vaughan, is for rails that comply with the specification. The other, by Messrs. Maclellan, is for rails that do not do so. In this case the difference in price in favour of the Belgian rails is only about 5s. 6d. a ton. For the reasons already given, it is thought that if Messrs. Bolckow and Vaughan's tender is accepted, the difference in quality will probably be commensurate with that of the price. The lowest tender in Section F case is by Gielgud, for goods manufactured partly by La Société d'Angleur. The amount is £3,974. Part of the material is said to be of British manufacture. The lowest British tender is that of Messrs. Maclellan—£3,974. Messrs. Bolckow and Vaughan have tendered for this section also. The amount is £4,038. In this case the difference in price between the British and foreign tenders amounts to about £1 per ton. As part of the material offered by Gielgud is of British manufacture, there does not appear to be any sufficient reason for passing over the lowest tender in this instance. It is recommended by Messrs. Mordey and Dawbarn, unless British manufacture is preferred. In the latter event Messrs. Maclellan's tender appears to be the one to accept. The total freight is quoted at about £49,000. Accepting this figure, the total amount, if the above recommendations are approved, would be about £88,000. It should be remembered that these contracts are based upon schedules within which some variation of quantity is allowed. To allow for this it will be well to provide for an expenditure of £92,000, although the actual amounts may be rather less."

## PROVISIONAL PATENTS, 1903.

DEC. 21.

**28003. Telephone transmitters.** Wallace Fairweather, 65, Chancery-lane, London. (The Kellogg Switchboard and Supply Company, United States.) (Complete specification.)

**28030. Improvements in electric meters.** Ernest Cecil Rimington, 1, Queen Victoria-street, London.

**28051. Improvements in synchronising apparatus for electrical machines.** Paul Martyn Lincoln, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Dec. 29, 1902, being date of application in United States.) (Complete specification.)

**28055. Improvements in arc lamps.** Société Française d'Incandescence par le Gaz (Système Auer), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 22, 1902, being date of application in France.) (Complete specification.)

**28057. Composition for use in the cells of electrical batteries** William Humphrey Wheatley, 40, Chancery-lane, London. (The Atwood Electric Company, United States.) (Complete specification.)

**28059. Improvements in trolley earth indicating apparatus.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**28060. Improvements in compensating systems for alternating electric current generators.** Elmer E. F. Creighton, Pittsfield, Co. of Berkshire, State of Massachusetts, United States.) (Date applied for under Patents Act, 1901, Dec. 20, 1902, being date of application in United States.) (Complete specification.)

DEC. 22.

**28071. Guide to facilitate the attachment of trolley head to trolley wire.** William Hector Mackenzie, "Les Posiers," Holdenhurst-road, Bournemouth.

**28073. Improvements in electrical light fittings.** Veritys, Limited, and Percy Garniss Ebbutt, Plume Works, Aston, Birmingham.

**28076. Electrical milk separator and preservative.** Charles Lillicrap, 59, Robert-street, Manselton, Swansea.

**28079. An electric chemico process of printing books, newspapers, posters, and typewritten sheets.** Alfred William Turner, 67A, Corporation-street, Birmingham.

**28093. An improved universal turn, steam, hydraulic, electric, or hand crane.** James Vaughan, 7, Dorothy-street, Gateshead-on-Tyne.

**28147. Improvements in electrically-operated switches.** William Hurd Hillyer, 18, Southampton-buildings, Chancery-lane London. (Complete specification.)

**28177. Improvements in or relating to pocket electric lamps or lighting appliances.** Wilhelm Quaschning, 6, Lord-street, Liverpool.

**28183. Improvements in and relating to electrically-actuated musical instruments.** William Kennedy-Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

DEC. 23.

**28192. A bearing fitted with balls with a central adjustment for the use on meters, dynamos, etc.** Thomas Haynes and William Henry Gowing, 114, Fentham-road, Erdington, Birmingham.

**28215. Improvements in electrical resistance coils.** Veritys, Limited, and George Owen Donovan, 11, Burlington-chambers, New-street, Birmingham.

**28232. Improvements in coin-freed apparatus for electric light supply.** Antonin Sabat, 65, Chancery-lane, London. (Complete specification.)

**28234. Improvements in moving-coil galvanometers and the like.** Robert William Paul, 68, High Holborn, London.

**28241. Window cleaner driven by an electrometer.** James Frederick Hoyne, 81, High Holborn, London.

**28252. An improved electric lighting batten for theatrical and other purposes and method of preventing confusion of colours by lamps therein.** Leo Sunderland, Norfolk House, Norfolk-street, Strand, London.

**28288. Improved construction or formation of galvanic elements for medico-electric generating appliances or apparatus.** Frank Derry, 173, Fleet-street, London.

**28290. Improvements in wave telegraphy.** Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**28291. Improvements in receivers for electromagnet waves.** Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 9, 1903, being date of application in United States.) (Complete specification.)

DEC. 24.

**28324 An automatic weigher for grain, coal, or other flowing materials, electrically controlled.** Charles John Simeon, Thomas St. Julian Babington Parnall, and William Edward Hipkins, Soho Foundry, Birmingham.

**28334. Improvements in connected with the trolleys of overhead electrically-driven vehicles.** Harold Hetherington Wilson, 23, Coleman-street, London.

**28349. Improvements in and relating to voltmeters.** F. Onland van de Kasteele, 81, High Holborn, London.

**28355. Trolley catchers.** Charles Bornside Robertson, 52, Chancery-lane, London. (Complete specification.)

**28399. Improvements in magnetic ore separator.** Frederick Titcomb Snyder, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**28400. Improved process for the production of hydroxides and oxides of metals by electrolysis.** Frederick Furneaux Hunt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**28401. Improvements in and relating to electric arc lamps.** Charles Perdrisat, 45, Southampton-buildings, Chancery-lane, London.

DEC. 28.

**28417. Improvements in and relating to electric vapour lamps.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 26, 1902, being date of application in United States.) (Complete specification.)

**28422. The supreme electric door handle alarm.** Sidney William Quick, 24, Wellington-road, South Shore Blackpool.

**28445. Improvements in connection with the trolley pulleys of overhead electric tramway systems.** Frank Barritt and William Allan Fraser, 17, St. Ann's-square, Manchester.

**28453. An improved electrical motor starting switch.** Joseph Crowther and Ughtred Horsfall, 10, Shippey-street, Ladybarn Withington, near Manchester.

**28494. Improvements in indicating devices for use with telephones, tills, and other enclosed appliances** Eugen Speyer, 45, Southampton-buildings, Chancery-lane London.

**28514. Improved electric stand lamp.** Georg Kamm, 322, High Holborn, London.

**28520. Improved socket for making temporary electrical connections.** Rendell Howard Fletcher, 22, Southampton-buildings, Chancery-lane, London.

DEC. 29.

**28545. Improved machine for covering wire with insulating material.** William George Heys, 51, Deansgate-arcade, Manchester. (Walter E. Ammon, United States.) (Complet specification.)

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**28553. Improvements in the construction of electric arc lamps.** August Erkstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

**28557. A new improved electrical terminal connection protector for sparking plugs for motors and all electrical appliances.** Emanuel Myer Goldburgh, 6, Disraeli-road, Forest Gate, London.

**28568. Improvements in and connected with section insulators for electric tramways.** John Money, 37, Chancery-lane, London.

**28574. A combined electric switch and fuse.** Henry Sessions Souttar and Thomas Hamilton-Adams, 4, South-street, Finsbury, London.

**28580. Improvements in or connected with transformers employed in high-frequency current circuits.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

**28607. Improvements in or relating to electrical fuseholders, fuse boxes, and the like.** Francis Gilson Baily, 11, Ramsay-garden, Edinburgh.

DEC. 30.

**28623. An improved joint-box for electrical conductors.** Harold Sheen Martin, 13, Cumberland-street, Liverpool.

**28632. Improvements in metallic conduits for electric light cables and the like.** Laurence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool.

**28662. Improvements in electric chain-welding machines.** Hugo Helberger, 111, Hatton-garden, London.

**28699. Improvements in telegraphy.** Harry O. Rugh, 46, Lincoln's-inn-fields, London. (Complete specification.)

**28700. Improvements in telegraphy.** Harry O. Rugh, 46, Lincoln's-inn-fields, London. (Complete specification.)

**28701. Improvements in telegraphy.** Harry O. Rugh, 46, Lincoln's-inn-fields, London. (Complete specification.)

DEC. 31.

**28723. Improvements in or connected with the electrical igniting devices of motor cycles.** Reginald Herbert Linaker, 5, John Dalton-street, Manchester.

**28735. Improvements in elastic supports and connections for incandescent electric lampholders.** Frank Westlake Parkinson, 34, Castle-street, Liverpool.

**28748. Improvements in trolley wheels or collectors for electric currents.** Paul Traugott Julius Estler and Joseph Lapish Jack, 52, Chancery-lane, London.

**28780. Improvements in electric furnaces or ovens** August Eimer, 56, Ludgate-hill, London. (Date applied for under Patents Act, 1901, May 22, 1903, being date of application in United States.) (Complete specification.)

**28782. Improvements in electric sectional furnaces.** August Eimer, 56, Ludgate-hill, London. (Date applied for under Patents Act, 1901, May 28, 1903, being date of application in United States.) (Complete specification.)

**28793. Improvements in or connected with electrically-operated trains.** Gustav Lüdorf, 36, Essex-street, Strand, London. (Complete specification.)

**28794. Improvements in arc lamps.** John Henry Woolrich and Eric Rivers Smith, 173, Fleet-street, London.

**28805. Improvements relating to electric furnaces.** Charles Prosper Eugène Schneider, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**28806. Improvements in sockets for incandescent electric lamps.** Charles Bakeley and John Herman Schrage, 40, Chancery-lane, London.

**28807. Improvements in sockets for incandescent electric lamps.** Charles Bakeley and John Herman Schrage, 40, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Jan. 21, 1904.*

1902.

**23262. Manufacture of electrodes for arc lamps.** Blondel.

**27850. Electric lighting of railway and other carriages and the like.** Hall.

**28071. Alternating electric current systems and switches therefor.** Rieder.

**28588. Magnetic brake and damper of vibrations.** Thomson, Baron Kelvin, and Kelvin and James White, Limited.

**28857. Electric switches.** Pieper.

**28932. Safety apparatus for use with overhead electrical tramways.** Hill.

**28950. Electrical signalling apparatus for railways.** Mackenzie. (Miller, Stiles, and Kelloway.)

1903.

**143. Electrical measuring instruments.** Chamberlain and Hookham, Limited, and Watts.

**175. Means for promoting electric discharges across a dielectric gap in a circuit.** Williams.

**870. Storage or secondary batteries.** Madigin.

**1676. Electrodes for accumulators.** Meygret.

**2212. Supporting standards and trolley arms used in overhead electric traction schemes.** Ross.

**2541. Ship's telegraphs and the like signalling apparatus specially applicable to automatic reply telegraphs.** Ray.

**3783. Electric light safety relay.** Johnson and Bircham.

**3957. Electric fittings.** Woodyer and Mayner.

**4557. Electric arc lamps.** Lewis.

**4618. Apparatus for electrically igniting miners' safety lamps.** Best.

**9571. Storage batteries.** Feldkamp.

**10814. Electric mining safety lamps with portable accumulators and charging devices.** Edwards. (Mallet and Parent.)

**15821. Magnetic balance or magnetometer and galvanometer.** Hibbert.

**22532. Electric arc lamps.** Girdlestone and Thorkelin.

**22680. Coherers for wireless telegraphic systems.** Dorman.

**23121. Railroad rail joints for electric railways.** Page. (Weber Railway Joint Manufacturing Company.)

**23557. Electrical clutch and brake mechanism.** Steckel.

**25028. Adjustable electric light pendants or fittings.** Galworthy and London Electrical Fittings Company, Limited.

**25677. Protecting electrical windings from static strains.** Pearson, Cutcheon, and Williamson.

**25814. Trolley heads for electric tramcars.** Willenbücher.

**25885. Apparatus for securing shades, reflectors, and the like to electric incandescent lamps.** Wolfenden.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅛-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6½ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5½-5¾ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-107 xd |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manut., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 4¼-4¾ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 94-97 xd |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | 1¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 104-108 xd |
| —— Ordinary | 5 | .. | 11-12 |
| —— 5 per cent. Pref. | 5 | .. | 5½-5⅝ xd |
| Crompton and Co. | 3 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 71-76 xd |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | — | 1⅝-1¾ |
| —— 7 per cent. Cumulative Pref. | 2 | — | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | — | 98-101 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 xd |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¾-10¼ xd |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 13¼-14½ |
| —— 4½ per cent. Preference | 5 | — | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | — | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | — | 18 19 xd |
| —— 4 per cent. Debentures | 100 | — | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | — | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | — | 34-37 |
| —— 5 per cent. Bonds | 100 | — | 100-103 xd |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | — | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Cert., Red. and Conv. | 100 | — | 114-117 |
| Bournemouth and Poole, Ordinary | 10 | — | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | — | 10-11 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | — | 101-104 xd |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | — | 10-10¼ |
| —— 7 per cent. Preference | 5 | — | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | — | 6¾-7⅛ |
| —— Nos. 20,001-30,000 | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | — | 14½ |
| —— " £10 Ord. | 6 | — | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 xd |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 103-105 |
| Chelsea Electricity Supply | 5 | .. | 5¼-6 |
| —— 4½ per cent. Debentures | 100 | .. | 105-108 xd |
| City of London, Ordinary | 10 | — | 10¼-11 |
| —— 6 per cent. Cumulative Pref. | 10 | — | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | — | 121-126 xd |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | — | 101-104 xd |
| County of London and Brush Provincial, Ordinary | 10 | — | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | — | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 107-110 xd |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | — | 6-6½ |
| —— 6 per cent. Cum. Pref. | 5 | — | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | — | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | — | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7½-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | — | 10¼-11¼ |
| —— per cent. Debenture Stock Red. | 100 | — | 100-103 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Kensington and Knightsbridge and Notting Hill | 100 .. | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 .. | 9½-10⅛ |
| London Electric, Ordinary | 3 .. | 1⅞-2⅛ |
| —— 6 per cent. Pref. | 5 .. | 5-5⅛ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 97-100 |
| Metropolitan Ordinary | 10 .. | 17-18 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 .. | 109-113 xd |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 .. | 95 98 xd |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 .. | 98-101 |
| —— Preference | 4 .. | 100 103 |
| Notting Hill Electric Lighting | 10 .. | 12½-13¼ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 407-14,310 | 5 .. | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 .. | 98-101 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 .. | 95-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 .. | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 .. | 85-90 |
| South London, Ordinary | .. | 3¼-3⅜ |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 .. | 14½-15½ |
| —— 7 per cent. Pref. | 5 .. | 7½-8⅛ |
| —— 3½ per cent. Deb. | 100 .. | 98-101 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 .. | 4⅛-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 .. | 4⅛-5⅛ |
| Westminster, Ordinary | 5 .. | 12 13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 .. | 5-5⅛ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 .. | 93 96 |
| —— 4 per cent. Pref. | 100 .. | 99-102 |
| —— " " deferred | 100 .. | 93-96 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 .. | 115-118 |
| City and South London, Consolidated Ordinary | 100 .. | 47-50 |
| —— 4 per cent. Debenture Stock | 100 .. | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 .. | 126-129 |
| —— " " " '96 | 100 .. | 123-126 |
| —— " " " '01 | 100 .. | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — .. | 13-13½ |
| —— Ordinary, 1-50,000 | — .. | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — .. | 102-104 |
| Waterloo and City, Ordinary | 100 .. | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 .. | 4⅛-5 |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 .. | 125-130 xd |
| Blackpool and Fleetwood Tramroad | 10 .. | 13¼-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 .. | 3⅜ 4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 .. | 97-102 xd |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 .. | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 .. | 10-10½ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 .. | 102-104 p.c. |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 — | 11¼-11⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 — | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 — | 120-125 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 — | 3-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 — | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 — | 4¼-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 .. | 104-107 xd |
| —— Prov. Cert., all paid | 100 .. | 98-101 xd |
| Cape Electric Tramways, Nos. 1-480,000 | 1 — | 1⅛-1⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 .. | 5-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 .. | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 — | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 — | 11-12 |
| —— Debentures | 100 .. | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 — | 12-13 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 — | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 — | 94-97 |
| Imperial Tramways Ordinary | all — | 22-22½ |
| —— 6 per cent. Cum. Pref. | all — | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 — | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 xd |
| Kidderminster and District Lighting and Traction, Pref. | 5 — | 3¾-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 — | 11-11¼ xd |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 .. | 104-106 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 — | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 .. | ⅛-1⅛ |
| New General Traction, Ordinary | 5 .. | ¼ |
| —— 6 per cent. Cum. Pref. | 5 — | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 .. | 89-94 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 .. | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 .. | 11¼-12⅛ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 .. | 99-102 xd |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 — | 8¼-9⅛ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 — | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 — | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 — | 1 |
| —— £101,152 6 per cent. Preference | 1 — | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. — | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 — | 101-103 |
| —— Deferred Stock | 100 .. | 77-80 |
| —— 6 per cent. Cum. First Pref. | 10 — | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 — | 13-14 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 — | 5¼-5⅜ |
| —— 3½ per cent. Deb. Stock, Red. | 100 — | 94 96 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 — | 100-102 xd |
| Oriental Telephone and Electric Company | 1 — | ⅛-1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Jan. 2 | 1,470 | 1,108 | + 362 | + 6,921*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | — | — | — | — | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | Dec. 26 | 4,970 | 5,126 | − 156 | + 9,879 | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Jan. 1 | 938 | 831 | + 77 | + 1,347 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | Dec. 31 | 344 | 374 | − 30 | − 176 | 17½ | 17½ | " 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | Jan. 2 | 224 | 209 | + 15 | − 42 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | " 3 | 2,149 | 2,265 | − 116 | + 8,318 | 38 | 38 | March 31 | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | Dec. 30 | 936 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | " 13 | 3,324 | 2,935 | + 389 | +16,566 | 41 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 3 | 730 | 772 | − 43 | + 2,591*h* | 6½ | 6½ | " 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | " 1 | 4,838 | 4,658 | + 180 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | " 2 | 865 | 716 | + 149 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | " 3 | 321 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | " 3 | 1,782 | 1,582 | + 200 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Central London Railway | " 2 | 6,591 | 6,683 | − 92 | − 92*h* | 6 | 6 | " 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | " 3 | 3,272 | 3,436 | − 164 | − 164*h* | 6⅞ | 6⅞ | " 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | Dec 31 | 377 | 360 | + 17 | − 3,358 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | Jan. 1 | 239 | 257 | − 18 | − 248 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | " 2 | 179 | 189 | − 10 | + 73 | 3 | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucar Electric Ry. | Dec 31 | 176 | 153 | + 23 | + 213*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | " 31 | 3,034 | 3,000 | + 34 | } — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | " 31 | 509 | 575 | + 31 | | | | | | | | | | | |
| Dundee City Tramways | " 30 | 810 | 865 | − 55 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | Jan. 2 | 589 | 473 | + 116 | + 7,623 | 10·75 | 10·75 | March 31 | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | " 2 | 14,965 | 14,187 | + 778 | +43,091*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | Dec 30 | 2,376 | 2,291 | + 85 | + 5,827 | 30½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | Jan. 2 | 1,183 | 1,159 | + 129 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | " 2 | 2,140 | 1,772 | + 368 | + 5,014 | 19 | 19 | " 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | Dec. 31 | 120 | 138 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | " 30 | 207 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | Jan. 2 | 5,289 | 4,913 | + 356 | +13,407 | 77 | 77 | March 25 | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | Dec. 26 | 10,838 | 10,576 | + 262 | +17,537 | 101 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | Jan. 3 | 1,563 | 1,496 | + 67 | — *h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | — | — | — | — | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | " 2 | 92 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | " 2 | 3,743 | 3,244 | + 499 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | Dec. 14 | 1,374 | 1,248 | + 126 | + 4,618 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | Jan. 4 | 102 | 116 | − 14 | — | 4½ | 4½ | March 31 | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Dec. 31 | 549 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | Jan. 4 | 3,984 | 3,308 | + 676 | +43,965 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | " 3 | 4,620 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | Dec. 31 | 810 | 983 | − 173 | — | 11 | 11 | " 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | Jan. 3 | 1,231 | 1,217 | + 14 | + 2,203 | 18·48 | 18·48 | " 31 | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | " 2 | 587 | 564 | + 23 | + 3,464 | 10·5 | 10·5 | " 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·05 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Electrical Engineers Volunteers.**—We are asked to state that the tablet erected at the headquarters of the corps of Electrical Engineers in memory of the members of that corps who died in South Africa during the late war, will be unveiled by Colonel Pitt, R.E., on 27th inst. at 8.30 p.m. Ex-members of the corps and friends of the members who died in South Africa are especially invited. Morning dress will be worn.

**Faraday House.** — The Electrical Standardising, Testing, and Training Institution announce that as the result of the recent scholarship examinations the examiners recommend the following awards: to H. S. Phillips, of Oakham School, an exhibition of 40 guineas, tenable for two years; L. W. Ballard, of Dunheved College, Launceston, and G. E. Whitton, of Wellingborough Grammar School, exhibitions of 30 guineas, tenable for two years; and H. R. Ainsley, of the Masonic School, a special prize of 20 guineas.

**Wireless Telegraphy on Lightships.** — An installation of wireless telegraphy, which will undoubtedly prove of the greatest value in the future, is about to be made in connection with the lightships off the south-east coast. The Goodwin Sands, though chiefly instrumental in forming the historic roadstead known as the Downs, are in themselves a considerable danger to passing vessels, especially in foggy weather; and there are at least four lightships stationed at different places over the sands to warn vessels which are not keeping their course. These lightships are about to be equipped with wireless telegraph apparatus, which will place them in easy communication with the Admiralty wireless telegraphy station near the Shakspere Cliff at Dover. In cases of disaster the apparatus should prove of the greatest value and importance in obtaining help.

**Turbine Rights in Germany.**—It is reported that a company has been formed in Berlin, under the title of the United Steam Turbine Company, to acquire the patent rights in Germany of the Curtis, the Riedler, and the Stumpff turbines. This is said to be the outcome of agreements between the Allgemeine Electricitäts-Gesellschaft, of Berlin, and the European branch companies of the General Electric Company of America, the Curtis Turbine Company, Profs. Riedler and Stumpff, and the German Inventions Introduction Company. It is further stated that there also comes into operation now the principal agreement between the Allgemeine Electricitäts-Gesellschaft and the General Electric Company of America, the Fort Wayne Electric Works Company, the Stanley Electric Manufactnriug Company, the Eddy Electric Corporation, the General Incandescent Ark Light Company, and the Northern Electric Company.

**Para Rubber.**—The Resident-General for the Federated Malay States, in his report for 1902, states, as regards the planting interest, that further experience confirms the belief, or rather endorses the certainty, that the combination of climate and soil in those States pre-eminently adapts them for the cultivation of rubber (Para and Rambong), the demand for which is annually increasing. He adds: "Export of Para rubber in quantity has not yet commenced, and we may have to wait a year or two longer for that consummation, but meanwhile we know that our samples realise high prices in England, and that additional outside capital is coming in to extend the area of land under this cultivation." The area under rubber cultivation at the end of 1902 is given approximately at 16,000 acres. It seems that the disinclination which exists to extend the cultivation of rubber in the Malay States is due, not to lack of faith in the future of this cultivation, but to want of capital.

**Electric Lighting at Calcutta.**—The *Indian Textile Journal*, in describing the electric light plant at Calcutta, says it is the best electric supply system in Asia. The total output of the generating station is over 2,400 kw., the largest set being rated at 713 kw. at 550 volts. There are two of these at present installed, besides six other sets of smaller dimension, and they are stated to be the largest in the East. They consist of Belliss and Willans engines direct connected to the generators. The distributing mains, of which there are 23, are laid underground, there being 80 miles of cable. The three-wire system has been adopted. There is apparently a good power load, as the station operates night and day, with three shifts of attendants. The charge for electrical energy varies for lighting, from 8d. to 3½d. per kilowatt-hour. For power, the rate varies from 4d. to 2d. It may be added that, in spite of the conservatism of the natives, the use of electric lighting and electrical power in Calcutta is on the increase.

**New Type of Safety Fuse.**—The *Western Electrician* illustrates an ingenious modification of the expulsion-type fuse which has just been placed on the American market. The fuse proper is contained in a hollow insulating tube of fibre in the middle of the insulating handle. The fuse, made of an alloy of metal, is short, and is connected by copper wires to the base of the knife contacts on each end of the handle, and fastened there by a screw. The blades at the ends are made to slide into contacts similar to the ordinary knife switch contact, which in turn are mounted on binding posts extending through the switch mounting and forming terminals on the other side for the attachment of the leads. Lignum vitæ is used to insulate the contacts and binding posts, and there are no exposed parts to come in contact with the hands. The safety feature of the fuse lies in the fact that it is impossible for the attendant, in refusing or making an examination, to pull both of the blades from the contacts at the same time before the current is turned off.

**Copper in 1903.**—During the past 12 months the copper market has for the most part again been under the control of American manipulation in regard to both the metal and shares. The course of the market has throughout been one of many surprises, and in nearly every case the final outcome has been against the bulk of operators on the London market. The year 1903 opened with a firm market and a rising tendency in prices. Prices continued their upward movement in spite of a temporary reaction, but from June to November there were some heavy fluctuations. The last month of the year, however, showed a steady improvement in values, chiefly owing to the strong statistical position on this side, together with a better demand from consumers both in Europe and America, and values at the close registered a net gain on balance of £4. 5s. per ton as compared with the closing price of 1902. The American exports to Europe amounted to 135,410 tons; the deliveries, excluding 1,950 tons shipped to America, to 262,327 tons; and, with total supplies amounting to 261,588 tons, the European visible supply has shrunk to 13,851 tons.

**Standardisation of Wiring Rules.**—At the meeting of the Electrical Contractors' Association held last week the subject which formed the basis of a paper by Mr. R. B. Johnson was the necessity for the standardisation of wiring rules. All our readers must be familiar with the excellent set of rules on wiring issued by the Institution of Electrical Engineers some months ago, and it was, perhaps, to be expected that the author of this paper should refer to them

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in terms of satisfaction and praise. Of course, the committee of the Institution, in preparing these regulations, had to adopt broad principles as a basis, and necessarily, as they stand, they apply only to general cases. But, as Mr. Johnson says in his paper, they may well form a sound basis for contractors to go upon. An instance of the way the Institution rules have been taken up by contractors was given by one of the speakers taking part in the subsequent discussion. He stated that in his office it was his custom to use a rubber stamp with an inscription to the effect that the wiring had been carried out in accordance with the Institution rules. This took the place of filling in details on the sheets supplied by the insurance companies, and he stated that he had never met with any opposition on this account. In the end it was agreed to draw up a standard rule regarding the relative positions of the meter, fuse, and main switch on consumers' premises, the drafting of which is to be left to the president of the association.

**The Noise of Lightning.**—Prof. John Trowbridge has an article in the *Scientific American* describing some experiments made with a view to studying the spectrum produced by electrical discharges of great quantity in air saturated by moisture. It was shown quite recently in some experiments carried out in the Jefferson Physical Laboratory that the great noise of a lightning discharge is largely due to the dissociation of water vapour, but in his experiments Prof. Trowbridge says he has brought out the fact with what may be called truly dazzling distinctness. At first sight it seems possible to study the spectrum of water vapour by causing electric sparks to pass from one surface of water to another; in other words, by employing water electrodes. It is, however, practically impossible to cause an electric spark of high E.M.F. to leap from one surface of a liquid to another. For this reason it is rare that lightning strikes the surface of level water. Therefore, in these experiments Prof. Trowbridge, having saturated two pieces of wood with distilled water, wrapped them with cotton wool, which was also heavily saturated with distilled water. When such terminals were separated a distance of 4in. a torrent of extremely bright sparks leaped across the interval. The noise of the discharge was deafening, and the operator was compelled to stuff his ears with cotton, and, furthermore, to wrap a heavy cloth around his ears. The striking distance of the sparks was increased by the employment of the wet terminals from 2in. to 4in. Prof. Trowbridge explains that the deafening noise was probably caused by the explosion of the hydrogen and oxygen gases produced by the dissociation of the water vapour, and he draws the conclusion that the noise of lightning discharges is doubtless enhanced in the same manner by the presence of great moisture in the clouds.

**Non-Metallic Minerals.**—Mr. Bennett H. Brough in his third Cantor lecture at the Society of Arts on the subject of non-metallic minerals, had something interesting to say about mica and bauxite. As regards the former, it is one of the constituents of granite and other rocks, and is thus widely distributed. Its earliest industrial use was probably, under the name of Muscovy glass, for window panes. It is now chiefly used as a transparent medium unaffected by a sudden exposure to heat, the largest quantity being employed for electrical purposes for insulating portions of dynamos. The waste scrap is turned to account as a lubricant, as an electric insulator, as non-conducting packing, and in paper manufacture. Large crystals form a valuable product; clear crystals measuring 8in. square fetch 18s. per lb., and scrap mica 13s. per cwt. A single crystal from North Carolina has been known to weigh nearly a ton. The world's supply is obtained from India, the United States, Canada, and Brazil, while it is also raised in smaller quantities in Norway, Siberia, and China. The hydrate of aluminium, identified by Berthier, in 1821, at Baux, near Arles, and named in consequence bauxite, is, as is generally known, now largely worked for the manufacture of aluminium. In Ireland it occurs with beds of iron ore between sheets of tertiary basalt in County Antrim. The bulk of the world's supply is, however, obtained from the United States and France. At Baux it occurs in masses of chalk. The world's production from the above three countries in 1901 was 106,180 metric tons. As engineers are aware, aluminium is now produced entirely in electric furnaces. It is used to a considerable extent for electrical purposes, mainly in the manufacture of transmission lines, but it has many other and equally important industrial applications.

**Electric Lighting at Battersea.**—We remember that when the municipal electric light works at Battersea were inaugurated just over two years ago, many ominous predictions were made by the opponents of municipal trading in that district as to the future success of the undertaking. It must be rather mortifying to these gentlemen to know that in the comparatively short time the works have been running the progress has been such as to satisfy the most ambitious hopes. The borough of Battersea is essentially a working-class district, and the enthusiastic manner in which the electric light has been taken up affords ground for the most cordial congratulations. The following particulars relating to applications for the supply of current to premises within the borough are for the quarter ended Dec. 15 last, and are sufficient proof of the headway which the undertaking is making. The actual number of consumers being supplied on that date was 473, while the total number of applications in hand exceeded 510, showing increases of 69 and 80 respectively on the previous quarter. Similarly, the total energy which the Council was asked to supply was equivalent to 40,315 8-c.p. lamps, and that actually supplied 35,423 8-c.p. lamps—increases of 5,338 and 5,626 respectively. For motive power also the demand is large, and is increasing. The applications for current for this purpose received on Dec. 15 represented 434¼ h.p., and that actually supplied 368⅝ h.p., showing increases on the previous quarter of 53 h.p. and 45¼ h.p. respectively. These figures should be extremely satisfactory both to the Electric Lighting Committee and to Mr. H. R. Forbes Mackay, the borough electrical engineer. We note that the committee propose to spend another £11,000 to provide additional plant to meet the increasing demand, and Messrs. Kennedy and Jenkin are to be asked to prepare a scheme.

**Dielectric Hysteresis.**—Some useful results of experiments have been published by Mr. P. Holitscher, who has been studying dielectric hysteresis and the heating of high-tension cables. The experiments were made on high-tension machines in order to obtain the hysteresis losses independent of the volume of the materials, and one of the difficulties of the work was the designing of a measuring method that would give accurate determinations of the small power involved. Mr. Holitscher's work shows that a relatively accurate and convenient method for determining great losses by dielectric hysteresis is obtained by applying to the capacity to be tested the high potential of a transformer, the loss of the transformer being deducted from the input supplied to it. With smaller losses, measurements are made direct in the high-tension circuit by means of a wattmeter, the low and high tension coils of which are interchanged, and incandescent lamps inserted as a shunt resistance in the pressure circuit. The losses met with are practically proportional to the number of periods, a loss

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by leakage of current being almost negligible as compared with dielectric hysteresis. The capacity, and, therefore, the dielectric constant, was by no means a constant quantity with the material tested—*i.e.*, micanite. It was altered within appreciable limits according to the electrostatic strain. As the variation of the capacity was an unknown quantity, it was impossible to determine in anticipation the increase of the dielectric hysteresis with the increase of the pressures. In high-tension machines with micanite tubes the dielectric hysteresis loss with higher strains on the micanite is approximately proportional to the third power of the tension. In determining the efficiency of a high-tension machine the loss by dielectric hysteresis is negligible, as comparatively thick material is generally chosen to provide against piercing.

**Difficult Telegraph Construction in Africa.**—A difficult piece of telegraph and telephone construction work has recently been completed in the Belgian Congo Settlements. The line is 750 miles long, the first section undertaken being that from Boma to Matadi, a distance of 18 miles. This length took no less than eight months to construct. White labour was precluded by the climate, and the majority of the work was carried out by natives under the direction of Europeans. The work was complicated by several difficult streams which had to be crossed. The crossing at Underhill was effected by means of two steel pylons, 50ft. high and 2,620ft. apart, and placed respectively 237ft. and 206ft. above the high-water level. The construction of the line from Léopoldville to Equateur was also very difficult. Surveys were particularly dangerous, and the zone unhealthy. Advantage was taken as far as possible of the forest trees in fixing the supports for the line. The crossing of the Kasai River was probably the most difficult piece of work, as it was necessary to keep the stream clear for the steamer traffic. Advantage was taken of a rocky island in the river, and the crossing was made in two spans, one of 1,472ft. and the other of 2,198ft., the supports being three iron pylons. Much trouble was experienced in getting the four conductors in place, but this was eventually accomplished with the aid of a steam tug. The maintenance of the line is expected to give considerable difficulty, for although the posts are either of iron or living trees, and, therefore, proof against the attacks of white ants, elephants abound, and storms occasion great interference by throwing down trees across the line. Atmospheric discharges are also troublesome. Birds make their nests on the wire, wasps nest in the insulators, and spiders cover the poles with web, collecting a litter of leaves and twigs. The line is used both for telephone and telegraph service, and the stations are protected by local garrisons.

**Electrolytic Precipitation of Gold from Cyanide Solution.**—In the November issue of the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa there appears an interesting paper by Mr. E. M. Hamilton recently presented to that society. It deals with the development of the electrolytic process for the precipitation of gold and silver from cyanide solutions, and it is not designed to reopen the old discussion on the respective merits of the electrolytic and zinc methods of precipitation. The author draws attention to improvements in the Siemens and Halske process which have been developed by Messrs. Chas. Butters and Co. in Mexico and the United States. With the apparatus in question, the anode used is a lead plate covered with peroxide, and the cathode is of tinplate. The advantage of this over lead foil is that it is practically indestructible. The great point in the process, however, is that the metals in solution are deposited as a slime instead of plating them on to the anode. In order that this may be done the current density used is increased until it is considerably higher than the proper ratio of the metals in solution when required for a reguline deposit. The advantages of the system over the old methods which were originally worked on the Rand are: firstly, the absence of any action on the anode, thus rendering it permanent, and avoiding by-products formed by its dissolution; secondly, as a consequence of the foregoing, a very wide latitude in the current density which may be employed, in contrast with the behaviour of the iron anode, which rapidly succumbed to the effects of a high current; and thirdly, the permanence of the cathode, which, instead of being melted down every month in order to recover the values deposited, remains in its place the whole time. The deposited slimes are collected at intervals without disturbing the anodes in the depositing troughs. The author concludes that, as regards the usefulness of this method of electrolytic precipitation it is possible that it would not be advantageously applied in the case of a proposition where the metal to be deposited is almost exclusively gold—this could only be found out by trial—but where the values are largely composed of silver (implying a considerable weight of metal to be thrown out of solution) it would seem likely to be very serviceable, and in cases where large quantities of copper are dissolved in company with the gold and silver the method would probably be found exceedingly valuable.

**Electric Power in France.**—Last year a congress was held in the Alps to consider the power that might be utilised in those mountains, which, up to the present time, have served only for the enjoyment of tourists. The report of this congress was recently printed in two large volumes, and forms the basis of an instructive communication to his Government by the U.S. Consul at Lyons The enquiries made by the congress showed the existence of 48,860 waterfalls in the Alps, 46,000 of which are in use, and represent 489,000 h.p. The hydraulic force has been employed in the production of electricity that is extensively utilised in chemical and metallurgical industries. Two years ago 85,000 h.p. was being used in the manufacture of aluminium, chlorate of potassium, carbure of calcium, metallurgical products, and soda and chloride. The electrical works in and around Lyons, furnishing power at a distance, possess 23,000 h.p. Power is supplied to flour mills, to chemical works, and to hundreds of weavers, where a whole family live, generation to generation, in two rooms encumbered by three or four looms. As the production was far in excess of consumption, many of the electrical works in the carbure of calcium business went into other lines, such as supplying power to mills at a distance, to mines, and manufacturers of dyestuffs. One works is now producing from an electric furnace steel which is said to compete for making tools with the best steel of France or England. An effort is now being made in France to supply individuals with electric power in their households. The movement is backed by heavy property owners, who fear that the application of steam or electricity in large factories would deprive them of tenants, and they have leased electrical appliances to their tenants to be paid for by instalments. In Lyons one of the most populous quarters of the city would be entirely deserted if the weavers could not enjoy the advantages of electrical power in their competition with steam-driven machinery. It is now proposed to extend the supply of electric power to outlying farmhouses within a radius of 100 miles for driving isolated looms. Turning his attention to electric traction, the consul notes that one of the steam roads in the neighbourhood of Lyons began running by electricity in September. The power is derived from a waterfall in the Alps. The success of the line has thus far been so signal

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that he believes that many trains on the great railroads of France will soon be operated by electricity.

**Engineering Schools in Germany.**—An interesting contribution to the subject of technical education is to be found in a report by Dr. Frederick Rose, the British consul at Stuttgart, which deals with secondary education in mechanical engineering and electrotechnics as afforded by special schools and other technical schools in Germany. Dr. Rose says that little attention was devoted to these branches of learning until 1880, when the Prussian Government founded a number of mechanical engineering schools, and, later on, higher mechanical engineering schools. All these, of which there now exist 13, are State schools, with the exception of two, which are municipally controlled, assisted by the State. Entrance is obtained to the higher schools by the production of a leaving certificate of the sixth class of a higher preparatory school, or by examination. The conditions of entrance to mechanical engineering schools are the production of a leaving certificate of an elementary school and a period of practical workshop training of at least four years, pupils being also strongly recommended to attend continuation schools before entering. Indigent and diligent pupils at both classes of schools are assisted by small grants of money, or by dispensation from fees. The Prussian higher mechanical engineering schools, Dr. Rose says, stand in the first rank of German schools for secondary technical instruction both as regards the scope and extent of the instruction given and the degree of preliminary educational qualifications exacted of intending pupils. They are organised to give that measure of complete general technical instruction which will enable their former pupils to occupy successfully positions in the branch of mechanical engineering, and to improve and amplify their knowledge of technical matters independent of further aid. The difference between the two classes lies partly in the degree of preliminary educational qualifications required. The instruction given in the higher grade is based upon a mathematical foundation, and conducted, as far as possible, in a scientific manner, whilst, as a rule, the instruction in the other schools occupies itself more with finished results than with the mathematical and scientific elucidation of the causes leading to the same. Those pupils who have completed the two years' course and have passed the final examination may either enter the State service or private works. The positions in the State service are those of lower technical officials in the State railway service and in the Imperial navy; the salaries range from £80 per annum in the lowest positions to about £350 per annum in the highest positions. Those pupils who desire to enter private works experience, as a rule, little difficulty in finding suitable positions. The directors of the various schools and the owners and managers of engineering works often communicate with one another with reference to the engagement of pupils who have finished their courses. Pupils may also, after passing the final examination, continue their studies at the technical universities as "outsiders," who cannot enter for the higher examinations. During the year 1902, despite the prevailing industrial depression in Germany, a steady increase was shown on the attendances, there being a total number of 3,610 pupils, as against 3,244 in the previous year. Of this number 1,359, or 37 6 per cent., were foreigners, including 17 from the United Kingdom, 16 from the United States, and 475 from Russia.

**Auckland (N.Z.) Electric Tramways.**—A little over a year ago the electric tramway system of the city of Auckland, New Zealand, was inaugurated by the Auckland Electric Tramways Company, who obtained the necessary concession from the municipality. In May last year there were 13¼ miles of double track in operation, 7¾ miles of which were formerly worked by horses, the remainder being new lines. Since then another four miles of line have been constructed, bringing the total length of the system to about 29 miles of single track, extending over 17 miles of route. It stretches right across the North Island connecting Auckland with the western part of Onehuga, and serves a population of about 70,000. The *New South Wales Railway Budget* describes some interesting features of the system, which comprises 11 miles of double and five miles of single track. The rail used is of the girder type weighing 92lb., and the track is laid to the standard gauge of 4ft. 8½in. Centre-pole construction predominates, but every variety of construction is to be seen in various districts, including span-wire construction at curves and junctions, side pole and brackets, and both iron and wooden poles are used. In the central district the cables have been laid underground; outside this quarter they are carried overhead on wooden cross-arms fixed to the poles. The test and telephone wires connected with the system are also carried overhead on small brackets For the sake of economy and simplicity, feeder pillars have only been used at the points where the feeders from the power stations are connected into the trolley wires. For dividing the trolley wire into half-mile sections, boxes are placed on the poles. These boxes are in two halves, placed on opposite sides of the pole, about 5ft. from the ground, and strapped together. The power station, which supplies the system with both the working and the lighting current, consists of two bays, each roughly 54ft. wide and 104ft. long. The plant at present installed consists of four Babcock and Wilcox boilers, each of 2,100 square feet heating surface, provided with Babcock and Wilcox chain grate stokers. The three engines installed were supplied by Cole, Marchent, and Morley, Limited, and are of the horizontal cross-compound Corliss type, each capable of 475 i.h.p. normal and 700 i.h.p. maximum output, running at 100 revolutions per minute, with steam pressure at stop valve of 150lb. per square inch. The specified maximum steam consumption at full rated load, working condensing, is 14½lb. per indicated horse-power hour; the minimum mechanical efficiency at the same load being 90 per cent. Direct connected to each engine is a 300-kw., eight-pole, continuous-current compound-wound railway generator by the General Electric Company of America, and capable of 50 per cent. overload. These generators are placed between the two cylinders, the armatures being pressed on to the engine shaft. There is also one 25-kw. auxiliary unit. The switchboard was also supplied by the General Electric Company of America. The board is of the flat pattern, with back connections. It may be added that the power-house also serves as a telephone exchange, with annunciator and distribution boards for placing the line stations into communication with either of the two depôts. Each of these line stations consists merely of a small plug box affixed to a pole. Every car carries a telephone instrument with an attachment for plugging into these boxes, of which there are 18 scattered over the route. Recent experience has shown this to be a better system than that of having instruments permanently in the boxes, the delicate transmitting and receiving mechanism being liable to soon get out of order with the moisture that will make its way into the best designed box.

**St. Marylebone Electric Light.**—The subject was again discussed at the St. Marylebone Borough Council meeting on Thursday evening last week, the question for consideration being the terms on which the Metropolitan Electric Supply Company would release the borough from its obligation to purchase their Marylebone undertaking at

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the present time. For the last few weeks a special committee of the Council has been in negotiation with the company, and two interviews have taken place between the committee and the company's representatives. The result is that the company decline to set aside the arbitrator's award in their favour unless they receive in some form a sum equivalent to the £1,212,000 fixed by the arbitrator. The company, however, are willing to facilitate the completion of the purchase of their St. Marylebone undertaking on the following terms, which were submitted at Thursday's meeting of the Council: "That, subject to the Borough Council leasing the Marylebone undertaking to the company from Jan. 1, 1905, until Dec. 31, 1931, the company, instead of requiring the immediate payment of £1,212,000 in cash, to accept stock having a charge upon the revenues and rates of the borough in priority to any subsequent loan, and bearing interest at a rate to be agreed, the Council to undertake to obtain for the stock a quotation on the London Stock Exchange and redeem it at par in 42 years. The annual rent to be paid by the company to be a fixed sum practically equivalent to the yearly interest on the stock. As regards capital to be provided by the Council in respect of the period from Jan. 1, 1902, until the commencement of the lease, the company to pay interest from the commencement of the lease at the same rate as that agreed for the stock. On the termination of the lease the Council to purchase, on terms to be arranged, a portion of the Willesden works (which portion the company would so arrange as to be suitable and sufficient for the supply of Marylebone in 1932) and compensate the company, also on terms to be arranged, for the capital to be expended by them in the borough during the lease. This suggestion was made on the supposition that no competition will be allowed within the Marylebone area, and it would, therefore, be necessary to provide that, in the event of such competition being sanctioned, the company should have power to terminate the lease, the company from the date of such termination supplying the Council with all electrical energy which the Council cannot themselves generate, subject to existing arrangements regarding the fixing of price by an arbitrator to be appointed by the Board of Trade. If the Council are prepared to adopt such a suggestion, it would, of course, be necessary that the borrowing powers proposed by the pending Bill should be reduced and other necessary amendments provided for.' Orally, the company have suggested that if the profits of the undertaking should become greater as the years go on, then they would pay a percentage of those extra profits to the Council; but an attempt on the part of the latter to obtain this undertaking in writing was met by the company declaring the point to be rather a matter of detail, which might be subsequently discussed if the Council thought that the general lines of the suggestions were practicable. The reading of the above terms was deemed by some of the members of the Council to be a fitting opportunity for laughter, but we should not have thought that the present, at any rate, was an appropriate time for the display of levity on the part of the Council, even if the outside world is inclined to regard their dilemma with some amusement. The matter before the meeting was not discussed at any length, but it was decided to call a special meeting for yesterday (Thursday) evening to further consider the company's terms, and also the clauses of the Parliamentary Bill which the Council are promoting in the ensuing session.

**Phenomena in Connection with Mercury Arcs.**—In a recent communication to the French Academy of Sciences, Mr. de Valbreuze records some experiments which he made on mercury arcs in U-tubes connected to a Sprengel air-pump, when the following phenomena were observed for pressures in the cold tube ranging between 0·004mm. and 0·002mm. of mercury. On the arc being first started, the anode presents a uniformly luminous surface of varying size, which later on becomes covered with small stars of great brilliancy, forming regular geometric figures. These stars were frequently located in the angles and the centre of a perfectly regular pentagon or hexagon; or else they were present in great numbers, being of very small dimensions and very movable, regularly distributed on concentric circumferences. These different aspects as a rule, alternated with one another, appearing and disappearing with extreme rapidity. As the electrode became hot the stars augmented in size, assuming the form of spherical luminous pearls placed on the mercury. Afterwards they formed groups, clinging to one another, so as to form a luminous central disc and one or more concentric luminous ring, being separated by dark rings. Finally, the dark rings disappeared, the anode resuming its usual aspect—namely, that of a uniformly luminous surface. In order to account for this phenomenon, the author suggests the hypothesis of a kind of surface membrane at the surface of the mercury, this membrane being more or less permeable to the current and determining by its vibratory state the regular shape of the figures observed. In the second part of his communication the author deals with some peculiarities in the starting of mercury arcs. According to current views, vacuum tubes with one or two mercury electrodes will require, in order to be started, a potential difference of some thousands of volts, when the normal passage of the current will take place with a fall of potential of only about 15 volts. Now, when applying to these tubes a potential difference of 550 volts, phenomena of spontaneous starting are observed under the following conditions: The anode tube being of iron and the cathode of mercury, a beautiful violet light is observed above the cathode, occupying the whole of the cross-section of the tube, as the internal pressure is about 0·015mm. of mercury, a slight greenish luminescence surrounding the anode, whereas the remainder is dark. The current traversing the tube is found to be from 0·01 to 0·02 ampere. In nearly all cases the normal arc is found to pass spontaneously after some minutes. If, on the other hand, the pressure be inferior to 0·015mm., dropping as far as 0·006mm., the preliminary phenomenon, while being quite identical, will be observed only in the case of the tube being somewhat hot, when the cathode light is found to diminish in intensity and to take a white colour. The arc is seldom completed spontaneously, whereas by imparting to the tube a slight shock it is produced instantaneously. In the case of both the anode and cathode being of mercury, the phenomena of spontaneous starting are much less frequent than in the former case, taking place only if the electrode be previously heated by the passage of the current, and for pressures ranging between 0·006m. and 0·015m.—*i.e.*, for the maximum of conductivity of the vacuum tubes. The phenomenon is attended by the appearance of a violet spot at the cathode and a greenish spot at the anode. The light will frequently fill part of the tube, forming stratifications, the colour of which is violet on one side and greenish on the other, a dark space separating both layers. The spontaneous starting of the arc is rarely observed, while any shock will be sufficient to complete the same. As by stirring the mercury surface the difficulties met with in starting the arc are found to be materially decreased, the author thinks that a surface membrane, opposing especially in the cold state a high resistance to the passage of the current, plays a part also in connection with these phenomena.

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## INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

*(Concluded from page 55.)*

### (12) PRIVATE INSTALLATIONS.

Telephone engineers are often asked to carry out construction work apart from the exchange system, and the general installations will be described.

*Street Fire-Alarms.* — The General Electric Company supply an excellent system, which is illustrated in Figs. 60 and 61. This system of street fire-alarms comprises street alarm and telephone posts to be fitted at given points, and an annunciator switchboard for the fire station. The functions of the post are to act as fire-alarm pulls to be operated by the public in the event of fire, and to serve as street telephones for the use of the fire brigade in the execution of their duties. They can also, if required, be used as police telephones. The function of the annunciator switchboard is to receive a call from the street posts, to indicate from which post the call is given, to discriminate between genuine and accidental calls such as "earths," to allow of the lines being tested, and, where required, to serve as a switch for connecting any street post with the police station, turncock, or other official on the system. When the pull in the post is operated, the battery current passes through the indicator drop corresponding to same along the line to the post, and through the bell in the post to earth; the indicator at once drops, closing the local alarm-bell circuit, and the bell in post at the same time rings. The fireman attendant in the watch-room inserts his answering plug in the spring-jack underneath the fallen shutter, and the discriminating buzzer at once emits a loud buzzing sound. If the alarm were caused by "earth" on the line, the buzzer would not operate, and the brigade would not be called out unnecessarily. If on inserting the answering plug the discriminating buzzer does not operate, it indicates either that someone wishes to telephone or that the line has become earthed and requires attention. The attendant can ascertain which by listening on the telephone and making the usual interrogatory enquiries. After calling out the brigade the attendant withdraws the answering plug and inserts in its place a plug belonging to the control indicator. This stops the bell ringing in the post, and the control indicator pointer is deflected to the "on" position. The answering plug is now available to receive further calls. When the post handle is replaced, the control indicator returns to the "off" position, and the control bell rings continuously until the plug is withdrawn and placed in its normal position. The attendant should now insert his answering plug and listen on the telephone to ascertain if the person replacing the pull wishes to speak to him. To test the lines from the station, the answering plug is inserted in each spring-jack successively and the generator handle turned. If the line is in proper order, the discriminating buzzer will be actuated, but if the line is discontinuous the buzzer will remain silent. This is a most useful adjunct, as it enables the lines to be tested as often as may be deemed necessary. The operation of the post is extremely simple. The pull is replaced by lifting the telephone. If it is required to speak to the fire station, it is only necessary to hold the receiver to the ear and press three or four times on the small push-button provided for the purpose.

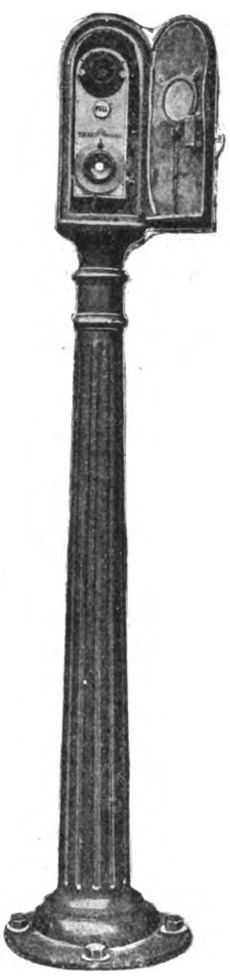

FIG. 60.

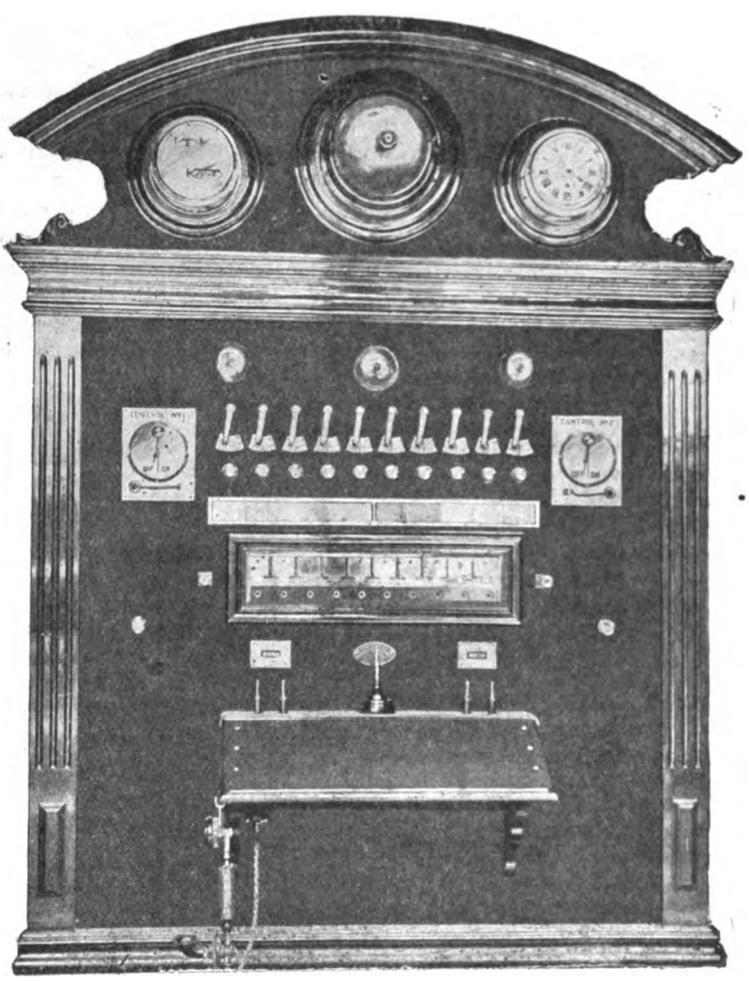

FIG. 61.

*Water-Level Indicators.* — Mr. George Kent supplies excellent water-level indicators which are too well known to be described in detail. Fig. 62 represents an electric level alarm for small tanks. An electric bell is fixed in the engineer's office or other suitable place, and is rung by this apparatus upon any predetermined top-water or low-water level being reached in the tank. Figs. 63 and 64 represent a transmitter and receiver respectively for water-level indicating. These instruments are designed to transmit to any given spot, such as the waterworks engineer's office, a record of the levels of wells or reservoirs situate at some distance. The arrangement of the apparatus may be modified to suit any local requirements, but the standard

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instruments consist of a transmitter fixed at the well or reservoir, and of the receiver fixed in the engineer's office or other desired spot, the distance between which may be anything. The transmitter is mounted on a strong iron base, and protected by a cast-iron cover. It is furnished with an indicator so that the level can be seen at the point of origin. The receiver is fitted into a glazed mahogany case, and is provided with a strong eight-day spring pendulum clock, an indicator showing the level in figures,

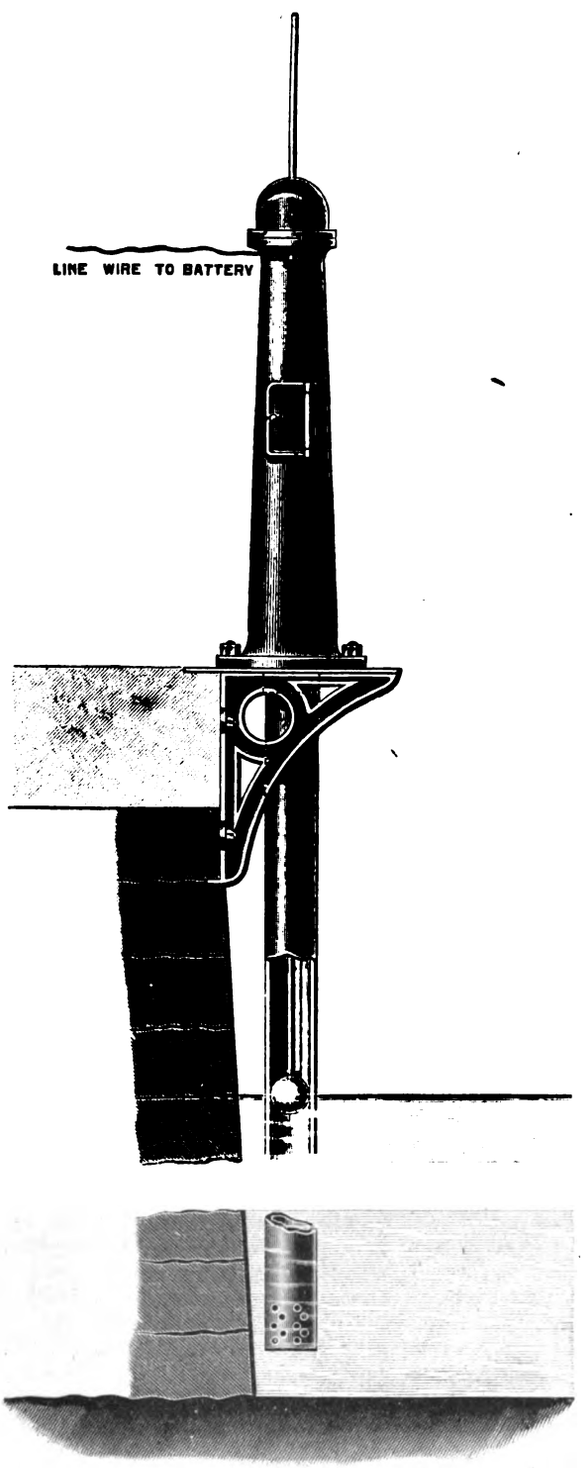


FIG. 62.

and whether that is rising or falling, and with a weekly or daily diagram apparatus showing the levels recorded. Each alteration of level transmitted may be anything from ½in. to 6in. or more; this is usually dependent upon the total depth to be recorded. For instance, a reservoir 5ft. deep could be measured by inch steps, but a well 100ft. deep would require much larger steps—say, 3in. or 6in. The apparatus can be arranged to give a diagram at the point of origin (at the transmitter) in addition to that at the receiver, or to have an indicator only at both ends. Alarm bells, to indicate any given level being reached, can be fitted if desired. The work is very carefully carried out, the electrical parts being constructed to provide a good margin of power, all contacts being "rubbing," so that they may remain clean and operative.

*Reply and Call Systems.*—A reliable and clever automatic replacement system is manufactured by the Berliner Telephone Company, and shown in Figs. 65 and 66. With the ordinary intercommunication system any department

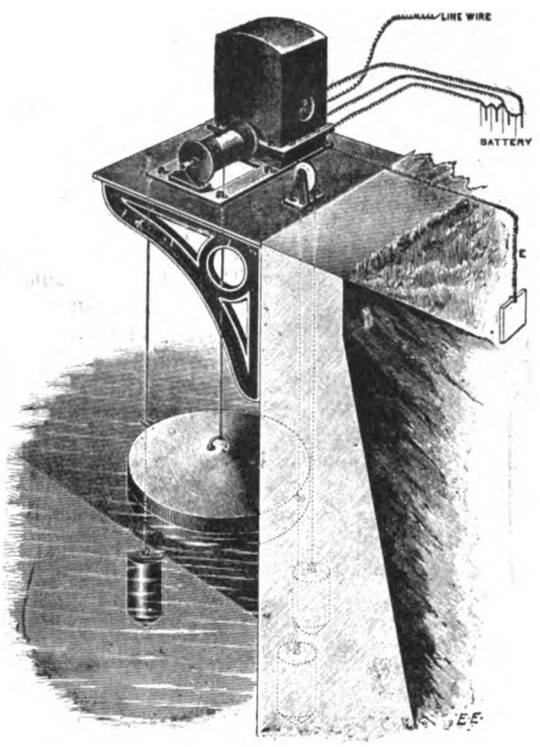


FIG. 63.

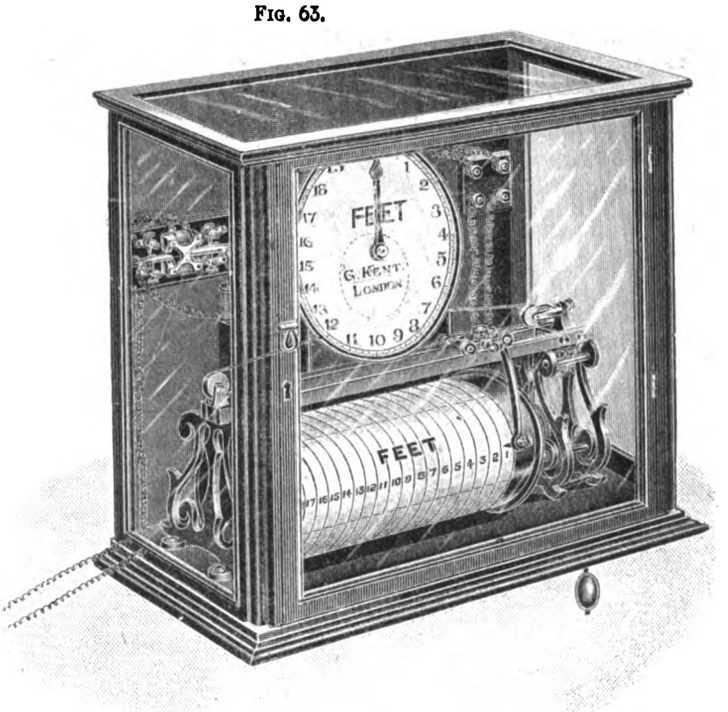


FIG. 64.

can speak to the other at will direct, without requiring a central station. It is, however, sometimes advisable that only the principal should be able to communicate to the various departments, and *vice versâ*, the departments not being able to speak to one another except through the principal. It is under these circumstances that the "reply and call" system will be found very useful. The principal, if he desires to speak to any department, has only to take the hand combination off the hook, pull down the lever of the number required, ring, and then speak;

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replacing the hand combination automatically restores the lever. If called up, he has simply to lift the hand combination and speak. The telephone is also provided with a pair of through connection plugs, enabling the principal to place any two departments in direct communication with each other, and he can, if he wishes, call up and speak to several departments at the same time by simultaneously pulling down the levers of the numbers required. The

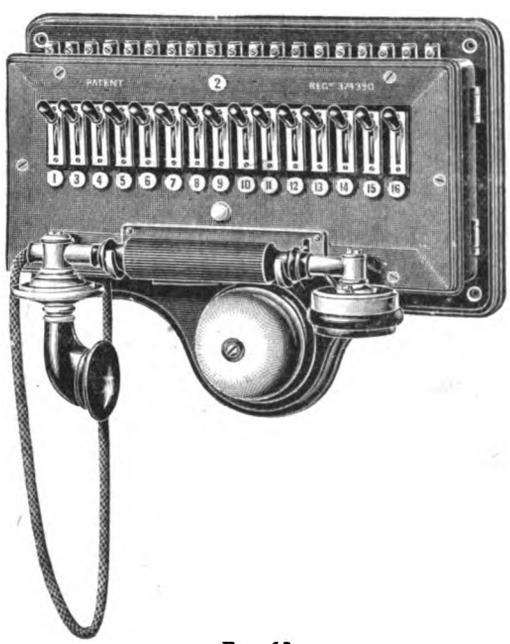

FIG. 65.

great advantage is that the two-way switch, hitherto indispensable at each side station, is not necessary with this instrument, thus doing away with the trouble and confusion caused by leaving the switch in the wrong position. The act of calling the central station automatically changes over the call line whether the receiver is on or off the hook. Directly the receiver is replaced the

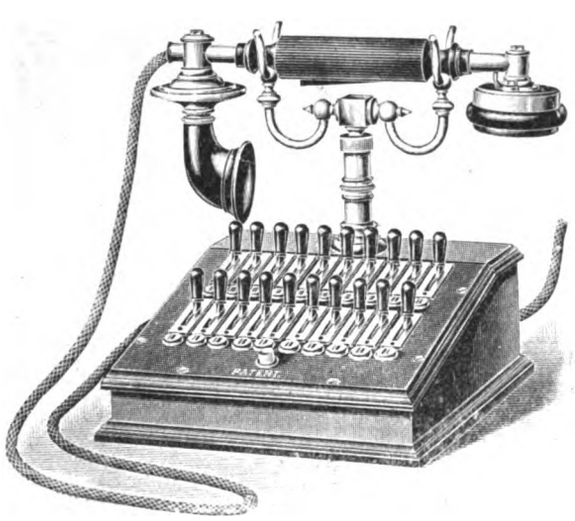

FIG. 66.

connection is automatically restored to the reply line, thus leaving the instrument ready to receive a call.

## THE DAVIS - PERRETT ELECTRICAL PROCESS FOR THE SEPARATION OF OIL FROM FEED WATER.

We have this week had the opportunity of inspecting at some large works at Tottenham an apparatus supplied by Messrs. Davis-Perrett, Limited, of 26, Great St. Helens, E.C., for the separation of oil from condensed feed water. The apparatus has been in regular work for 13 months, and on full load deals with some 3,500 gallons of condensed feed water per hour. The system in question is the invention of Messrs. Davis and Perrett, who in the course of their engineering work had considerable trouble with oil in boilers, although the feed water used had been treated by the ordinary methods for removing the oil. They found from experiment that whereas with the untreated condensed water it was practically impossible to remove the oil by mechanical filtration, this could be done if the water was first subjected to electrolytic action. The difficulty in passing electricity through a mixture of condensed water and oil was its high resistance, the mixture being almost an insulator. They, therefore, added a small amount of a solution of washing soda before treatment. Their experiments were successful, and led to the laying down of plant on a large scale for the purpose of treating condensed water commercially. It was then found that by adding a small quantity of tap water to the water to be treated, its conductivity could be made sufficient to enable the current to pass through at voltages commonly in use. In fact, the small amount of make-up which is always required was more than sufficient for the purpose. The following brief description of the plant at Tottenham will show how the process is worked, and also the space required.

The wooden tank in which the current is passed through the condensed water is 12ft. long, 2ft. 6in. wide, and 2ft. 3in. deep. It is divided up by wooden partitions into three compartments, through which the water can pass in parallel streams. Inside the long sides of the trough there are grooves cut, 4½in. apart, into which the iron electrodes can be slipped. These are arranged alternately, so that the stream of water passes under the first electrode, over the second, and under the third, and so on till the exit is reached. The alternate electrodes in the one division of the tank are connected together and a potential of 50 volts maintained between the adjacent plates. At the time of our visit the three compartments were connected in series and were together taking 20 amperes at 150 volts. With the above described arrangement of electrodes the water passing through the compartments is subjected to electrolysing currents from the one iron plate to the other, and this converts the soapy solution of oil into one containing a flocculent brown precipitate. The exact action by which this is done is the subject of different theories, but a certain amount of iron enters into the water in the form of hydrated pyroxide and is collected with the oil. The passage of the water through this electrolysing vat is continuous, and we tested the motion by filtering first a glassful of the water passing into the vat, which after filtering was still soapy. A second glassful taken from the outlet and filtered gave a clear bright water.

The overflow from this electrolysing vat is led into a central filtering tank, in which the filtering medium is wood shaving tightly packed between iron gratings. On either side of this are two gravity filter tanks, on the bottom of which a layer of sand and then sawdust is placed. These filters are cleaned twice a week, and together occupy a space 15ft. by 12ft. Under them is a large receiving tank, which acts as the hot-well. Only one of the gravity filtering tanks is in use at any one time, and the water is continually passing through it. A third filter of the pressure type, able to deal with the whole of the water, occupying a space of 6ft. by 4ft., was also shown us, and is intended to be used where space is limited instead of the sand filters. This is of a type which could be used on board ship or in other places where space is limited. A small Worthington pump is in this case used to force the treated water through filter cloths arranged in a press which can be easily cleaned.

Having now described the equipment, it remains to speak of the result. Water taken from the outlet of the filter tank was absolutely bright and clear. Also, if the feed tank was skimmed with a glass, no trace of oil could be detected, although this tank would tend to accumulate any residue of oil which passed through the filters. Messrs. Davis-Perrett, Limited, have had the water analysed by Mr. Cecil H. Cribb, F.I.C., the public analyst to the city of Westminster. His report, dated Oct. 8, reads as follows:

"On Thursday, Oct. 8 last, I visited the works at Tottenham and took samples of water before and after treatment by your process for the separation of oil. I am

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informed that the plant was dealing with from 2,000 to 3,000 gallons of water per hour at the time. I have examined the samples then taken and have obtained the following results: The untreated feed water, which was turbid, contained 1·07 grains of oil per gallon, while the treated water, which was quite clear, contained ·01 grain per gallon of something which simulated oil as far as the analytical process is concerned, but which on account of the extremely small quantity it was quite impossible to identify with certainty as such. A large bulk of the water was operated upon and precautions were taken to eliminate every apparent source of error inherent in the method of estimation employed, so that I have no doubt as to the figure ·01 grain representing the outside limit of what is present. I am, however, extremely doubtful whether even that minute proportion *is* oil, because my own distilled water, which is prepared under conditions which preclude the possibility of oil getting into it, when examined in precisely the same way, gave results which would indicate the presence of ·03 grain of 'oil.' Until, therefore, further experiments have been made this point must remain in doubt, but in any case the quantity is so minute that the sample after treatment may certainly be regarded as *practically free from oil.*

"(Signed) CECIL H. CRIBB."

These satisfactory results have led to the adoption of the system in other places—for instance, a large plant capable of dealing with 6,000 gallons of water per hour is being installed at the new Shoreditch electricity works under the advice of Messrs. Kincaid, Waller, Manville, and Dawson. It is due to trouble with oil in the filtered water that the plant is being installed, and it will be interesting to compare the results obtained at Shoreditch with those from Tottenham. As regards the cost, it is found that less than one unit of electricity is required per 1,000 gallons of water treated per hour. The cost of this may be taken as the extra cost of coal required, which may therefore be as low as ½d. per 1,000 gallons of water treated. The current through the electrolytic cell is varied by the amount of make-up water introduced. When this has been correctly adjusted there is no alteration in the current which passes through the coil, even if the supply of condensed water is varied. In other words, the change which is effected in the oily mixture does not affect its conductivity. The system is one which is of interest to electrical engineers from two points of view—*i.e.*, as electrical theorists and as central-station engineers. Therefore the extensions in the use of the system will be followed with great interest.

## GREAT NORTHERN AND CITY RAILWAY.

The construction of the railway was authorised in 1892, but work was not commenced on it until 1899 by a company formed for the purpose the previous year. The contractors, Messrs. S. Pearson and Son, Limited, have not only constructed the tunnels, but have also been responsible for the complete electrical equipment and for the actual working for the first three years after opening. By invitation from this firm we were able to inspect the line and its equipment on Wednesday last, and to test the comfort of the rolling-stock when travelling at schedule rates.

The following general details of this new railway will be of interest before proceeding to the electrical equipment of the trains and in the generating station. The portion of the line which is to be opened in two or three weeks has for its present City terminus (until the authorised extension to the Lothbury corner of the Bank of England is completed) a station at that portion of Moorgate-street which adjoins the stations of the Metropolitan and the City and South London Railways. At this point there is a means of interchange of communication between the City and South London and the new line, which will allow passengers to go from one line to the other without coming to the surface at all. The stations going northwards are then as follows: Old-street (where the present station of the City and South London Railway is to be used as a joint station), Essex-road, Highbury, Drayton-park, and Finsbury Park. With these four intermediate stations to be stopped at the trains are scheduled to complete the journey of 3½ miles in 13½ minutes.

At Drayton-park the lines come to the surface, and extensive repair shops and carriage sheds for the accommodation of the rolling-stock have been provided. It was at this point that originally it was intended to effect a physical connection for running purposes with the Great Northern Railway. The Act of 1892 gave powers for such physical connection, but after extended negotiations with the Great Northern Railway Company it was decided that Finsbury Park Station would be incapable of handling the large number of Great Northern and other trains coming from the North and from the South, as well as the trains from the new line (which would have to be stopped and turned round), without seriously interfering with the Great Northern main-line traffic. This difficulty was met by the construction of an underground station at Finsbury Park, which is placed directly under the Great Northern Station. Here an extensive booking hall and other accommodation have been constructed in approximately 12 months—an exceedingly short time for the work—without interfering in the slightest degree with any of the traffic of the Great Northern Railway, notwithstanding the fact that the main-line expresses ran right over the top of the workings within a few inches of the heads of the miners. The object of bringing this booking hall so close to the level of the permanent way is to enable the interchange of traffic to be carried on with the minimum of exertion and inconvenience to the travelling public. Ample lift accommodation is supplied here for dealing with the masses of people who will be unloaded from the trains every few minutes, and there are for the more energetic easy inclines and stairways which will enable them to reach the platforms (only some 40ft. below the rails of the Great Northern Railway) in almost less time than the lifts can be possibly filled and lowered. The depth from the street level is even less than the above.

The principal feature of the tunnels connected with this railway is the unusually large diameter of the "tube" itself, which is 16ft. as against 11ft. 8in. on the Central London Railway and 10ft. 6in. on the City and South London Railway. This permits of the use of much larger rolling-stock, and a better accommodation and space for the motors and other machinery actuating the train. It will also be of immense benefit in relation to ventilation and the general purity of the atmosphere. A novelty in connection with the construction of the tunnels of the Great Northern and City Railway, and one which, from the tests on Wednesday, minimises the amount of noise and vibration, is the introduction for a very great proportion of their length of a vitrified blue brick invert supporting the iron roof. This construction is less resonant than the complete iron rings, and the fact that the "tube" is constructed of a combination of such different materials makes the transmission of the waves causing sound more difficult, with a consequent saving in noise.

A feature of all the stations of this line is the great width and ample proportions of the stairs and the passages by which they are approached. The length of the platforms is about 450ft. for the terminal and 420ft. for the way stations, allowing ample margin for the trains and their possible growth should the traffic demand it. The trains now in use consist of seven coaches, each 50ft. long. The electric lifts at Moorgate-street and Essex-road were supplied by Messrs. Easton and Co., of Erith, while those at Finsbury Park had to be modified in view of the small amount of head room, and are electric hydraulic. They were supplied by the Chester Engineering Hydraulic Company. They consist of hydraulic lifts, the water under pressure for which is provided by pumps which are electrically driven. The power to drive these pumps is taken from the traction cables, and an hydraulic accumulator is installed to actuate the lift for one or two journeys should the electric supply be cut off. The electric motors are automatically controlled by the movement of this hydraulic accumulator.

The rolling-stock for this railway was described in our issue for Dec. 25, 1903, and we propose to give further details of the electrical equipment of the same in our next issue, where a description of the generating station will also

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appear. The sub-contractors for the whole of the electrical work are the British Thomson-Houston Company, and Mr. A. H. Walton has had charge of the work.

The line from its southern end to Drayton-park has had for its engineers Sir Douglas Fox and Partners, represented by Mr. Daniel L. Hutchinson. From Drayton-park to Finsbury Park, including the repair shops and carriage sheds, which work has been carried out by the Great Northern Railway Company, has had for its engineer Mr. Alexander Ross, chief engineer of the Great Northern Railway, and Mr. H. W. Sadler. Mr. E. W. Moir, M.I.C.E., one of the directors of Messrs. S. Pearson and Son, Limited, the general contractors for the whole of the railway, has had charge of the line, on their account, during its progress.

Messrs. Pearson's agents in charge of the southern and northern ends of the work respectively have been Mr. B. Everett and Mr. H. Japp.

The general control and the engineering of the running line will now be taken up by Mr. R. P. Brousson, who has had considerable experience in the electric traction installations both in connection with the Central London Railway and during the construction of this work.

## LONDON COUNTY COUNCIL TRAMWAYS.

It was as nearly as possible eight months ago, to wit, May 15, 1903, that the Prince of Wales inaugurated the first section of the tramways in South London to be reconstructed for electrical traction under the scheme of the London County Council—that is to say, the lines between the London termini and Clapham and Tooting. Since then the electric service has also been initiated on two smaller sections which provide communication between Brixton-road and Vauxhall Station and between Camberwell New-road and the cable terminus at Kennington. These two, however, are but small connecting lines, and the section which is about to be opened to the public between the Elephant and Castle and New Cross and Greenwich is, practically speaking, the second and last of the important main routes of the South London system to be reconstructed for electrical traction on the underground conduit system. The preliminaries in connection with the reconstruction work were commenced in May of 1901, so that the relaying of the lines and their equipment for electrical working has occupied close on 2½ years. The completion of this important section, it is to be noted, practically sounds the death-knell of the horse car in South London so far as the London County Council are concerned, although under the original scheme there still remain some short lengths of horse tramways, principally in the Southwark and Bermondsey districts, to be electrified, and the cable section between Kennington and Streatham Village has also to be converted to electrical working. But for all practical purposes the horse car will after Sunday next be abolished on all the principal lines of the Council's southern system, and for the first time since the electric cars began running there will be an opportunity of judging of the benefits to South Londoners of the change over from horse to electric traction. Many and loud have been the complaints against the speed of the electric cars on the Council's system, and the opinion has been expressed both by the man in the street and the public Press that in this respect there was no gain by the adoption of the electric system. They did not stop to think that the electric service was hampered by the horse cars from other sections and that the speed must necessarily be regulated by the latter, and they were condemning a system before it had had a fair trial. The opening of the New Cross and Greenwich lines for the electric service will bring about an entirely different state of affairs, and we may venture to predict that the speed of the electric service will very much improve in consequence. The new lines were inspected by Colonel Yorke, for the track, and Mr. A. P. Trotter, for the electrical equipment, on Monday, and if the police certificate is received in time the electric cars will begin to run for the public on Sunday.

The reconstruction of the track has been executed from the designs and under the supervision of Mr. Maurice Fitzmaurice, C.M.G., the Council's chief engineer. The electrical portion of the work has been carried out by Mr. J. H. Rider, the Council's electrical engineer, under the supervision of Mr. Alfred Baker, who was until recently the Council's tramway manager. The section comprises, roughly, 20 miles of single track—that it is to say, the distance from the London termini to Greenwich terminus is nearly eight miles, and the alternative route along the Walworth-road, between the Elephant and New Cross Gate, accounts for the other two miles. If the traffic should require it, it will thus be possible to institute a circular route between the Elephant and Castle and New Cross Gate, the cars proceeding by the New and Old Kent roads on the outward journey, and returning from New Cross *vid* Walworth-road to the Elephant and Castle. Practically speaking, it is double line the whole distance, for the only piece of single line is close on to Greenwich terminus, where the road is narrow for about 60ft. This, however, is to be remedied before long, when the road can be widened. The permanent way was laid partly by Messrs. J. G. White and Co. and partly by Messrs. Dick, Kerr, and Co. The cars are practically identical in design and appearance with those working on the Tooting section. The car bodies, mounted on McGuire and Brill trucks, were supplied by the Brush Electrical Company, of Loughborough, and the electrical equipments by the British Westinghouse Company, of Trafford Park. The motors are, roughly, of 30 h.p. each.

The power station at Greenwich, which is designed to ultimately supply current for working the whole of the South London lines and some parts of the Council's northern system, is now under construction, but will take many months to finish. When completed it will be one of the largest electrical generating stations in the world. It will ultimately have plant amounting to about 40,000 h.p. There will be 12 units in all: four of 5,000 h.p. each and eight of 2,500 h.p. each. The former are being made by Messrs. Musgrave and Sons, and will cost something like £96,000. Steam will be produced by means of water-tube boilers, and coal will be brought directly to the wharf outside the station by water. The position of the site on the river will also enable condensing plant to be used, which will materially reduce the amount of coal to be consumed. Current will be generated at about 6,600 volts pressure on the three-phase alternating system, and will be transmitted by underground cables to various sub-stations. At these sub-stations it will be reduced by means of rotary transformers to 550 volts pressure direct current, and transmitted to the various sections by distribution cables.

Pending the completion of this station, arrangements have had to be made for the supply of current for the working of the new section. Under an agreement with the London Electric Supply Corporation, the Council have been granted the temporary use of a portion of the company's premises at Deptford, and have erected temporarily two sets of plant, which will ultimately find a permanent home in the Greenwich station. Each of these sets is of 1,500 kw. running at 150 revolutions per minute. The generators were made by Messrs. Dick, Kerr, and Co., and the engines by Messrs. Ferranti Limited. The switchboard was supplied by the Westinghouse Company. Steam for working the plant will be supplied by the London Electric Supply Corporation, as is at present being done by the South London Electric Supply Company at Loughborough, in connection with the supply of current for working the Tooting, etc., section. The cost of working the lines under this temporary arrangement is necessarily more than it would be if the Council were in a position to commence the working of the tramways from their own generating station; but even taking this into account, the extra profits arising from the substitution of electrical power for horse power, it is anticipated, will be considerable. In connection with the New Cross and Greenwich lines sub-stations have been provided at New Cross, Camberwell, and the Elephant and Castle. At the latter the plant consists of five motor-generators of 300 kw. each running at 300 revolutions per minute. They receive current at 6,600 volts, which is reduced to 550 volts continuous current for the working lines. At the Camberwell and New Cross sub-

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stations the equipment is the same, with the exception that there are four instead of five machines. The whole of the machinery at these stations was supplied by Messrs. Dick, Kerr, and Co. The switchboards for controlling the motor-generators were supplied and fixed by the Westinghouse Company, and the low-tension switchboards for distributing were made and fixed by the firm of Bertram Thomas, of Manchester. The British Insulated Wire Company, of Preston, laid the low-tension cables, and Messrs. Siemens Bros. the high-tension cables. Pending the completion of the large car-shed about to be erected at New Cross, temporary arrangements have been made for the alteration of existing car-sheds to accommodate the cars and for the provision of a new shed at Rye-lane. The whole of the buildings have been designed by the superintending architect of the Council, Mr. W. E. Riley, F.R.I.B.A., and have been erected under his supervision with the exception of the sub-stations and the alterations of existing car-sheds, which have been carried out by the Council's Works Department under the direction of the Council's works manager, Mr. Humphreys.

A special tour of inspection of the new lines was made on Tuesday morning, in which members of the Highways Committee of the London County Council, the mayors and councils of the metropolitan boroughs of Camberwell, Lambeth, Deptford, and Greenwich, the responsible officials of the Council, and members of the daily and technical Press, participated. Seven cars were provided for the purpose, and among those who did the journey to Greenwich and back were Mr. J. Williams-Benn (chairman of the Highways Committee), Mr. A. L. C. Fell (chief officer of the tramways department), Mr. J. H. Rider (chief electrical engineer), and Mr. J. Shepherd (chief assistant engineer). Notwithstanding the fact that the ordinary service of horse cars was working as usual, the run from Waterloo Station to Greenwich terminus was made in 40 minutes, the whole trip occupying a little over 1½ hours. It was particularly noticeable that the cars worked exceedingly smoothly and with but little noise, and there was no hitch of any kind. There were many objects of interest to be noted *en route*, chief among which, however, were the two huge chimney shafts of the Greenwich power-house, which could be indistinctly discerned through the misty atmosphere. These shafts are each 260ft. high. Special attention was also given to the car-shed now being built at New Cross, and, notwithstanding the unpropitious weather, the trip was full of interest. It is hoped that the present terminus at Greenwich will not long remain the end of the County Council system in that direction. A few yards beyond is the terminus of the Woolwich and South-East London Tramways Company's lines, which the Council have already given notice to purchase. They run out to Plumstead, but when the undertaking is acquired by the Council and converted to electrical working, an extension will be made to the county boundary at Abbey Wood. Of the future work before the Highways Committee in connection with the South London system, we have already mentioned that the cable section between Kennington and Streatham is to be electrically equipped. In addition to this the reconstruction of the line from Bermondsey New-road to the Tower Bridge is under way, and the electric cars are expected to be running in a few months; also the line to Southwark Bridge will be electrically equipped shortly. When this work is completed, all the lines which previously formed the undertaking of the London Tramways Company south of the Thames will have been reconstructed for electrical traction, together with short sections of line formerly belonging to the South London Tramways Company. They will form an admirably connected system, and will afford every facility for interchange of traffic in the south of London, besides giving another terminus at Southwark Bridge nearer the City than any of the present termini.

The full technical details of the conduit construction used on these South London lines will be found in our issues for May 15 and 22 last year.

**Harrow-road and Willesden.**—The promoters have withdrawn the application to the Light Railway Commissioners relating to the Harrow-road and Willesden Light Railways (and Lands) Order 1903.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

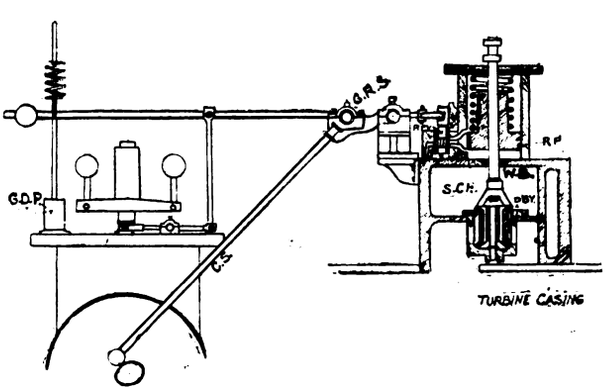
653. Describe what you consider to be the best system of electric lighting for railway carriages. Give sketches.—H. J. E.

654. Describe fully the Hopkinson or other modern method of testing large numbers of electric motors quickly and economically.—J. S. B.

### ANSWERS.

*Question No.* 645.—Describe one modern type of governor used in conjunction with steam-turbines. Give a detailed account of its method of operation and construction.

*Best Answer to No.* 645 (*awarded* 10*s.*).—There are two distinct methods of governing used on the Parsons steam-turbine—namely, first, by the use of an electrical governor, the action of which is that the increase of speed, and consequently of voltage (when driving an electrical generator), increases the pull of a solenoid connected across the fields of the generator upon a plunger within it, which is attached to the steam-regulating valve by certain links and gear; the second method is by the use of a centrifugal governor. The former has not, in the writer's experience, proved altogether satisfactory, being liable to hunt, and he will, therefore, endeavour to describe a form of centrifugal governor in use on a pair of 3,000-h.p. turbines in his care which has given satisfaction by reason of its reliability and sensitiveness. It may here be noted that it is of some importance that the speed should drop but little from no load to full load, as, apart from the reasons for the desirability of this in any prime mover, there is only one most economical speed of the vanes for a given turbine working under given conditions, and any drop in speed will detract seriously from the efficiency. In the case under consideration the speed variation is from 1,070 to 1,040 revolutions per minute, or nearly 3 per cent. without any adjustment of the regulating spring, which, however, is used to keep the speed constant.




The figure shows the general arrangement of the governor and valves. The steam is admitted to the turbine in a series of puffs, in the present case one for every 6½ revolutions of the turbine, or about 160 per minute. Steam is supplied from the range through the stop valve to the steam-chest, S. Ch, and passes to the turbine casing through the double-beat valve, D B V. This is raised and lowered periodically by the action of steam pressure on the relay piston, R P, forcing it up against the spring and lifting the double-beat valve with it, the spring closing it again on the steam being exhausted from the relay

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cylinder. In the older and smaller types the steam which leaked past the neck bush, N B, was utilised for this purpose, but there is now fitted a small supplementary valve, having a long tapered plug, capable of fine adjustment. This cannot be seen in the sketch, being fitted to the front of the cylinder and connecting it to the steam-chest. The exhausting of the steam is effected by the relay plunger valve, R P V, which is raised and lowered alternately by a link from the governor rock shaft, G R S, this being given a rocking motion by the cam shaft, C S. The cam is driven by worm gearing off the turbine shaft, and the governor is itself driven off the same worm shaft by bevel gearing. It is a spring loaded, bellcrank armed governor, without any special features, and is fitted with a regulator spring and handwheel to adjust the speed. The effect of its action is to alter the mean height of the rock shaft, and, therefore, the lift of the relay plunger valve, so that the latter is opened more or less in accordance with the load, and thus effects the exhausting of the steam from the relay cylinder in a greater or less degree, the steam passing from the passages shown in the sketch through a pipe to the condenser, or to atmosphere in the case of a non-condensing turbine. It should be clearly understood that this relay plunger valve does not affect the admission of steam to the relay cylinder, but only the exhausting. Steam is being admitted all the time, but so slowly that it is only when the above valve is closed that it can attain sufficient pressure to open the double-beat valve. The result of this arrangement is to alter the duration of the puffs of steam admitted to the turbine, so that although the number of puffs per minute remains unaltered, the amount of steam passed at each puff will vary with the load. When the turbine is working at its maximum capacity, the puffs will merge into one continuous stream, and there will be no motion of the double-beat valve. It will be noticed that the cam shaft does all the work of operating the rock shaft and relay plunger valve, and the governor merely settling the amount of opening has but little work to do, which, of course, tends to aid steady running. This governor is in the present case supplemented by a similar one as an emergency governor, which is set at about 20 per cent. over speed and releases a catch which cause a heavy weight to drop and shut another double-beat valve, similar to the one shown, and in series with it. The governor described has given every satisfaction, as before stated, and with reasonable care should never go wrong or give any trouble. The governor dashpot, G D P, should be kept filled with clean paraffin, and, like all other dashpots, needs to be cleaned out at times, or it will stick and lead to bad governing. It is also necessary to take off the relay cylinder cover and clean and examine the relay piston at intervals, especially when the turbine is first put down, as any dirt in the cylinder will prevent the proper working of the piston. If a supplementary governor valve for admitting steam to this cylinder be fitted it should be kept locked, as it is not necessary to adjust it when once set, and should it be altered whilst the turbine is on load, big variations in speed would probably result.—R. S. B.

*Answer to No.* 645 (*awarded* 7*s.* 6*d.*).—The steam-turbine is mostly used at the present time for driving electrical machines than for any other purpose in land engineering, on account of its one great advantage over the ordinary reciprocating steam-engine, and that is the uniformity of the turning effort it creates on the shaft. Thus is obtained a constant angular velocity of the armature of the electrical machine, which is directly coupled to the shaft of the turbine. But, as is the case with the ordinary steam-engine, we require a reliable governor which will easily respond to any variation in the load on the turbine, and thus vary the speed accordingly.

Fig. 1 gives the general arrangement of the governor mechanism which is used on the Parsons steam-turbine. It is of the flyball type, and the crank levers to which the balls are attached are swung on knife-edges instead of pins. F and G are two loose collars which can slide up the spindle, S. The collar F is pressed downwards on to the two small wheels projecting from the ball levers by means of a spring (omitted in diagram), but when the governor rotates the wheels press upwards (owing to the centrifugal force pushing the balls outwards) against the force of the spring, thus raising the collar F. Also, due to the connection between collar G and the flyball arms, the lever, H, is raised, because of the pin projecting from it being carried in the grooved collar G. Now the points D and E are fixed, and the rod C receives a vertical reciprocating motion from an eccentric attached to the turbine. This motion, as it can easily be seen, is transmitted to the lever, H, and then indirectly to the valve rod, V, which works a small relay valve, A. As this valve travels up and down it admits steam to the

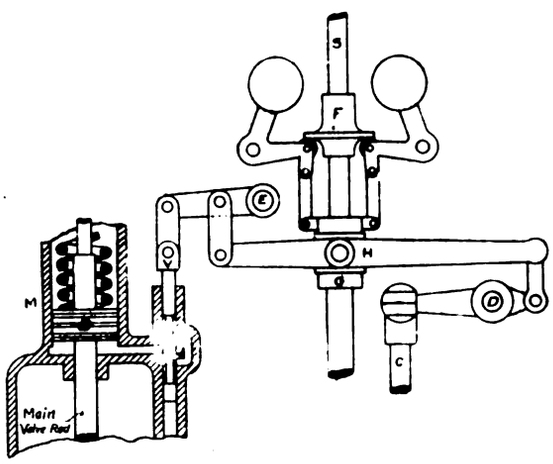


Fig. 1

cylinder, M, and thereby forcing the piston, B, upwards against the compression of a spring (shown in section). As the valve, A, closes the cylinder to steam and opens to exhaust the spring forces the piston downwards, and the used steam is exhausted. The piston, B, thus gives continuous reciprocating motion to the main valve rod, and the steam is admitted to the turbine in a series of puffs, as the main valve opens and closes at constant intervals of time It can easily be seen that if the time of the relay valve opening to steam be lengthened or shortened, a corresponding variation in interval of admission of the steam to the turbine by the main valve will take place. This is exactly what the action of the governor depends upon; as the speed of the governor balls vary, so the fulcrum pin in the rod, H, is raised or lowered, and consequently the plane of oscillation of the relay valve is varied, which allows a longer or shorter period of steam and admission to cylinder, M, and thereby a corresponding variation in the main steam supply. The puffs of steam admitted to the turbine are of either long or short duration according to the load, but at full load they merge into an almost continuous blast.

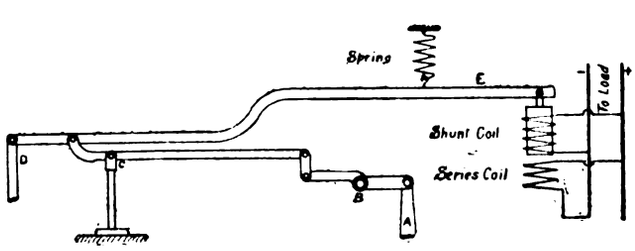


Fig. 2.

Very successful use has also been made of the electrical governor, which is shown diagrammatically in Fig. 2, this type being only adapted to a turbine driving a dynamo, but it works a relay valve in an exactly similar manner to the governor previously described. In the system of levers B and C are the only fixed points, and reciprocating motion is given to the rod A. This is transmitted to the rod D, which actuates the relay valve. The lever E is supported by a sensitive spring, and to the end of E is attached a soft-iron core which works in a solenoid, there being two windings—series and shunt—which are excited from the mains supplied by the generator. When in operation, the relay valve oscillates continuously, and the core moves a very small amount by reason of its mass. At the same time it is ready to respond to any change in the magnetic pull of the solenoid created by any difference in

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pressure on the mains from which it is excited. Thus the position of the lever E is varied relatively to lever D, and the relay valve is controlled in the same way as in the previous case. As the pressure falls in the mains the solenoid indirectly actuates the relay valve, which causes the admission of steam to the turbine to be increased, and thereby raise the speed of the generator.—H. R. G.

*Answer to No.* 645 (*awarded* 7*s.* 6*d.*).—It is not indicated in the question what make of turbine the governing arrangements of which it is required to describe, but as the Parsons steam-turbine is the most common kind at present in use in England, I presume that is the one "A. D." wishes to be enlightened upon, though De Laval turbines are running—and running well, too, I believe—in several parts in this country, and now the patents are running out many new makes are being put on the market. Owing to the adaptability of the steam-turbine to the driving of dynamos, they are usually made for this purpose, so I shall first describe the Parsons electric governor.

Fig. 1 is a sectional elevation of same In this A is the double-beat valve admitting steam to the turbine; B is the steam space, from which the steam goes through valve A to the turbine; C is a rather leaky bush; D is a piston attached to the main valve rod, E; E is the main valve rod; F is a spring tending to force D down hard, and thus shutting valve A; G is a valve worked by the combined actions of the cam lever, H, and the solenoid arm, K; H is the cam lever, which has a rocking motion up and down off an eccentric driven from the turbine main spindle by means of a worm and wormwheel (not shown); J is where the cam lever, H, is pivoted,

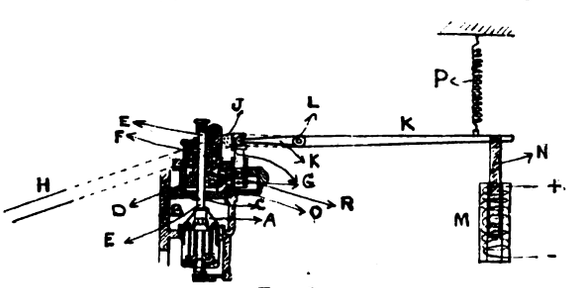


FIG. 1.

and so L is given an up and down motion; K is the solenoid arm, pivoted at the point L, and supported at one extremity by the combined pulls of the solenoid, M, on the plunger, N, and also the spring P and at the other extremity works upon the valve G; M is a solenoid wound with many turns, and connected across the brushes of the dynamo; P is a spring variable in length at will, tending to pull the plunger, N, out of the solenoid, M; Q R are two passages, allowing steam which has leaked past the bush, C, to escape quicker than it can leak again.

Now suppose valve G is closed, then steam leaks past C into the space below the piston, D, and, being at about full pressure, lifts D against the action of the spring F. The action of lifting D opens the main valve, A, allowing steam to pass into the turbine. As the turbine is assumed to be running, almost as soon as this has happened valve G opens, allowing the steam below D lifting up this piston to escape round to the top side through Q and R, and so away. Spring F immediately forces D down, as the steam escapes from below quicker than it can leak in past bush, C. As D is forced down, main valve, A, is closed, and no more steam passes into the turbine till valve G again closes, and the same cycle of operations is gone through again. I think it will now be seen how this main valve allowing steam to pass into the turbine is worked, and it will also be noticed that the steam arrives at the turbine blades in a series of puffs or gusts, and not in a constant stream, owing to valve G being not always closed. It will now be seen that the movements of opening and shutting of the valve G are governed by the movements of the lever K, which is controlled by the movements of the point L. The movement of L is due to two motions as before indicated: (1) an up and down motion due to the eccentric worm and wormwheel on the main shaft, which, it will be seen, will have a perfectly constant amplitude; (2) an up and down motion due to the differences in the pulls on the other extremity of it of the spring P and the solenoid and plunger, M and N.

Now, if valve G were simply worked by the motion due to the eccentric, etc., for a constant speed, the duration of each gust of steam into the turbine would be the same; but if the load varied, the speed would either increase or decrease, as in the case of load coming off machine would race, and although the duration of each gust of steam into the turbine would be less, still the total number of gusts would increase, and the net result would be that the machine would still continue to race, and there would be no governing at all. When, however, we also take into account the motion due to the pull of the solenoid, we now get a very good governing action, as if the machine should tend to race owing to load having been thrown off, the increase of speed will bring up the volts on the dynamo; hence it will send a greater current round the coils of the solenoid, which will, therefore, exert a greater pull on the plunger, and so draw it in a bit further; and then, taking the whole lever K as having its fulcrum at the point L, it will raise the other end, thus raising the valve G more than it already has been running at, and so will increase the time during which the two passages, Q and R, are open, and piston, D, is forced down longer by spring F for each main valve opening cycle, and the duration of each gust of steam into the turbine is lessened and the machine tends to run slower. And *vice versâ*, if load increases, speed tends to decrease, volts will drop; hence pull on N by the solenoid will not be as great, and spring P will pull up the end of the arm, thus tending to lower valve G, and therefore increasing the length of time when Q and R are closed, so steam leaking past C raises piston, D, longer for each valve-opening cycle, and the duration of each gust of steam into the turbine is increased, and the machine tends to speed up to its constant speed. Thus it will be seen that the governor governs so as to keep a constant voltage across the terminals of the machine, and so incidentally rights any slight variation in the voltage of a machine due to the load, as it is a well-known fact that the voltage on a shunt dynamo tends to fall as the load on the machine increases, and *vice versâ*. Thus this type of governor allows you not to keep such a constant watch on the voltmeter, and obviates to a more or less extent the trouble of every now and then having to run to your rheostat handle. So far, however, I have assumed that "A. D.'s" turbine is driving a dynamo. Possibly this is not the case, and so he would not be able to govern it by means of the solenoid, but it will be seen that he could substitute an ordinary type of governor and balls for the solenoid and plunger, seeing that as the speed increases the lever is depressed and the duration of the steam gusts lessened, and the speed consequently brought to the normal.

The above is, I think, a very reliable type, and is fitted to the turbine whose running I have had to do with. I have made use of an illustration in R. M. Nielson's book on the "Steam-Turbine," published by Longmans, for my above diagram.—E. R. ALEXANDER.

*Question No.* 646.—Give an explanation of reactance voltage in a dynamo, and a reliable method of how to calculate same. How does it affect the sparking conditions of a machine?

*Best Answer to No.* 646 (*awarded* 10*s.*).—When an alternating current is applied to a circuit containing resistance and self-induction the "apparent resistance" of the circuit is given by the expression $\sqrt{R^2 + (2\pi n L)^2}$, in which R is the ohmic resistance, L the inductance, and $n$ the frequency. This expression is usually called the "impedance." Now, when the ohmic resistance is small the term $R^2$ will be very small when compared with $(2\pi n L)^2$, especially if the frequency is high. The expression thus becomes $2\pi n L$, and is called the "reactance" of the circuit. If C be the value of the current at any instant, the "reactance voltage" (or voltage of self-induction) will, therefore, be $2\pi n L C$. Now, in the armature of a modern direct-current machine the reactance voltage in the coil short-circuited under the brush is that voltage due to the lines induced in the coil by the current undergoing

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reversal, which, being a rapidly changing current, is accompanied by a rapidly changing magnetic flux of self-induction through the circuit traversed by it. As the coils successively arrive at the position of short-circuit under the brush, they cease for a moment to be part of the main circuit of the armature winding from negative to positive brushes, and the current of constant strength, which had up to the moment before been flowing through them, must stop and reverse—*i.e.*, it must undergo one-half of a complete cycle during the very brief time that the coil is short-circuited under the brush. In order that satisfactory commutation shall take place, we may either depend upon electromagnetic assistance in reversing the current in this coil, or adopt such proportions for the coil that the reactance voltage in it has, at full load, such a low value as in itself to ensure freedom from sparking.

The latter method is, in the writer's opinion, much the preferable, and a thorough understanding of this method can be got from the following, which comes from Mr. W. B. Esson, who recently said: "You probably want some kind of fringe for bringing the current in the section to zero and reversing it, but the magnitude of this fringe must be dependent on the reactance voltage. Make the reactance voltage negligible, and then you can be independent of this fringe; or, in other words, you can do without a positive field, and work even with a negative one. . . . The idea of reactance is not new, and when the matter is looked carefully into, reducing the reactance voltage really means making the commutator sections for a given machine as numerous as possible." (*Proc.*, Inst.E.E., vol. xxxii., p 464.) The last sentence can be completed further by adding, "Thus making the cross-section of the magnetic circuit linked by each turn as small as possible."

The reason why reversal by means of the impressed magnetic field is so undesirable, is that, as the load increases, the distorting influence of the armature current distorts this field further away from the geometrical neutral point. Hence, while the ideal brush position at no load is at this point, an increase of load and of current in the armature would be best provided for by an increased rate of change of the impressed magnetic field linked with the short-circuited coil, to offset the increased reactance voltage in it, this reactance voltage increasing, of course, with the load. Now, to have a portion of the impressed magnetic flux linked with the coils when short-circuited under the brushes, the latter must be slightly displaced from the geometrical neutral point. Then, for some value of the load, the reactance voltage will be just offset by the E.M.F. induced in the coil by the impressed field. With increasing load we should require a stronger impressed field to neutralise the higher reactance voltage set up by the increased current. Instead, however, of this being the case, the magnetic flux is distorted, in proportion to the load, further and further away from the neutral point. Even if it were permissible to alter the brush position as the load increased, there would always be some limit to the load where there could not be found any brush position where the rate of cutting of this impressed flux by the short-circuited coil would be sufficient to offset the reactance voltage in that coil.

So much for the process of electromagnetic commutation, which, by means of auxiliary features in the design, has been employed extensively. But it is much better to proportion the armature for low reactance voltage at full load, and thus make it at all loads *inherently* incapable of sparking. In this process the impressed magnetic field is not made use of, and reliance is placed upon the small inductance of the coil for obtaining sparkless commutation at the instant of abrupt change in current strength as the coil leaves the brush. This leads to commutators of rather large diameter having the segments narrow and numerous, and hence to increased cost for labour. But the great decrease in the "stray" losses in commutation, ensuring a temperature rise of not over 12 5deg. C. per watt per square inch of cylindrical radiating surface, enables the commutator to be made proportionally shorter than in cases where there exists a considerable probability of from 50 to 80 per cent. higher total commutator losses than are attributable to brush friction and contact resistance loss. Thus a proportional saving in material is effected, as the radiating surface need not be so great as where these "stray" losses exist.

The general method of calculating the reactance voltage will now be given, after which it will be applied to the calculation for a machine. It has been previously stated that the current in coils, as they arrive at the position of short-circuit, must undergo one-half of a complete cycle during the very brief time that the coil is short-circuited under the brush. Now, this change in the value of the current doubtless takes place at a rate very different from that of a sine wave change, but as no satisfactory experimental data are available, and, further, an experimental determination would be very difficult, it is convenient (for the sake of uniformity in the calculations) to make the assumption that this rate of change of current follows a sine law. The rate at which commutation takes place (expressed in cycles per second) is now required. Let P be the peripheral speed of the commutator in *inches per second*, and T the length of the arc of contact of the brush in inches. The current is therefore reversed in $\frac{T}{P}$ seconds, which is the time of one-half of a cycle, and, consequently, the frequency of commutation is $\frac{P}{2T}$ cycles per second. We further require to know L—*i.e.*, the mutual inductance of *one* coil between adjacent segments with relation to *all* the coils simultaneously undergoing commutation. Now, *all* the coils simultaneously undergoing commutation are active in setting up lines through any one short-circuited coil. Hence we must estimate the total E M.F. set up by all these simultaneously short-circuited coils, and ultimately the flux resulting from the sum of their magnetomotive force.

From fairly satisfactory experiments there have been deduced as practical values for open slot windings that for the "embedded" portion of the coil there will be set up 12 C.G.S. lines per ampere-turn per inch of "embedded length." For the "free length"—*i e*, the end connections and also that portion of the rest of the turn corresponding to the space occupied by the core ventilating ducts—there will be set up two C.G.S. lines per ampere-turn per inch of "free length." It must further be noted that if each side of the short-circuited group of coils consists of $m$ conductors, then $m$ ampere-turns are concerned per inch of "embedded" length in setting up lines through any one of the short-circuited coils, whereas for the "free" length only $\frac{m}{2}$ ampere-turns per inch of "free" length are concerned. This will be rendered clear by reference to Fig. 1, in which

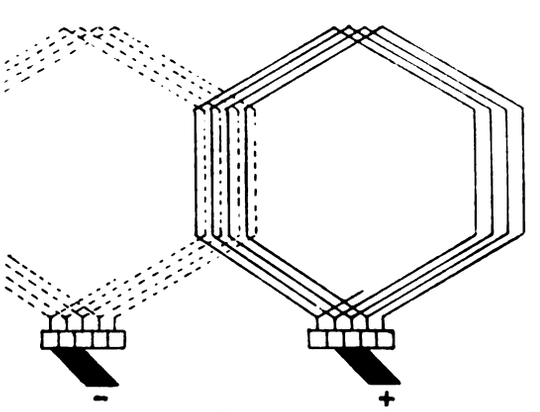


FIG. 1.

a group of short-circuited coils are shown in full lines. It will be seen that for the "embedded" portion, the coils simultaneously undergoing short-circuit at the other brush (shown by dotted lines) have also an effect in setting up lines through the coils under consideration, but for the "free" portion they have no effect. This point should be carefully noted, otherwise a little confusion may be experienced in the working out which is given below. Furthermore, it should be noted that the "linkage" of magnetic lines and short-circuited turns per coil between segments is equal to the above deduced total flux set up through any one short-circuited coil

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between adjacent segments multiplied by the number of turns in one such coil.

The above method can now be applied to the calculation of the reactance voltage in a given case—viz, a six-pole 250-kw. generator:

*Specification.* — Number of poles, 6; kilowatts, 250; revolutions per minute, 320; terminal volts, full load, 550; ditto, no load, 500; amperes, full load, 455.

*Armature.*—Number of slots, 150; number of face conductors, 1,200; conductors per slot, 8; number of circuits, 6; style of winding, multiple-circuit single; type of construction of winding, barrel-wound drum; effective length of armature laminations, 9·9in. (by effective length is meant the *net* length of the armature laminations); mean length of one armature turn, 84·5in.; amperes per circuit (C), 75·7.

*Commutation.*—Number of segments in commutator, 600; number of segments per pole, 100; diameter of commutator, 37·4in.; periphery of commutator, 117·3in.; peripheral speed, 625in. per second ( = P); length of arc of contact of brush ( = T), 0·625in.; frequency of commutation, 500 cycles per second, $n = \frac{P}{2T}$; width of a segment at periphery (including insulation), 0·197in.; maximum number of coils short-circuited under a brush, 4; turns per coil ($w$), 1; maximum number of simultaneously commutated conductors per group ($r$), 8; "free length" per turn ($f$), 64·7in.; "embedded length" per turn ($e$), 19·8in.; lines per ampere-turn per inch of "free length" ($u$), 2; lines per ampere-turn per inch of "embedded length" ($v$), 12; lines per ampere-turn for "free length" ($u \times f$), 129; lines per ampere-turn for "embedded length" ($v \times e$), 238; lines per ampere for "free length" $\left(\frac{r}{2} \times u \times f\right) = p$, 516; lines per ampere for "embedded length" $(r \times v \times e) = q$, 1,900; total lines linked with short-circuited coil per ampere $(p+q)$, 2,416; inductance per segment* (L), ·000024 henry; reactance of short-circuited coil ($= 2\pi n$ L), ·075 ohm; reactance voltage of short-circuited coil ($= 2\pi n$ L C), 5·7 volts.

Further data of this machine which may be of interest are: volts per commutator segment, 5·5; armature ampere-turns per pole, 7,600.

*Brushes.*—Number of sets, 6; number per set, 4; area of contact of one brush, 1·09 square inches; type of brush, carbon.

It has been found in practice that for a machine of this size the value of the reactance voltage—viz., 5·7 volts—permits of sparkless commutation at full and also at considerable overloads. With smaller machines, of course, this value should be reduced.

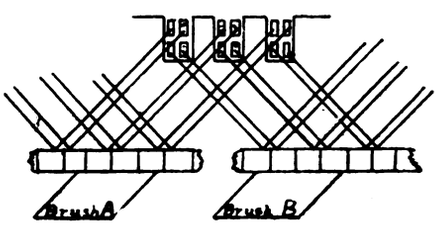
The above example has been worked out for a multiple-circuit winding of the armature (sometimes termed a "lap" winding). The method of calculation is exactly similar for two-circuit windings,† but in this case the correct number of amperes per turn will be total amperes from commutator divided by 2, and is *independent* of the number of brush sets. When only two brush sets are employed, the value found for the reactance voltage by the above method will have to be multiplied by the number of pairs of poles. This will be clear on reference to a diagram of a two-circuit winding.‡ When as many brushes are employed as there are poles, the calculation then is the same as for a multiple-circuit winding (the correct value for "amperes per conductor" being inserted). A word may be said of the interpretation of the above method when used in conjunction with *multiple* windings—*i.e.*, two or more single windings superposed upon the same armature, each furnishing but a small part of the total current of the machine. For a multiple-circuit double winding care must be taken to employ the right value for the current per conductor—viz., one-half that for a multiple-circuit single winding—and also to note that the time during which a coil is short-circuited under a brush is for a given width of brush less than for a multiple-circuit *single* winding.—REACTANCE.

* The inductance of one coil with relation to *all* the turns simultaneously short-circuited equals $(p+q) \times 1 \times 10^{-8}$, or $2{,}416 \times 10^{-8}$.

† For the distinction between multiple-circuit and two-circuit windings see the *Electrical Engineer* for July 3, 1903, pp. 19 and 20.

‡ *Ibid*, p. 20, Fig. 2.

*Answer to No.* 646 (*awarded 7s. 6d.*).—The study of reactance voltage and the introduction of the term is principally due to Messrs. Parshall and Hobart. It is an inductance effect, and is defined by them as "the voltage estimated to be induced during the process of commutation." The following example is from "Electric Generators," by the above authors, and illustrates for one case the calculation of reactance voltage: Output, 200 kw.; voltage, 550; revolutions per minute, 750; four-pole continuous current; four-circuit single winding; 120 slots, four conductors per slot; diameter of commutator, 20in., 240 segments; brushes, ·75in. thick; segments, ·26in. wide. There is one complete turn per segment, consequently three complete turns is the maximum number being short-circuited at one brush at any instant.




The figure shows a group of adjoining conductors in the slots occupying the commutating zone between two pole-tips. Three of these conductors are short-circuited at one brush and three at the other, altogether six on the conductors in 1½ slots.

$$\text{Full-load current} = \frac{200{,}000}{550} = 364 \text{ amperes.}$$

$$\text{Current per circuit} = \frac{364}{4} = 91 \text{ amperes.}$$

During the period of short-circuit this current of 91 amperes must die down to zero and increase to 91 amperes in the opposite direction by the time it emerges from the brush, so that it may be able to join the other side of the circuit.

We now go on to calculate the inductance, and in doing so it must be noted that the coil is situated in a varying flux, caused not only by the changes in the coil under consideration, but by the changes in five other adjacent coils as well. The voltage induced will be six times as great as if the coil had alone been undergoing commutation at the moment. It should also be noted, by the way, that since it is the voltage in one turn that is wanted, it will not be the *square* of six times as great: Gross length of laminations = 10in.; flux set up in one turn per ampere in that turn and per inch of length of armature lamination = 20 C.G.S. lines; ∴ flux of self-inductance = 10 × 20 = 200 lines; self-inductance = $200 \times 10^{-8}$ = ·0000020 henry; mutual inductance of one turn with relation to six turns simultaneously undergoing commutation = 6 × ·0000020 = ·000012 henry; circumference of commutator = 20 × 3·14 = 62·8in.; revolutions per second = $\frac{750}{60}$ = 12·5; peripheral speed of commutator = 62·8 × 12·5 = 785in. per second; thickness of radial carbon brush = ·75. Current is completely reversed in $\frac{\cdot 75}{\cdot 785}$ = ·00095 seconds, which is the time of completion of a half cycle. Consequently the reversal occurs at an average rate of $\frac{1}{2 \times \cdot 00095}$ = 530 cycles per second.

We now require to make a very unwarranted assumption—for want of a better—of a sine wave of variation: reactance = 2 × π × 530 × ·000012 = ·040 ohm; reactance voltage = 91 × ·040 = 3·6 volts.

At a later date, and after further consideration of the subject, Mr. Hobart read a paper before the Electrical Section of the Glasgow Engineering Congress in September, 1901. In it he gave the results of his study of various forms of coils, and giving values for the field per ampere-turn per centimetre length of coil. He gave two values, one for the embedded length and the other for the free length or end connections. The values given, reduced to C.G.S. lines per ampere-turn per inch length of coil, are as

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follows: 10 C.G.S. lines per ampere-turn per inch of embedded length; two C.G.S. lines per ampere-turn per inch of free length.

The following example illustrative of this method of Mr. Hobart is taken from "Modern Electric Practice: Taking a case where we have two inductors, one turn per segment and four turns short-circuited under each line of brushes; also embedded length per turn, 24in.; free length per turn, 50in.; revolutions per minute of armature, 360; diameter of commutator, 28in.; thickness of brush, ·875in.; linkage of embedded length = 8 × 10 × 24 = 1,920; linkage of free length = 4 × 2 × 50 = 400; total linkage, 2,320.

Then if L = inductance in henrys $L = \frac{2,320}{10^8} = ·0000232.$

The periodicity of reversal is given by

$$\sim = \frac{n \pi d_1}{2 t} = \frac{6 \times 3·1415 \times 28}{2 \times ·875} = 300, \text{ say.}$$

where $\sim$ = periodicity of reversal; $n$ = revolutions per second; $d_1$ = diameter of commutator in inches; $t$ = thickness of brush in inches.

Then if the current to be commuted by one line of brush is, say, 50,

$$\text{Reactance voltage} = 2 \pi \sim L C$$
$$= 2 \times 3·1415 \times 300 \times ·0000232 \times 50$$
$$= 2·17 \text{ volts.}$$

In order to get good results, and to ensure that heavy overloading may be possible without trouble from sparking, Mr. Hobart states that the reactance voltage should not exceed three volts.—T. McG.

*Answer to No.* 646 (*awarded* 7*s.* 6*d.*).—The commutation of a continuous-current machine practically consists in causing an alternating current of high periodicity to flow in each section in turn under each of the collecting brushes. The current in the commutated section has first to be reduced from its normal value to zero, and then increased again to its normal value, but in the reverse direction, during the time the section is short-circuited by the brush—*i.e.*, half a complete alternation has to be carried out in that time. This reversal of current is brought about partly by giving the brushes a lead so as to bring the section in question into a magnetic field by which a reversing E.M.F. can be induced, and partly by the automatic increase in the resistance between the brush and the commutator segment which is about to leave the brush. The latter factor is only of importance when carbon brushes are employed.

Changes of current in any inductive circuit such as an armature section—*i.e.*, a circuit capable of setting up a magnetic flux around itself when a current flows in it—are opposed and retarded by a back voltage of self-induction or reactance voltage, just as in an alternate-current choking coil or transformer. Thus, as soon as the current in the short-circuited section commences to fall, the magnetic flux looped with it due to its own current, and which has nothing to do with the main flux of the machine set up by the field-magnet coils, also falls and sets up a voltage tending to prevent the drop in current. In order to ensure the current falling to zero, and then increasing to its full reversed value again in the time taken by the section to pass under the brush, it will, therefore, be necessary to find a stronger reversing field (by giving the brushes more lead) than would be necessary if the section had no reactance. Consequently the range of load over which a machine can be kept sparkless is less if the reactance voltage is high than if it is low. The amount of flux looped with an armature section due to its own current depends on the amount of the current, the number of turns in the section, the length of the conductor embedded in the slots of the core, and the length of the end connections beyond the slots. The reactance voltage set up in the section during commutation due to the cutting of this flux depends again on the turns in the section, the time of commutation—*i.e.*, the peripheral speed of the commutator and the width of the brush—and also on the number of sections commutated at one time, for the changes of flux set up by any one section affect neighbouring sections by mutual induction.

For the purpose of calculating the reactance voltage it is usual in practice to make the same assumption as for most alternate-current calculations—viz, that the change of current in the commutated section follows a sine law. Though this assumption is probably far from correct, it serves well enough for comparative purposes, and the reactance voltage calculation based on it has been found to be a fairly reliable measure of the sparking qualities of continuous-current machines. The derivation of the formula for the calculation of the reactance voltage by the best known method—viz, Hobart's—was explained in detail in the answers to question No. 534 in the issue of this paper for Dec. 5, 1902, so need not be repeated here. The formula is:

$$\text{Reactance voltage} = \frac{R \times D \times T^2 \times S \times C(x + ·1\,y)}{b} \times 1·32 \div 10^8$$

where R = number of revolutions per minute of the machine;
D = diameter of commutator;
T = number of turns in a section;
S = maximum number of sections short-circuited by a brush at one time = the next whole number larger than the ratio

$$\frac{\text{Width of brush}}{\text{Width of one commutator segment with mica}}$$

C = current in each conductor

$$= \frac{\text{Total current of machine}}{\text{Number of poles}}$$

for a plain parallel coupled armature winding, and

$$= \frac{\text{Total current of machine}}{2}$$

for an ordinary two-circuit series-coupled armature winding;
$x$ = twice the length of the armature iron parallel to the shaft in centimetres;
$y$ = the length of the two end connections in centimetres—*i.e.*, the length of one complete turn of armature winding less $x$;
$b$ = width of the brush (measured in the same units as D is measured in).

The formula as it stands is correct for parallel-coupled armatures, but must be multiplied by the number of pairs of poles for series-coupled armatures, as the short-circuit under the brush with series-coupled armatures consists of that number of sections in series. The value of the reactance voltage worked as above should not exceed three or four volts for really good working according to Hobart, though satisfactory machines have been built with quite double these values.—Q.

*Answer to No.* 646 (*awarded* 5*s.*).—The coefficient of self-induction is the term applied to the magnetic flux surrounding a conductor carrying a current of one ampere. Another term for this flux is inductance, and in text-books is usually denoted by the symbol L. The henry is the unit of inductance, and is equal to the cutting of $10^8$ C.G.S when one ampere is flowing along the conductor. When a circuit contains more than one turn the inductance is the sum of the fluxes surrounding each turn

$$L \times N \times 10^{-8} = \text{henrys}$$

where N equals the number of turns in the circuit. The term "reactance" has been given to the product of the inductance, and $2 \pi \times$ (periodicity of the current in the circuit), and on the assumption that the current follows a true sine curve the following equation is obtained:

$$\text{Reactance voltage} = 2 \pi . L . N . C . n,$$

where $n$ = periodicity of the current and C = the root mean square value of the current in amperes. In an alternating-current circuit the reactance, or more commonly called impedance, corresponds to the resistance in a continuous-current circuit, and as in the latter circuit resistance multiplied by current equals volts (Ohm's law), so reactance voltage equals reactance multiplied by current. The term "reactance voltage" was first used by Mr. Hobart in his paper on this subject a few years ago. Now, in a continuous-current dynamo or motor the current in the armature section short-circuited by the brush, has to fall to zero and build up in the opposite direction so as to reach its maximum value before the brush leaves it. If this

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complete cycle is not carried out, a difference of potential will occur between the commutator segments as they leave the tips of the brushes, and thus will produce sparking. The reversal of the current in the short-circuited coil is produced to a certain extent by the action of the carbon brushes (which is explained very fully in a paper by Mr. Rothert in the *Electrical Engineer* of Nov. 21 and 28, 1902), but chiefly by the strength of the magnetic field at the leading pole-tip under which commutation occurs. The general practice of dynamo designers is to so design the poles and pole-pieces as to ensure as far as possible no variation in the field strength at the leading pole-tip due to distortion by the armature reaction. One method frequently adopted is to make a slot up the centre of each pole, thereby placing an air-gap in the path of the flux produced by the armature ampere-turns (see Fig. 1).

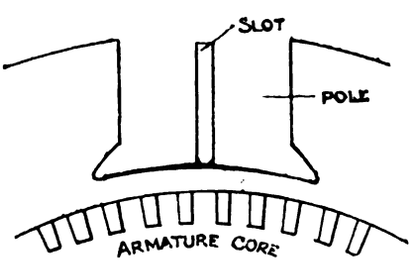


FIG. 1.

Many rules have been brought forward for calculating the reactance voltage on continuous-current dynamos, but they are almost all based on the figures given by Mr. Hobart at the Glasgow Congress. The latter does not profess to calculate the actual reactance volts, but to obtain figures proportional to the reactance volts which can be used for comparing the sparking properties of different machines. From experiments Mr. Hobart discovered that with ordinary slot-wound drum armatures the inductance per centimetre length of conductor embedded in the slot per ampere flowing is four C.G.S. lines, and that the inductance per centimetre length of end connections per ampere flowing is ·8 C.G.S. lines. Referring to Fig 2, where three turns of an armature winding are short-circuited under the positive brush and three under the negative brush, the inductance of one turn with relation to all the turns simultaneously short-circuited can be calculated as follows:

Inductance per ampere-turn for end connections = ·8 × 20 × 4 = 64 C.G.S. lines.

Ditto embedded conductors = 4 × 10 × 2 = 80 ditto.

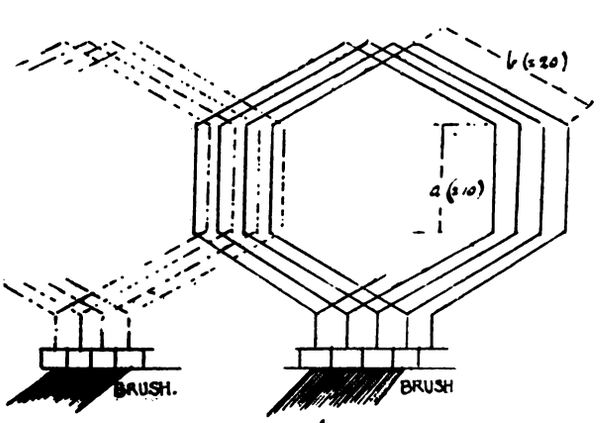


FIG. 2.

From Fig. 2 it is seen that each embedded conductor is acted upon by all the conductors short-circuited by the positive and negative brushes by induction, but each end-connection conductor is only acted upon by the conductors short-circuited under one brush, as the end connections do not overlap as in the case of the embedded conductors, consequently

Inductance per ampere for end connections = 3 × 64 = 192 C.G.S. lines.

Ditto embedded conductors = 6 × 80 = 480 ditto.

Therefore, inductance of one turn with relation to all the turns simultaneously short-circuited

$$= 672 \times 10^{-8} = \cdot 00000672 \text{ henry.}$$

Assuming that the periodicity of reversal equals 500,

$$\text{Reactance} = 2\pi \times 500 \times \cdot 00000672 = \cdot 0212 \text{ ohm,}$$

and if the current to be reversed in each set of brushes is 100 amperes,

$$\text{Reactance voltage} = 100 \times \cdot 0212 = 2 \cdot 12 \text{ volts.}$$

Mr. Hobart fixes the limit for satisfactory working at three volts, and this figure, from tests carried out by the writer, should not be used unless absolutely necessary owing to mechanical difficulties, as two volts is a far more satisfactory limit for general practice to obtain perfect commutation. The writer has given the above example at some length to explain clearly the meaning of the term reactance voltage.

From the above example a general formula can be obtained for any dynamo or motor as follows:

Let $x$ = number of turns in one armature section;
$a$ = length of embedded conductor—*i.e.*, length of armature core;
$b$ = length of end connection. Then

$$\text{Inductance} = 3 \cdot 2 \times (5a + b) \text{—see complete working of above example;}$$

$$\text{Reactance voltage} = 2\pi \times n \times C \times 3 \cdot 2\, n\, (5a + b) \times 10^{-8};$$

where $C$ = current in armature section;
$n$ = periodicity of commutation or time of short-circuiting a section of the armature.—P.

## THE LIGHT THAT FAILED.

(*With apologies to Mr. Kipling.*)

There's a Chief in a certain city
Who mourns for the light that failed;
There's many a man, more's the pity,
Who thinks he should be gaoled,
And there's Tom and Jack and Harry
Who worked till the gaslight paled.

The 'bus bars shorted across—
A greaser screamed and fled,
And a ten-foot arc from the H.T. side
Followed him as he sped;
While with a grating, jarring, sickening sound
The crankshafts turned around.

There's a "short" on the traction circuit,
There's an "earth" on the lighting main,
The switchboard's burnt to a cinder,
And the Shift Engineer's insane.
It is five p.m. in the evening,
No light to-night—that's plain.

The Committee men sat and talked
And much brainy speech did flow,
While the grocer explained to the butcher
How *he* could have run the show;
But Tom and Jack and Harry worked with might and main
And Santa Claus expressed surprise, when the arcs shone out again.

C. H. S.

## APPOINTMENTS VACANT.

**Fitter-Driver,** Brierley Hill, Staffs. Wages 30s See advertisement.

**Electrician** to take charge of test-room of large electrical engineer's works. See advertisement in last issue.

**Chief Assistant Electrical Engineer,** Croydon. £200. Applications by Jan. 30. See advertisement.

**Tramways Manager,** Stockport. Salary £300 per annum. Applications to the Town Clerk by Jan. 25.

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**Assistant Superintendents of Telegraphs,** Ceylon. Salary Rs.3,500, rising to Rs.5,000 by biennial increments of Rs.500. Applications to Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by Jan. 30.

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**TO CORRESPONDENTS.**

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*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## MONEY.

"Why do you tell the same thing twenty times?" was the question, and the answer came, "Because it is not learnt or understood by telling nineteen times." A very appropriate reply, but one that is too often forgotten. The present condition of the money market was foretold; it is bad, but as yet many people refuse to realise the fact. Schemers put forth schemes with estimates which assume that money is plethoric and can be had as cheaply as it could be had a few years ago. Just consider one or two phases of the question. As a test look once more at Marylebone. It wants, say, two millions, which not long since could have been had at 3 per cent., now probaby not under 4 per cent., if for that—a difference for interest of twenty thousand pounds a year. Apply this view to any undertaking which involves compulsory payment of interest, and you at once see that the revenue of the undertaking must be at least twenty thousand pounds a year more than would have been necessary at the lower rate of interest. In order to obtain this amount the charges for the product must be increased, for, as a rule, the consumer pays. Directly this fact is realised we must go a step further and point out that the charges made by the new undertaking will most certainly be compared with the charges of some older undertaking carried out when money was cheaper, with a result not flattering to the new undertaking. Of course, the different conditions will not be mentioned, but the worse result will be attributed to bad management and organisation. Enough has been said to show how fallacious mere figures may be, and that in reality a concern showing worse results may have been more economically engineered and better managed in all respects than the one giving better results. It has been assumed that though money may be dearer it can be obtained, but this is just what cannot be done at the present time. Scheme after scheme can be put forward of work necessary, of work with great potentialities, but money is so hard to get that the work can often be carried out only by getting contractors to finance. We are not quite sure, but when the history of modern progress comes to be written it will be found that contractors financing jumped into extreme prominence with the introduction of the electrical era. This method of finance is not so good as that which holds when the customer has the money to pay for what the contractor is asked to do. Manufacturing firms are, in the electrical world, generally contracting firms, and under existing conditions must be financiers also. This brings us to a further point—that money having been scarce amongst home contractors, as well as with other people, foreign contractors and financiers have during the past three or four years been able to make considerable headway here because they could command money. It is, therefore, with some degree of comfort that we contemplate the finish of the Great Northern and City Railway, a concern of the highest importance, carried out under the auspices of an entirely British company, though it seems conclusively only by the financial aid of the contractors—Messrs. S. Pearson and Son. This railway is exceptional for more reasons than that it is an all-British line, which most of the new tubes are not. As a means of relieving congestion in traffic on the older lines, it is practically unequalled amongst the large number of tube schemes now in progress. The journey from Finsbury Park into the City by any of the railways now available has for years been a most uncomfortable one to all having to travel during the busy hours night and morning. The number of people to be carried has vastly exceeded the limits of accommodation, not only of the

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trains, but also at the railway stations mostly used. The overcrowding has been excessive, and, as far as can be seen, it has been quite unavoidable. This new railway will by its more direct route vastly improve matters, and will save those wishing to get from Finsbury Park into the City both time and money. It will be remembered that Mr. James Swinburne at the Institution dinner last year remarked on the impossibility of improving means of communication, because when you doubled the facilities four times as many people wished to use them. It remains to be seen how far this will be true with the Great Northern and City Railway, but we are sure that the traffic morning and evening will severely test even the large accommodation provided on the trains. The engineers of the line have partially allowed for this by providing long platforms, and we trust that the seating accommodation of the trains will be increased as it is found necessary. The excellent system of control provided by the multiple-unit system with three motor coaches also enables the length of train to be reduced in the slack portion of the day. The advantages of this new all-British deep-level line over the older types of tube railways may be summed up as follows: The composite brick and iron tube is quieter, the ventilation is better, the means of access more convenient. Lastly, the risk of fire in the stations or on the trains has been reduced to the vanishing point by careful detailed design. The line is an example of modern engineering work of which we as a nation may be proud.

## OBITUARY.

### The Late Mr. R. C. Quin.

We regret to record the death by drowning of Mr. R. C. Quin, a member of the firm of Quin and Speight, consulting electrical engineers, Victoria street, S.W., whose tragic end occurred at Tamney, co. Donegal, on Monday. Mr. Quin was with a party of engineers surveying a quarry, and while standing on the pier a tidal wave swept in and washed him into the sea. A gallant attempt was made to save him by Mr. Margerison, of Bradford, the owner of the quarry, and at the inquest on Tuesday the jury highly commended Mr. Margerison's bravery. Mr. Quin throughout his life had been intimately connected with municipal electrical work, and he claimed that the length of time he had served was only exceeded by Mr. Sidney Baynes, his former chief at Bradford. It was at the electrical works in this town that he first commenced his experience with corporations, after having been a pupil of Mr. J. N. Shoolbred, the consulting engineer for the original scheme at Bradford. From 1891 to 1896 he acted as assistant engineer to the Brighton Corporation, and was then appointed as resident engineer at Blackpool. This position he held until March, 1902, but for three years previous to this he had carried on a large consulting practice with Mr. Speight. Mr. Quin, as consulting engineer, was responsible for a large amount of lighting and tramway work in the Lancashire district, and had a wide circle of friends there. He patented numerous electrical devices, many of which have come into considerable use. One of the first of his patents, taken out in conjunction with Mr. A. Wright, was for the combined alternating and continuous current system used at Brighton. A better known patent was that designed to prevent the fall of a live trolley wire. This apparatus, first shown at Blackpool, was fully described in our columns at the time, and it has had the approval of the Board of Trade. We much regret that such a promising career has been ended in such a manner, and at the early age of 39, as Mr. Quin has rendered very great service to the electrical profession as a whole.

### The Late Dr. Friedrich von Hefner-Alteneck.

We regret to have to announce the death on Thursday last week of Dr. Friedrich von Hefner-Alteneck, who in the past was responsible for so much original work in the early days of the development of electrical engineering. After a good education at the polytechnic schools at Zürich and Munich, he was led by what he saw at the Paris Exhibition of 1867 towards electrical work, obtaining in that year a small position in the shops of Messrs. Siemens and Halske. He was quickly promoted, and finally held a directorship in that firm. It was he who in 1872 invented the drum winding for the armatures of direct-current dynamos, and he also took a great part in the development of arc lighting from the old Jablochkoff candles. Herr von Alteneck had to do with a vast number of improvements in electrical apparatus. Amongst his inventions is a transmission dynamometer for measuring the force transmitted by a belt. This instrument is widely known, but it has not obtained the general use which has been accorded to the more recent work of the deceased. We refer to the standard of light called by his name which was introduced in 1883, and is now almost exclusively employed in Germany. It is known under the name of the "Hefner" standard. The contributions of the deceased to technical literature were numerous, and always highly valued. Since his retirement from active work with the above-named firm he had devoted himself to private research with considerable results. He will be much regretted in Germany, where he had a wide circle of friends amongst technical men.

### The Late Mr. Ernest Thompson.

We regret to announce that Mr. Ernest Thompson, of the firm of Nalder Bros. and Thompson, died on Sunday last after a long and painful illness. Mr. Thompson had been managing director of the above firm since its inception in 1896, and had done much good work in the standards of electrical measuring instruments on a commercial basis.

## THE BRISTOL FIRE — ITS PROBABLE CAUSE, EFFECTS, AND PREVENTION.

BY W. H. CLOTHIER.

*(Continued from page 59.)*

### PART II.—THE FAULTS.

Let us assemble concisely as possible, firstly, the respective faults developed at the origin of the trouble and, secondly, the obstacles which handicapped the speedy re-establishment of the supply.

*Firstly.*—(1) Primary fault, at present not disclosed, on some part of the system, causing excess current through machine fuses. (2) Failure of machine fuse or fuses, and the consequent development of an arc on the switchgear. (3) Fire spreading to cables, platform, and roof.

*Secondly.*—(4) Time requisite to shut down the machines and so stop the arc. (5) Time taken to extinguish the fire. (6) Time spent in obtaining light and examining the damage. (7) Time required to clear away damaged cables and to make temporary connections; the whole proceedings, after the event, being handicapped by poor light and the necessity of obtaining material, labour, etc, to make the temporary connections. (8) In the meantime Avonbank, containing a sound switchgear, cables, and uninjured machines, was standing idle and helpless.

Let us also consider in the same sequence the conditions which might have saved or even reduced the extent of the damage, and the length of the interval which elapsed before the supply was fully re-established.

1. The primary fault, being foreign to the switchgear question, need not be commented upon here.

2. The fuses were an obsolete type, and might have been replaced by a more satisfactory and later design or dispensed with altogether on the machine circuits.

3. A less inflammable material on the floor and on the cables would have reduced the intensity of the fire. The question of insulation on the switchgear platform would seem to be an important one. It is a very common practice to use wooden platforms and also to lay heavy rubber mats over the same. The heat and flames produced by the combustion of these may do a great deal of damage in a very short time. In the interests of safety to the attendants and material, the floor should undoubtedly

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be made of non-inflammable material. The problem is to find a suitable fire-resisting material which shall have the requisite insulating properties. In the absence of a better suggestion forthcoming, glass set in a metal frame may be used to advantage. The absence of inflammable material in the roof structure would obviously minimise the extent of the damage resulting from a fire inside the station.

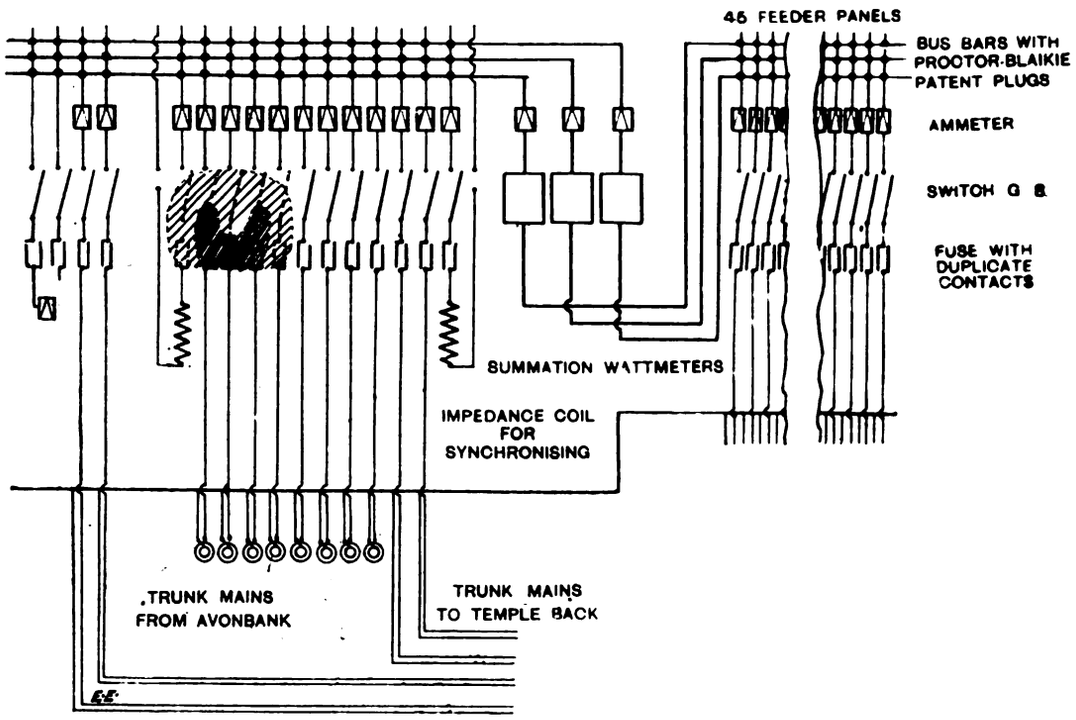


FIG. 1.—Diagram of Connections between Avon Bank and Temple Back Stations, Bristol. The arc fused all metal within the darkest patch shown, and destroyed all slate, porcelain, etc., within the shaded patch.

4. Had it been possible to get near the trunk main switches Avonbank might have been isolated. Although this would have shortened the time during which the arc was maintained, it is very questionable whether any other material saving would have been effected, as the fire seemed to get an instantaneous hold upon the gear and its contiguous parts.

5. The time spent in extinguishing the fire when once fairly started could, of course, only have been avoided by absolute prevention of the fire in the first instance, and one would hardly suggest the use of special fire-extinguishing apparatus in a central station other than sand, which can only be of service in case of small accidents.

6. Some of the inconveniences caused by the absence of light under similar conditions would be avoided by the systematic installation in central stations of flare lamps or acetylene lamps, which must be kept in regular order, so that they can be lit up immediately there are signs of impending trouble. An electric device for lighting all lamps simultaneously from a distance would be an acquisition for this purpose.

7. What seemed at one time to be ample provision against a failure was the introduction, at the instigation of the engineer, of triplicate 'bus bars; without prejudice to the policy of duplicate 'bus bars for convenience under ordinary working conditions, it must be admitted that the complications are of very little service in case of emergency. If the full advantages during and after an emergency are to be derived by the duplication of parts, it must be complete. To cope with a failure of the magnitude that the one in question eventually attained, we should duplicate the entire switchgear and also the connections from the place at which the feeders enter the station. One might be put to considerable expense in preparing for every conceivable emergency, and it is difficult to know where to draw the line, but the expense may be justifiable when employed in some simple form of switchgear and connections consisting of the barest necessities for temporary use in case of accident, these being kept in readiness and possibly at periods practised upon by the staff and men employed in the station.

8. Local conditions of moment, which need not enter this discussion, were considered when it was decided to feed the whole of the area covered by the Corporation supply through the switchgear in the old station, and the possibility of the entire basketful of eggs, as it were, falling

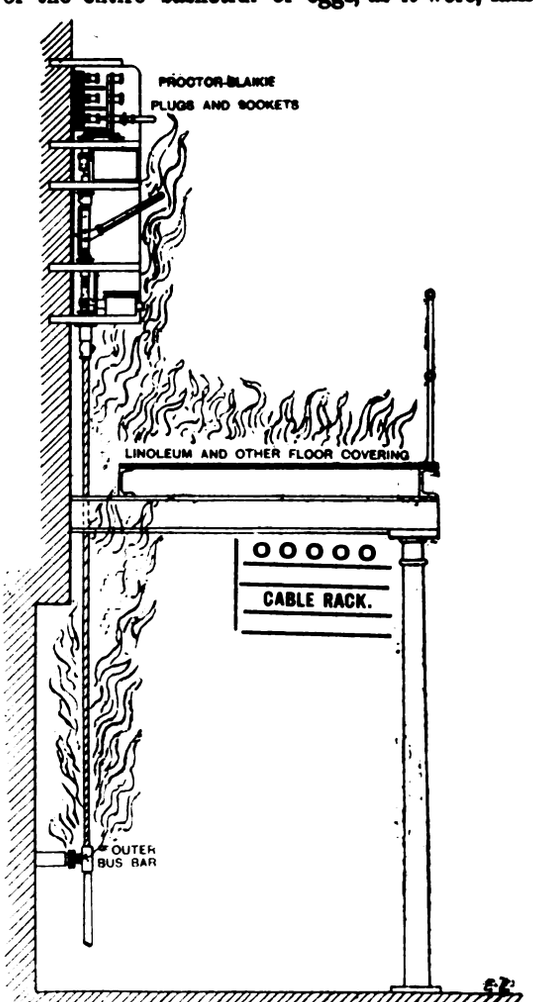


FIG. 2.—Sectional Elevation of Switchboard, showing extent of conflagration. The cables in the rack under switchboard platform were also involved.

seemed at the time unlikely, but in the light of the past experience a much speedier resumption of the supply—at least to certain districts—could have been effected had it

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been possible to distribute from Avonbank independent of Temple Back.

### Part III.—Possible Prevention.

It is easy to say "what might have been" and to criticise a design after an accident. Such criticisms, however, are more difficult to expound beforehand, and, moreover, the arguments usually require substantiating by a practical demonstration like the occurrence of a serious accident or breakdown before they become convincing. And so one direct object of this discussion is to dwell specifically upon the recent experiences at Bristol and to derive from them some lessons which will apply, not necessarily to switchgears and connections in general (for that would cover too extensive a field), but to installations and systems similar to that existing at Bristol—single-phase alternating current at pressures not exceeding, say, 3,000 volts.

There is but little doubt that the trouble was instigated by some error in the design, manufacture, erection, or upkeep of some part or parts of the machine fuse panel, although it must be admitted that the greatest damage was wrought by the combustion of material contiguous to although not actually the manufacturer's part of the switch-

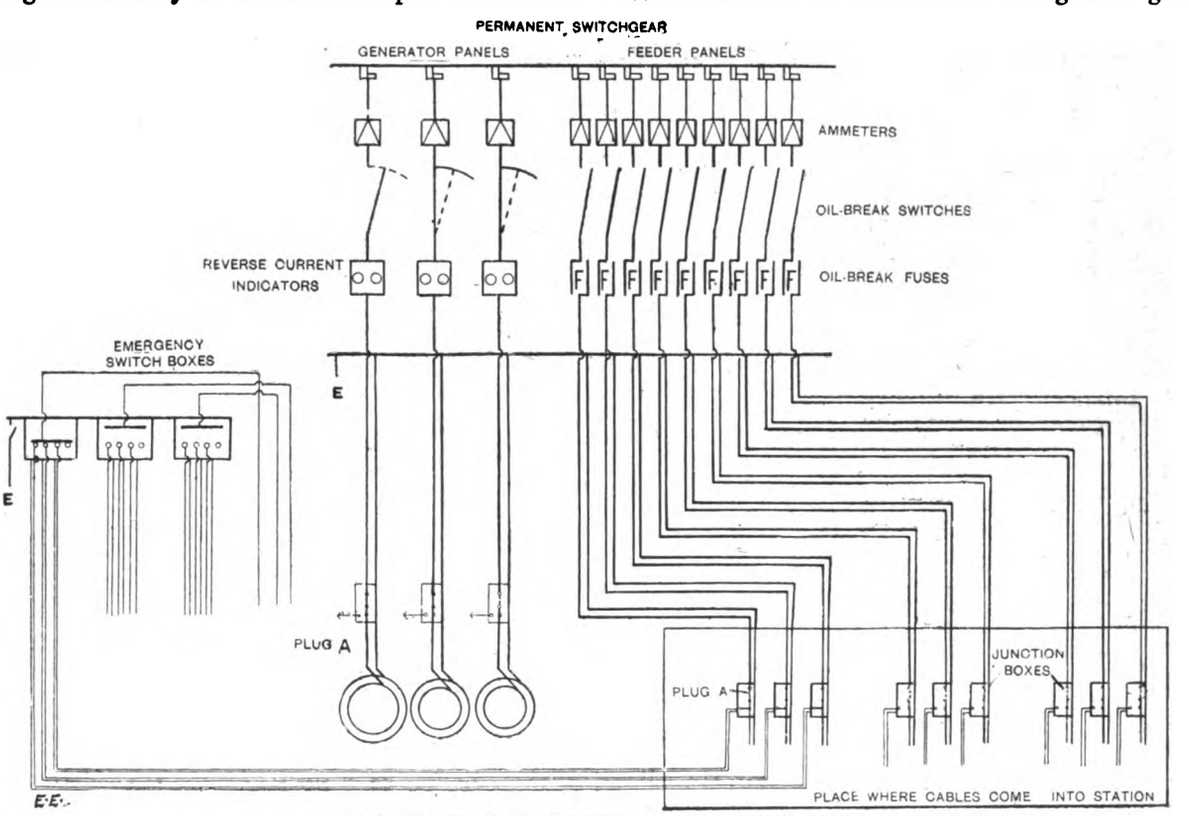


Fig. 3.—Diagram showing Connections to Proposed Stand-by Gear.

gear. The fuse design was prepared some five or six years ago, at a time when there was not the same general appreciation of the importance of the central-station switchgear, nor the same facilities for testing, etc., that exist at the present time. At that time the design in detail was considered satisfactory in use, although somewhat difficult to manufacture. A special factor to be considered was the necessity for a design of fuse and fuse panel which would occupy the same space as that taken up by an existing design then used for half the capacity, the reason being that at places where switchgear had been installed with provision on the slate frame for extensions it was found convenient to double the size of the generators included in the extension schemes. After events proved the fuse troublesome due to overheating and leakage of oil, although a switch designed at the same time under corresponding conditions gave better results, and is now being used to a very large extent. Designs which are more carefully watched than the one in question during the manufacture and in the early stages of use under normal and abnormal conditions will often take years to develop faults. When these faults are recognised, it is often difficult for users to go to the trouble and expense of eradicating them. Moreover, it is also a curious and yet by no means uncommon experience to find that faults will develop at one installation and not at another upon certain standard materials and appliances which are identical in design and construction, and apparently working under similar conditions. Such factors as these are responsible for the use at the present time of obsolete designs on which there is room for improvement.

*Protecting Devices for Generators.*—In the foregoing portions of this discussion it has been suggested that fuses should be eliminated from the generator circuits. This introduces again a much-discussed question on which there are three pronounced sides: on generator circuits the use of (1) fuses; (2) reverse current or discriminating automatic circuit breakers; (3) no fuses or automatic devices.

*Fuses.*—The first is admitted to be theoretically bad, because, among other well-known reasons, the sound machines are likely to be isolated at the wrong time. Doubtless in many instances generator fuses have been instrumental in saving generators from destruction, and have possibly thereby prevented more serious accidents, though by the irony of things these cases are the ones we hear the least about, but, on the other hand, there have been cases when the simultaneous fusing of all generator fuses has caused an interruption to the supply. Fuses, if used at all, should be fused to blow at two or three times the working capacity of the generator, and the size cannot be determined by the capacity of the individual generator to be protected, but should be based upon the total capacity of all the generators running in parallel, because a short-circuit on a generator is not fed by the faulty machine only, but by others running in parallel with it. And the current which instantaneously passes through a fuse before it has time to melt can assume enormous proportions as compared with the current which is just sufficient to melt the fuse in a test-room, as recorded on tables of fusing capacities for various metals.

*Reverse-Current Automatic Devices.*—A really reliable device that would automatically open the generator switches on the reversal of current has long been sought for, but, unfortunately, those who have worked in this direction have found that, whilst the device meets the requirements for high-resistance faults, in cases of low-resistance faults—*i.e.*, short-circuit on the armature, etc.—the low potential difference across the shunt coil on alternating-current systems renders this apparatus inoperative and useless just at the time when reliability and certainty in action are most essential. Moreover, on account of the

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momentary interchange of current during synchronising operations, it becomes necessary either to cut out the automatic device whilst synchronising, or else to introduce a time element into the action; and so it is no better than a fuse in respect to the instantaneous increase in the current strength during the time interval between the occurrence and isolation of the fault.

*No Automatic Protecting Devices.*—In the absence, then, of an absolutely reliable automatic protecting device for generators, it is better to do without automatic protection, and then if a fault occurs on a generator or its connections to the switchgear, the attendant should have time to pull out the machine switch; but in any case it would seem better to risk injuring the plant than to cause a complete, or even partial, cessation in the supply to the consumers.

*Are Other Precautions Essential?*—Let us consider whether it is requisite to add gear and connections for temporary use in cases of emergency to existing installations, and if so, how can it be done without involving additional risks or unreasonable expenditure in initial cost, upkeep, and supervision? The duplication of 'bus bars and mains, the provision of spare machines, and also the division of switchgears into sections interconnected with one another, have all been devised and provided for convenience in running, cleaning, repairs, renewals, etc., and also for the possible prevention of a cessation in supply in the event of a failure of any machine, feeder, section of switchgear, etc. But, possibly due to the rarity of the complete destruction of switchgears, it is generally left to the resources of the engineers on the site to do as best as they can, utilising any material they can lay hands upon when serious breakdowns do occur. Moreover, although in many old stations there is a chaotic display of inflammable cables, precautions are but rarely or inadequately taken to guard against the not altogether remote possibility of a short-circuit, or fire, or both of these contingencies, cutting off the mains or feeders and the machines from the centre of the sytem upon which the greatest reliance is necessary, in that the whole supply emanates therefrom. It seems hardly necessary, with the Bristol experience at our service, to ask whether such precautions are essential or not, but the extent to which the connections and gear hereby suggested are carried out will depend, of course, on a good many local conditions.

*Proposed Stand-by Gear.*—For the barest necessities it is proposed to arrange on the switchboard platform, or at any other convenient place at least 20ft. away from the permanent switchgear, a system including an arrangement of connections and switch boxes, one of these boxes being provided for each alternator installed (illustrated diagrammatically in Fig. 3). Each feeder has also a place in one or more of these boxes, the connections being arranged so that each machine can be run independently upon a group of feeders, the number of which will vary according to the size of the machine and feeders. Then in the event of a breakdown placing the entire switchgear out of commission, the supply can be rapidly reinstated by the independent running of all machines for the time being on the several groups of feeders which are respectively connected up solid. Arrangments are also made so that in the event of any single machine being out of commission, the feeders which were allocated to that machine may be coupled up to the other generators.

The supply pressure may be regulated on the engine stop valve and governor, and indicated by a group of incandescent lamps in series connected to the alternator terminals, or preferably by a pair of lamps connected in parallel between the earth terminal and a tapping from alternator armature; or else the lamps may be connected across the secondaries of permanent instrument transformers at places where these are fixed near to the generators. The detail construction of the proposed emergency boxes is shown in Fig. 4. The outer conductor, which also forms the metallic sheathing of the cables, can be connected solid to the box, and all parts carrying high potential will be surrounded by metal which is joined to the outer conductor, and so, for questions of safety, the boxes will be practically analogous to a section of cable. The cables for temporary use may be joined to the permanent mains or feeders at a point where they enter the station, or even at boxes outside the station. Junction boxes can be used with the cases insulated and joined to the outer conductor, and so devised that it is impossible to make accidental contact with the inner conductor without first taking the box to pieces. The cables being only for temporary use may be run at higher current density than usual; subject to the dielectric being of fire-resisting quality, two or three thousand amperes per square inch will not be excessive. In some cases, where complete isolation of the permanent cables is considered advisable, the above junction box may contain an additional plug or plug switch as shown at A (Fig. 3).

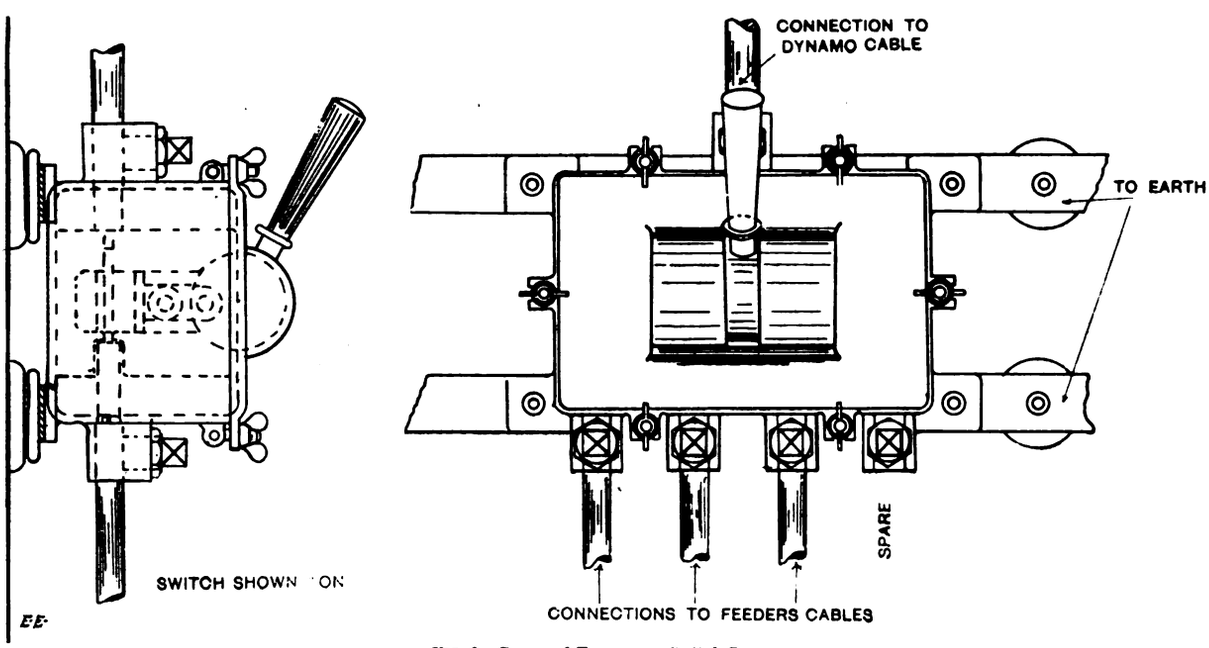


FIG. 4.—Proposed Emergency Switch Box.

The system roughly sketched above affords a ready means of isolating for cleaning and other purposes, besides forearming against the complete or partial disablement of the permanent switchgear or connections inside the electricity works. It can also be used for another important purpose. Assuming that fuses are dispensed with on the generator panels and a generator is showing signs of failure, rather than run the risk of shutting down the whole plant, the emergency switch of the doubtful generator can be closed and its main switch opened. It will be seen from Fig. 3 that the generator is now electrically joined to the 'bus bars through the feeder switches and fuse in parallel. Now the doubtful generator can be isolated automatically by the feeder fuses blowing, or by hand on the feeder switches, and then the chances are that the weak alternator, being

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isolated from the others, will be enabled to keep up the supply to its feeders until a change-over can be safely effected.

The use of this system may also be extended to cable charging, it being a simple matter to run up one of the machines on any circuit independent of the remainder. A doubtful main or feeder can also be run up gradually in this way. Or, again, on special occasions when the load is very heavy for the plant available, and at such times when it is most essential that the supply is maintained at any cost, the entire equipment can be connected up solid by closing all the emergency switch boxes, and as further precaution, any of the main switches on the permanent gear may be opened, thus protecting the generator from the others in case a fault develops on that machine. The useful features of these operations are that the circuits are not actually broken under load, the operations merely diverting the current into other paths, and so the formation of a ferocious arc is warded off. And, moreover, these objects can be achieved on existing equipments at a very moderate cost and without any alteration to the existing switchboards other than the removal of the fuses, which can be done whilst the several panels are alive.

### Summary.

To sum up, the obvious objects to be achieved on existing systems are: (1) prevention of accidents; (2) provision for limiting the extent of the damage resulting from an accident; (3) provision for speedily resuming the supply after an inevitable interruption has occurred. With the above in view, the following steps are suggested: (1) examine all fuses, especially those which have been in use for some time, and those containing springs and flexible conductors which are likely to alter in temper, flexibility, and so on; (2) remove fuses from machine panels, and (3) though it may not be imperative the replacement of them by current direction indicators; (4) see that all exposed cables, at least those on or near the switchboard, have a fire-resisting covering: (5) remove all highly inflammable material contiguous to the switchboard, such as floor coverings, etc.; (6) equip the station with some form of light which can be quickly lit up at a short notice for temporary use, and which shall be independent of the electrical plant or the local gas supply; (7) provide for the partial or total disablement of the main switchboard and connections thereto, by the installation of some simple form of supplementary gear and connections of a permanent nature, which shall always be in readiness for temporary use.

In conclusion, the event under discussion cannot be recorded without a mention of the energetic and skilful way in which Mr. H. Faraday Proctor and his assistant engineers (Messrs. H. H. Cousins and J. H. Bolam) coped with a very trying situation at the expense of their comfort during a period when they should have been partaking of Christmas festivities. It is not the intention to claim originality for the suggestions herein, for the principal features are merely the results of observation after the accident in question, and for the rest, of course, the supplementary equipment proposed is only an application of three known factors—parallel running, which is common, independent running, which is almost ancient history, and connecting up solid, which is not often resorted to, because switchgear accidents are fortunately rare. But it is hoped that they or better ideas evoked by this discussion may allay the natural anxiety on the part of those engineers who have to ask themselves what they are to do to prevent a recurrence of the Bristol calamity. The author also begs to recognise the information given by the Corporation officials at Bristol as to the occurrence inside the electricity works, and to appreciate the assistance rendered by the local daily newspapers in expressing the outside effects, and the opinions, as it were, of the man in the streets, although, to be literal, in this case one must include those in the works, shops, private houses, and others, who, after all, despite their sometime technical shortcomings, represent the commercial root upon which the electrical industry exists.

[We are desired by Mr. Clothier to explain that the analytical examination of the causes and effects of the Bristol fire, concluded herewith, was submitted by him to the Institution of Electrical Engineers, but although he was courteously invited to read it before a sectional meeting, difficulty was found in arranging an early date for that purpose. Consequently, owing to the exigency of the case, it was agreed instead to introduce the matter through the technical Press. Considering the importance of the subject, free discussion is invited, and Mr. Clothier expresses his willingness to answer any relevant questions that may arise as a direct issue of the paper. We shall be pleased to receive and publish any comments from our readers on this matter.—Ed. *E. E.*]

## SIMPLE MAGNETIC MEASUREMENTS.

At the conference of teachers in technical institutes held in London last week, Mr. W. Hibbert, of the Regent-street Polytechnic, lectured on new apparatus for the teaching of electricity and magnetism. Amongst the exhibits was the Hibbert magnetic balance, illustrated in Figs. 1 and 2.

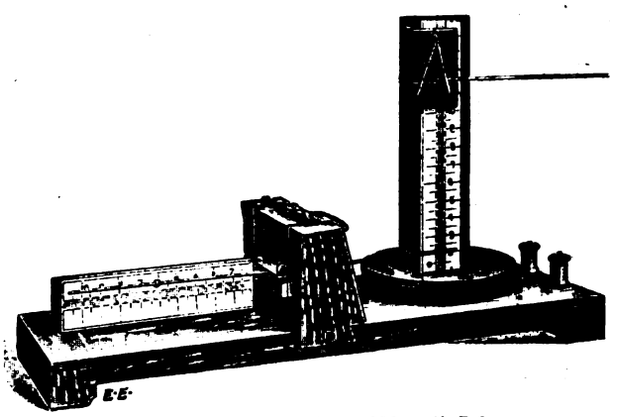


Fig. 1.—The Hibbert Experimental Magnetic Balance.

It consists of a long magnetic needle suspended by silk threads in the pattern shown, and in the better one by steel points working on agates, which is analogous to the beam of an ordinary balance. On the left-hand side of this beam is a weight, capable of being moved along its length, a horizontal scale being furnished to read the position this weight is distant from the point of suspension. A vertical scale is provided on the right-hand side for measuring the distance between the magnet under test and the suspended one. A coil of wire is also fixed on the base for experiments on the measurement of currents. The silk threads on the No. 1 model carry a small block into which the magnet is clamped by a brass spring lever, which also serves for the final balancing of the system.

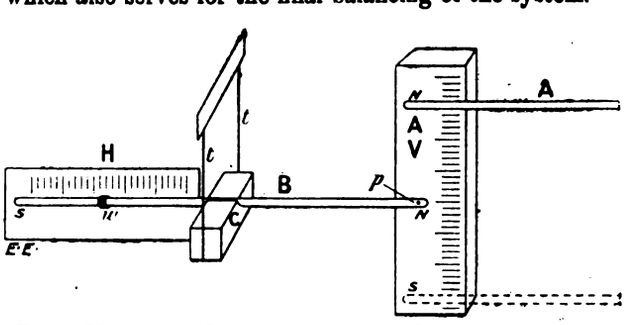


Fig. 2.—Diagrammatic Sketch of the Balance. B is a long magnetised needle acting as the beam of the balance. A is a magnet whose pole is repelling that of B. *w* is the sliding weight which balances the magnetic force. C is the cradle carrying B. *t t* are the supporting threads.

In the No. 2 model the magnet is clamped in a V-slot by a screw, so that various sized magnets can readily be used, and counterweights are provided for finally balancing. In this magnetic balance the magnetic force which is to be measured is made to act upon one pole of the suspended magnet or beam so as to depress it. The value of the force is obtained by sliding one of the two weights along the opposite end until the beam is restored to its equilibrium position, which is indicated on the vertical scale, and the distance of the weight from the point of suspension is indicated on the horizontal scale. The weights are adjusted

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in dynes (20 and 50), hence the value is read off directly in dynes. Any magnetic quantity can be measured. The value of a pole, the intensity of a field, the value of a current, the intensity of magnetisation, and the magnetic induction of a rod, are all measurable with an accuracy sufficiently exact for elementary purposes. We were shown one of these balances at the Southport meeting of the British Association, when Mr. Hibbert determined the absolute measure of a pole within five minutes, and without reference to the earth's field.

Amongst the other instruments explained at the above lecture were a cheap form of ballistic galvanometer and a modified form of electroscope.

## FORTHCOMING EVENTS.

SATURDAY, JAN. 16.

**Institution of Mechanical Engineers.**—At 8 p.m., ordinary meeting. Paper: "Sixth Report to the Alloys Research Committee on the Temperature of Steel," by the late Sir Wm. C. Roberts-Austen, K.C.B., etc., and Prof. Wm. Gowland.

**Royal Institution.**—At 9 p.m., discourse by the Right Hon. Lord Rayleigh on "Shadows."

MONDAY, JAN. 18.

**Institution of Electrical Engineers** (Newcastle Section).—Ordinary meeting. Paper: "The Distribution of Electricity in Shipyards and Engine Works," by Mr. J. A. Anderson.

TUESDAY, JAN. 19.

**Royal Statistical Society.**—At 5 p.m., ordinary meeting. Paper: "On the Smaller Urban Districts of England and Wales," by Mr. Thos. A. Welton.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper for further discussion: "The Electrical Reconstruction of the South London Tramways on the Conduit System," by Mr. Alexander Millar. Paper: "The Sanding-up of Tidal Harbours," by Mr. A. E. Carey

**Institution of Electrical Engineers** (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Coal Consumption in Central Stations," by Mr. A. S. Giles.

WEDNESDAY, JAN. 20.

**Institution of Electrical Engineers** (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "The Equipment of a Sub-Station with Rotary Converters," by Mr. O. J. Davis.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the works of Messrs. Elliott Bros., Lewisham.

**Royal Meteorological Society.**—At 7.45 p.m., annual general meeting.

**Society of Arts.**—At 8 p.m., ordinary meeting. "Organ Design," by Mr. Thos. Casson.

**Liverpool Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "Voltage Regulation in Alternating-Current Plants," by Mr. H. S. Meyer.

THURSDAY, JAN. 21.

**Institution of Electrical Engineers** (Leeds Section).—At 7.30 p.m. ordinary meeting. Paper: "Alternators in Parallel," by Mr. H. Bohle.

**Birmingham University Engineering Society.**—Ordinary meeting. Paper: "Union Theory and Practice," by Mr. C. A. Smith.

FRIDAY, JAN. 22.

**Royal Institution.**—At 9 p.m., discourse by Rev. Walter Sidgreaves on "Spectroscopic Studies of Astrophysical Problems at Stonyhurst College Observatory."

**Junior Institution of Engineers.**—At 8 p.m., ordinary meeting. Presidential address by Mr. J. Fletcher Moulton, K.C., M.P., F.R.S.

**Physical Society.**—At 5 p.m., Royal College of Science, ordinary meeting. Papers: "The Photographic Action of Radium Rays," by Mr. S. Skinner; "Astigmatic Aberration," by Mr. W. Bennett; "Some New Cases of Interference and Diffraction," by Prof. R. W. Wood; and Exhibition of Instruments by Messrs. Crompton and Co.

**Electro-Harmonic Society.**—At 8 p.m., smoking concert, Holborn Restaurant.

**North-East Coast Institution.**—General meeting at Newcastle.

SATURDAY, JAN. 23.

**Glasgow Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Some Observations on Mechanical Training," by Mr. Wm. D. Hamilton.

## TRADE NOTICES AND NOVELTIES.

### Litholite Handles, Bushes, etc.

We have received from Messrs. Hunt and Hess, 3, The Grove, Hackney, London, N.E., a copy of their third sheet of litholite handles, bushes, etc., giving a few of the latest patterns, together with a report of some tests to which a sample of litholite was recently subjected at the Westminster Electrical Testing Laboratories. These tests show the specific resistivity of the sample to have been 6 550,000 megohms per centimetre cube at a temperature of 58deg. F., and when subjected to a testing pressure of 1,500 volts. In the test for dielectric strength, the sample—8/16in. in diameter and 0 327in. thick—broke down with an alternating pressure of 36,000 volts, having previously withstood 35,000 volts for a period of five minutes.

### Double-Tariff Meter Apparatus.

We are indebted to the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., for particulars of a new double-tariff meter apparatus which they are introducing. This apparatus consists essentially of a contact clock, or contactor, as it is called—a well-made pendulum clock, designed to run for one month with one winding, and provided on the arbor, to which the hour hands are attached, with two cams controlling two contact springs, which according to the setting of the cams "make" and "break" the shunt (pressure) circuits of two watt-hour meters. One of these meters registers the units consumed during the peak period, for which the maximum price is charged, while the other records those consumed outside this period, charged at a minimum rate; or one meter, called the standard meter, can be arranged to record the total energy used, whilst the second, or rebate meter, registers the units used during any particular period. It should be mentioned that the meters may be of any make. The Electrical Company are also putting on the market a complete apparatus, consisting of a standard watt-hour meter, a rebate meter, and a contactor, mounted on a slate or wooden base, and already interconnected, which has the advantage of coming out considerably cheaper than two separate meters and a contactor. Owing to the method of construction adopted, all the contacts on the contactor are on the front of the clock and under observation, there being no contacts hidden behind the face. This is a valuable feature, inasmuch as periodical inspection can be made quite easily, and without in any way breaking seals or opening cases. The whole apparatus is put up in a dust-tight case, an ingenious arrangement making it possible to wind up and reset the apparatus without in any way disturbing the dust-tight sealing. Further particulars, with illustrations and prices of this apparatus, are contained in the firm's list No. 16 D.

### General Electric Specialities.

From the General Electric Company, Limited, Queen Victoria-street, London, E.C., we have a copy of their Progress Sheet for the current month, giving prices and particulars of their latest production. New pattern cut-out boards, distribution boards, plug adaptors, reflectors, and shop window fixtures are among the articles illustrated. Included is a description of a new form of Pressel switch for controlling circuits through a pendant cord. This switch is provided with two pushes—one at the bottom and one at the side. The action permits of it being manipulated with one hand, the bottom push switching on and the side push switching off. Particulars and illustrations are also given of "Limpet" plugs, which have been designed to supersede the old method of plugging a wall. A tool called a "jumper" is used for making holes to receive these plugs. Prices are quoted for the single and double braided insulated cables supplied by the firm for aerial runs.

### Elevating and Conveying Machinery.

A well-illustrated catalogue which we have received from Messrs. Gibbons Bros., Limited, Dibdale Works, Dudley, Worcester, deals with elevating and conveying machinery as supplied by them for a variety of purposes. We note that the firm make a speciality of stamped steel-ribbed seamless buckets, for which special advantages are claimed as regards strength and lightness.

### Electrical Plant.

From Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne, we have three recently-issued circulars containing illustrations of some of the work carried out by them. The illustrations in the first of these circulars—No. 52—are intended to show the various types of electrical machinery, especially engines and generators, manufactured by the firm for the equipment of central power stations. Instances are included of plant supplied for corporations, railway companies, tramways, engine works, and collieries, and arranged to suit varying local conditions. The second illustrates representative machines of various types driven by electric motors including every variety of crane, a varied assortment of shipyard tools, such as punches, shears, straightening machines, etc., also electric winches, capstans, and geared motors, besides several applications of electric motors to machinery in steel and iron works; while the third and last covers electrical mining machinery, such as pumps, haulage gears, locomotives, capstans, coal-cutters, switches, etc. Without exception the illustrations are of machinery in actual use. Incidentally they serve to convey an idea of the wide range of requirements covered by the firm's manufactures.

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## Publications.

THE HALF-TONE PROCESS. By Julius Verfasser. 5s. net. Iliffe and Son, Limited.—This is the third edition, which, owing to the great progress made during the last seven years, has been entirely rewritten and furnished with new and most excellent blocks. The making of process blocks is described in a practical manner, and nothing appears to have been omitted that is necessary to serve as a complete guide to the working of the half-tone and kindred processes. The last chapter, dealing with the three-colour half-tone process, is preceded by an exceedingly well-executed plate by André and Sleigh, Limited, Bushey, Herts. A long chapter is devoted to the details of the electric lighting installation required for the studio. The author, who hides himself under the translation "Verfasser," has no need to do so on account of any shortcomings of his offspring.

WILLING'S PRESS GUIDE.—The thirty-first annual issue is in no way different in form and arrangement from its many predecessors, and is just as handy and useful as they were.

THE LOCOMOTIVE SIMPLY EXPLAINED.—A first introduction of the study of the locomotive engine by Chas. W. Lake. 6d. net. Percival Marshall and Co. This book is well illustrated, and is just what it pretends to be.

## THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.

BY WM. BREW.

*Introductory.*—In bringing this subject before you at the request of our local secretary, I am at the outset met with difficulties. In the first place, the Dublin system of three-phase generation and distribution being unique in this country, I fear a great deal more will be expected from me than it will be possible in the scope of a short paper and the little time at my disposal to deal with. In the second place, I cannot help feeling that any reference to the Dublin system will be wholly incomplete unless the elaborate arrangements for the change over of the city electrical supply from single-phase to three-phase be fully described. When it is remembered that the change over of this supply from the 2,000-volt, 83-period, single-phase station at Fleet-street to the 5,000-volt, 50-period, three-phase station at the Pigeon House, situated over three miles distant, could be comfortably effected by the Corporation staff in something like 20 seconds, whereas the arrangements for accomplishing this result had been maturing for something over two years, it will be agreed, I think, that the plans shaped by the consulting engineer had been well conceived. Much as I should like to describe at length the numerous difficulties which were encountered and the manner in which they were overcome, I am unfortunately compelled in the present short paper to deal merely with a few electrical points which I can only hope may prove of interest to you.

*Generating Plant.*—The three-phase generator is essentially suitable for power transmission. Its prime cost and weight are usually about 30 per cent. less than a single-phase machine of the same output, whilst with star winding and earthed neutral point the pressure tending to break down the insulation of the machine is only 57 per cent. of that between the line wires transmitting the power. In three-phase transmission systems at extra high pressure the line voltage at which step-up transformers become advisable at the generating station is thus much higher (with resulting economy as regards plant and working losses) than would be the case if single-phase generators were used earthed at one pole in the usual manner.

It was urged at one time that generating direct at extra high pressure at the Pigeon House station, which is so near the sea, would be out of the question, and that step-up transformers would have to be employed. The 5,000-volt, three-phase alternators have, however, been working continuously now for seven months without giving any intimation that the sea air disagreed with them. Mesh-wound generators of large size have been found to give trouble from harmonics and idle currents circulating in their closed windings, which, in addition, are subject to the full line pressure. In the case of Dublin, we have four star-wound Oerlikon generators—two of 1,000 kw. and two of 500 kw. output—driven direct by marine-type compound engines with Corliss valve gear. The principal data of these machines are as follows:

| | 1,000-kw. sets. | 500-kw. sets. |
|---|---|---|
| Speed, revolutions per minute | 84 | 94 |
| Number of magnet poles | 72 | 64 |
| Number of coils per phase | 36 | 32 |
| Weight of flywheels and magnets, in tons | 44 | 33 |
| Diameter of wheels, in feet | 18·3 | 14·2 |

The arrangement of pole-pieces and stator slots in these sets is shown in Fig. 1, from which it will be seen that there are six slots per pair of poles. We should thus expect to find harmonics of the fifth and seventh order in evidence upon the fundamental wave of 50 ∼ per second under favourable circumstances. The electrical characteristics of these machines are illustrated by Figs. 2 and 3. The curves marked A give the relation between exciting current and terminal pressure. The curves

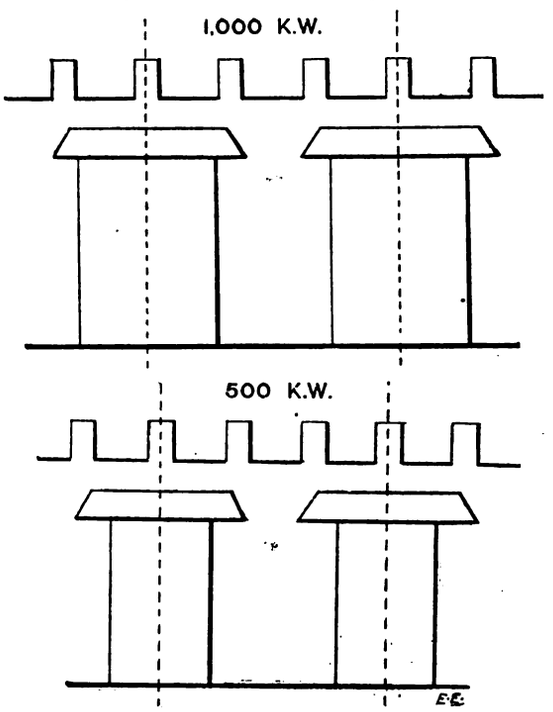


FIG. 1.

marked B give the short-circuit current of the machines for various values of the exciting current. The synchronous impedance of these machines, or the relation between terminal volts on open circuit to short-circuit current at the same speed and excitation, can be read at once from these curves; it will be seen that the short-circuit stator current with an excitation

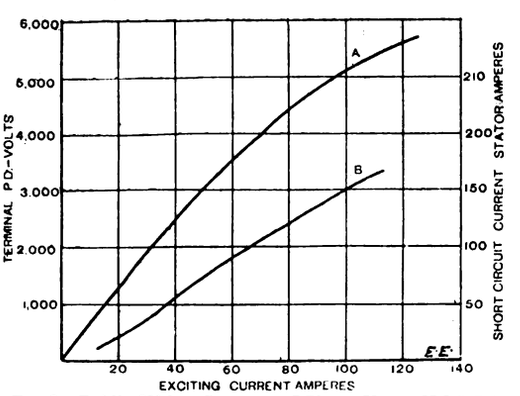


FIG. 2.—Dublin 500-kw. Generator, 3 Phase, 50 ∼, 93·5 R.P.M.

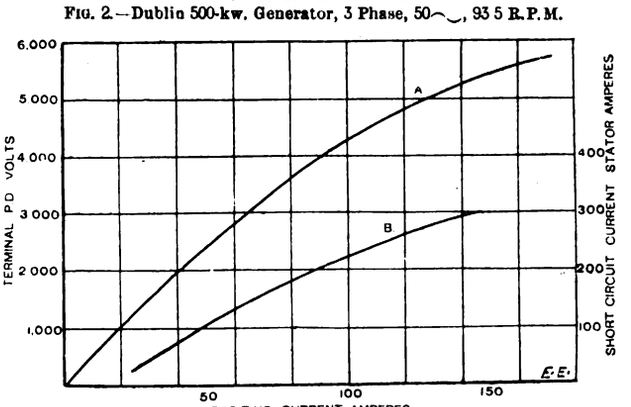


FIG. 3.—Dublin 1,000-kw. Generator, 3 Phase, 50 ∼, 84 R.P.M.

which would produce full terminal potential difference of 5,000 volts is in the case of the 500-kw. sets 148 amperes, and in the case of the 1,000-kw. sets 240 amperes. These quantities are of importance in connection with calculations on resonance,* and will be referred to later.

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, Jan. 14.

* An interesting paper on this subject by Mr. Field will be found in the *Journal* of the Institution of Electrical Engineers, vol. xxxii. part 4.

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It is well known that the excitation of an alternator necessary to maintain full terminal pressure, varies for the same armature current according to the power factor of the load. On open circuit or with small armature current the demagnetising effect of a lagging current or magnetising effect of a leading current upon the magnet poles will be inappreciable, and a rise

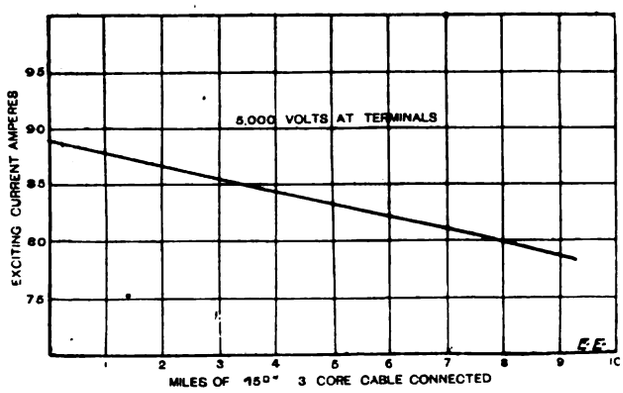


FIG. 4.—Dublin 500-kw. Generator, 94 R.P.M.

in pressure will either indicate resonance or the neutralising of the armature self-induction by the capacity of the cable. The curve (Fig. 4) is interesting in this respect, and shows how the exciting current necessary to maintain full terminal pressure of 5,000 volts on one of the small Dublin sets varies according to the length of three-core cable connected on open circuit. In this case the alternator is only supplying a charging current to the cable.

*(To be continued.)*

## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion held further sittings at the Westminster Palace Hotel, under the presidency of Sir David Barbour, on Thursday and Friday last week.

**Mr. James William Bradley, C.E.**, engineer and surveyor of Westminster, advocated better control over the operations of cable and pipe laying companies. The inconvenience caused by trenching pointed to the great desirability of pipe subways being provided.

**Mr. Stephen Sellon,** late chief engineer to the British Electric Traction Company, said his evidence was intended to show that the local authorities in the country had frequently abused the powers which Parliament had given to them. From 1880 to 1895 the tramway business in this country was at a standstill. The lines in operation were generally discreditable to the districts which they served, as well as to the owners. This condition had been very much improved since the introduction of electric traction. Between 1880 and 1895 there was a very large number of lines practically bankrupt on account of the very severe clauses introduced into their orders by the exercise of the local authorities' veto, by the large amount of money paid as the price of consent, and also by the operation of the forty-third section of the Tramways Act, 1870. Owing to this section many lines were considerably over-capitalised, and this was due to the difficulty of getting financiers to find money except at exorbitant rates when the terms of purchase and the length of tenure were in accordance with the Tramways Act. The forty-third section had been fatal to the interests of the public, its real effect having been to prevent a company already owning lines from making any considerable extensions of its undertaking or introducing modern improvements. For the same reasons electrification had been delayed on the lines worked by the London County Council in the south until the present year, and on those lines leased in the north there was no immediate prospect of electrification. The unreasonable opposition of various authorities to the overhead trolley system was responsible for the delay in the north, as the leasing company would have gladly agreed to conversion on that system, but could not face the extravagant capital charges which conduit work would burden it with. The London United Tramways Company, having a longer remainder of tenure and the good fortune to find more reasonable local authorities outside the county of London, by perseverance over several years broke down the opposition of the London County Council and other bodies to overhead electric traction, and obtained powers greatly to extend their lines. Two years ago they opened the first electrically-worked tramway with splendid results, which had already sensibly ameliorated living and travelling conditions in the western suburbs. Tramway development in London was ridiculously small and inadequate; it had been stopped for years past as far as private enterprise was concerned, and whilst the present obstacles were maintained private enterprise could do nothing to assist. Those obstacles might be summarised as (1) procedure in obtaining powers; (2) vetoes on construction matters; (3) tenure. Costliness was common to the three methods of obtaining tramway powers—provisional order, light railway order, and private Bill. The enormous waste of money in the promotion of undertakings went a long way to deter schemes of undoubted public utility being introduced, and, if introduced, the temptation to buy off opposition by accepting detrimental clauses was very great. A method of cheapening present procedure was essential to proper development. The British Electric Traction Company had spent over £120,000 in promotion expenditure since 1896, and that was exclusive of the cost of the Acts and orders of existing lines purchased. Procedure by provisional orders was unsatisfactory for several reasons, among them being that the making of the order by the Board of Trade was not final, since opposition could be raised to the order on the confirmation Bill, and further costly opposition might then have to be met before the committees of both Houses. Such procedure was inapplicable to any London schemes; even the London County Council found procedure by private Bill necessary. The greatest difficulty in the way of the last-named method was the operation of Standing Order 22, which obliged promoters to produce the consents of local and road authorities before a Bill was considered, exactly as Section 5 of the Tramways Act did in the provisional order procedure. Light railway procedure, whilst in some respects more economical and satisfactory than either of the others, had the drawbacks, among others, of slowness, apparently due to the small number of members and staff of the Commission; the recent tendency of the Commission to regard the preliminary consents of local and road authorities as essential, although the Light Railway Act did not follow the Tramways Act in that respect; and the final appeal to the Board of Trade, on confirmation, by opponents. Under any of the methods the business of tramway promotion was a lottery. The local authorities should not have a veto. In London especially it was necessary that none of the 29 road authorities should be permitted to block schemes vitally necessary for the health and comfort of the whole population; nor did he regard it as proper that the London County Council should have an absolute veto. The unexhausted value of the undertaking as a going concern was a suitable definition of the purchase price. He suggested that the initial term of tenure should be 50 years, and the recurring term 15 years, and that no purchase of a part of an undertaking involving severance should be permitted. He objected to a local authority working its own tramway. An addition of four or five members to the Light Railway Commission was required; and, so augmented, it should deal with tramways and light railways, and all questions of urban and suburban traffic which involved the disturbance of streets or concerned a local authority. Its decisions should be final; but they should have the power of referring any case involving great principles to Parliament, if they thought fit, the procedure in that case to be similar to that under the Scottish Private Bill Act. He did not think that such a tribunal should carry out any initiation, as the London traffic problem could only be dealt with by a commission empowered to obtain the most experienced evidence, assisted by a skilled staff. By such means a definite programme could be laid down for the guidance of promoters and of the tribunal, who should sanction schemes in accordance with that programme only. The only way of dealing with the street traffic in London was by tramways on the surface and in shallow subways. Along any street the electric car was of great assistance in relieving congestion, provided that the tramways were under unified management, and had sufficient extent to avoid termini in crowded places. A single working authority for the whole of the London tramways would afford the only satisfactory solution. Experience showed that municipal bodies were quite ready to sacrifice the requirements of districts outside their boundary lines, so as to maintain their system of splendid isolation. The fusion of the tramway interests by the Metropolitan Electric Tramways and the Middlesex and Hertford County Councils had gone a long way to solve the traffic problem in the northern suburban area. It had been arranged that the two County Councils should construct and own the tracks, and that all roads affected should be widened to a minimum width throughout of 50ft. The company would own the equipment, car-sheds, and rolling-stock, and work the whole system; it would pay annually to the County Councils 4½ and 4 per cent. respectively upon the capital cost of track construction, including the cost of land, bridge, and road widenings. The company would then be entitled to receive 4½ per cent. in the one case and 6 per cent. in the other upon its own capital expenditure, and after those charges had been met the remaining profit would be divided up in the ratio of 45 and 40 per cent. respectively to the County Councils and 55 and 60 per cent. to the company. On the economic aspect of tramways, Mr. Sellon put in figures showing their superior efficiency to omnibuses in the cost of transport, both using horse traction, as shown by the working of the London General Omnibus Company and the North Metropolitan Tramways Company. With regard to the wear of the surface, horsed omnibuses cost nearly five times as much electric tramcars for equal carrying capacity. He also put in figures to show the comparative uselessness of a subway line compared with a surface line for short distances. The witness also gave a sample estimate for an electrical tramway in the central part of London, Victoria to Charing Cross, distance 1·5 miles. The capital expenditure on construction would amount to £26,000; annual expenditure, £3,510; and working expenses, 5·25d. per car mile. If the receipts per car mile were only 1d. in excess of the working expenses, a daily car mileage of 2,553 would earn the amount needed, equal to 1,702 journeys daily. He proposed the laying of surface tramways in the City, and the area immediately surrounding, as follows: East to west—(No. 1) Victoria-embankment, Queen Victoria-street, Cornhill, and Leadenhall-street (east-going line), Lombard-street and Fenchurch-street (west-going line), joining existing tramways at Aldgate; (No. 2) Strand, Fleet-street, Ludgate-hill, St. Paul's-churchyard, Cannon-street, Eastcheap, Great Tower-street, Tower-hill, Upper East Smithfield, joining existing tramways at London Dock end of Leman-street; (No. 3) Oxford-street, Holborn, High Holborn, Holborn-viaduct, Newgate-street, Cheapside, Poultry, and from Mansion House to Aldgate on same lines as No. 1; (No. 4) leaving No. 3 at Holborn-circus, following Charterhouse-street, Smithfield Market, Long-lane, Barbican, Beech-street, Chiswell-street, Finsbury square, Sun-street, under Liverpool-street Station, Brushfield street, joining existing tramway in Commercial-street, Spitalfields; (No. 5) leaving No. 3 at Hart-street, Bloomsbury, joining existing tramway in Theobald's-road, and so completing the existing east and west route

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between Bloomsbury and Shoreditch. North to south routes—(No. 6) from existing tramway terminus at south end of Gray's-inn-road, Holborn, to Holborn-circus, St. Andrew-street, St Bride-s treet, New Bridge-street, Blackfriars Bridge, joining existing tramway in Blackfriars-road; (No. 7) from existing tramway terminus in Farringdon-road, Farringdon-road, Farringdon-street, joinining No. 6 at Ludgate-circus; (No. 8) from existing tramway terminus in Goswell-road, Aldersgate-street, St. Martin's-le-Grand, Gresham-street, King-street, Queen-street, Queen-street-place, Southwark Bridge, joining existing tramways in Southwark Bridge-road; (No. 9) from existing tramway terminus at Finsbury-square, Finsbury-pavement, Moorgate-street, Princes-street, King William-street, London Bridge, Borough High-street, joining existing tramways in Tooley-street and Great Dover-street; (No. 10) from existing tramway terminus in Shoreditch High-street, Shoreditch High-street, Norton Folgate, Bishopsgate-street Without, Bishopsgate-street Within, Gracechurch-street, joining No. 9 in King William-street; (No. 11) a line connecting Nos. 9 and 10, *viâ* Finsbury-circus, East street, Blomfield-street, and Liverpool-street. A line calculated to benefit the public by diverting traffic from the City was (No. 12) from existing tramway in the Borough, Southwark-street, Stamford-street, York-road, Lambeth, joining existing tramway in Westminster Bridge-road and crossing Westminster Bridge to the proposed Embankment line and one in Victoria-street.

The Commission adjourned.

## ST. MARYLEBONE LIGHTING.

The Electric Supply Committee last night submitted to the Borough Council the following report: "The committee have had under consideration the letter from the Metropolitan Electric Supply Company referred to them by the Council at their meeting on Thursday last. The terms of this letter are not always as clear as might be desired, but the committee think that they can be under no misapprehension in calling attention to the following broad principles involved in the offer: First, the Council are required to surrender entirely all the good-will of the company for the next 27 years. This was apparently valued by the arbitrator at about £1,000,000 sterling. In return for this concession the Council will gain only postponement of the payment of the capital sum under the award for 42 years. Secondly, the company is to be secured in an absolute monopoly of the whole supply during the lease. The consumers will practically be at the mercy of the company, as the only effectual check—that of possible competition—will be completely removed. Thirdly, the company stipulates that the bonds to be given them in payment shall have a priority over any subsequent debt of the Council. This will practically mean that the Council will be unable for 42 years to borrow any sum whatever even for the most necessary local improvements. At all events, any such fresh loans would be of the nature of a second mortgage, and could only be obtained under most onerous conditions. It will be observed that the company propose only to pay a rent sufficient to cover the interest on the proposed stock. The Council would, therefore, have either to leave the payment of the whole sum to their successors or to raise an annual sinking fund from the rates. The amount of the sinking fund necessary to redeem the capital in 42 years would, on the 2¾ per cent. tables, be £15,765. The committee understand that the sentence in the company's letter referring to capital to be provided in respect of the period from Jan. 1, 1902, until the commencement of the lease means that the Council should issue similar stock for this amount, which is estimated by the engineer at £124,250. On this point, however, the letter is not quite clear. The committee further notice that nothing is said in the letter with regard to costs, and they take this to mean that the expenditure already incurred by the Council—about £60,000—will have to be at once provided from the rates. The Council will be bound on the termination of the lease, whether on Dec. 31, 1931, or earlier in the event of competition being admitted, to purchase at an agreed price the whole of the fresh capital expended by the company on so much of their Willesden works as the company thinks fit to say is suitable and sufficient for the supply of Marylebone. It is estimated by Mr. Wright from the figures supplied by the company in the arbitration that by the end of 1931 the capital required for this purpose, after allowing for depreciation, will be not less than £800,000. The Borough Council will be called upon to find this additional sum for buildings and plant in the design and erection of which they have had little or no voice, and would further be indefinitely tied to a system of supply which, as they have often reported to the Council, is in the highest degree uneconomical and undesirable in the interests of the borough.—ERNEST R. DEDENHAM, Chairman."

## PERSONAL.

The Aston Electricity Committee have appointed Mr. R. B. Leach, of Green Mount, Queen's Park, Manchester, meter superintendent and mains inspector, at a salary of £91 per annum; Mr. F. W. Parsons, of the electric supply department, Northwich, switchboard attendant, at £52 per annum; and Mr. A. G. Turner, of the electric supply department, Watford, chief clerk, at £117 per annum.

The Bournemouth Council have increased the salary of the tramways traffic manager (Mr. C. Barber) from £250 to £300 per annum.

Mr. L. Gilmore, of the Crewe electricity works, having obtained an appointment as mains superintendent under the Bexhill Corporation, there is a vacancy in that department.

The salaries of the charge engineers of the Plymouth electricity works have been increased by £12 per annum.

The Newcastle City Council have agreed to raise the salary of Mr. A. E. Rossignol, tramway manager, from £750 to £850 a year, rising to £1,000.

With reference to the advertisement in our issue of Dec. 11, 1903, for an assistant electrical engineer to the Sanitary Commissioners, Gibraltar, we are informed that Mr. Harry A. Nott has been appointed to the post. Mr. Nott is resigning the position he now holds as mains superintendent to the Wimbledon Urban District Council.

# COMPANIES' MEETINGS AND REPORTS.

## LIVERPOOL OVERHEAD RAILWAY.

A special general meeting of the proprietors of this railway was held at Liverpool on Tuesday to consider the following resolution: "That £60,000, being the whole of the share capital authorised to be created by the Liverpool Overhead Railway Act, 1900, be and the same is hereby created in 6,000 preference shares of £10 each, bearing interest at the rate of £5 per cent. per annum, and that the directors be and they are hereby authorised to issue such preference shares in such amounts and manner at such times and on such terms as they may from time to time think fit. Also, that the holders of the preference shares hereby created shall be entitled to vote on the same scale of voting as the holders of ordinary shares."

**Sir William B. Forwood** presided, and, in moving the adoption of the resolution, said the object of the new share capital was to enable them to pay for the extension which they had undertaken to make at the north end of the line in connection with the Lancashire and Yorkshire Railway at Seaforth Station. They had to construct a new station at Seaforth Sands, and to erect a bridge across Primrose-road and an abutment on the far side of that road. The Lancashire and Yorkshire Railway on their part would continue the line from that point up to their station at Seaforth. The estimated cost of the bridge and the new station was £14,000. They had also to lay a new third rail from the Seaford Station right away to the Dingle at an expenditure of £12,000. Although they were laying this third rail in connection with the Lancashire and Yorkshire Railway, yet he thought it was an expenditure which they would have been wise to incur even if they had made no special arrangement with that company. It would become the positive electric rail, and they would use the present conductor as the negative rail, which they would bind in with the existing rails. By that means they hoped to obtain greatly increased efficiency, and they believed they would save in power a sum of money which would be quite equal to the interest on the investment. There would also be a probable increase of plant required at the generating station, which would cost £7,900, so that the total estimated cost of the extension would be £33,900. At the present time the Overhead Railway Company's traffic at Seaforth Sands Station amounted to 3,800 passengers per day. If they got at the Seaforth Station of the Lancashire and Yorkshire Railway Company 745 passengers per day, it would be sufficient to pay the working cost of the extension and interest on the new capital which they proposed to raise. In addition to the cost of the extension, they also wished to make good their capital account.

**Mr. G. H. Hornby** seconded the resolution, which was adopted.

## NEW COMPANIES REGISTERED.

**Electrograph, Limited (79,649).**—Capital, £10,000. Object: to acquire the interest of E. G. Craven in an invention known as "electrograph," etc. Registered office: Donington House, Norfolk-street, Strand, W.C.

**A.E.G. Electrical Company of South Africa, Limited (79,666).** Capital, £50,000. Object: to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for light, heat, motive power, etc., in South Africa or elsewhere.

**William Elder and Sons, Limited.**—Capital, £15,000. Object: to acquire and carry on the business of W. Elder as engineers, electrical engineers, producers and suppliers of electricity, etc. Registered office: 17, Main-street, Tweedmouth.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cuba.**—The Insular Railway Company will shortly require material for installing an electric tramway in Marianas.

**Warsaw.**—The Municipality are open to receive tenders for electric tramways. Particulars may be obtained on application.

**Rome.**—The Admiralty require tenders for electric lamps, estimated at £6,000, by Jan. 23. Foreign competitors are invited.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Peteringa (Croatia).**—The Municipality require tenders for installation and working of electric lighting; 6 to 8 arc and 160 to 180 incandescent lamps are required for the street-lighting.

**Punta Arenas (Straits of Magellan).**—Tenders are invited for the public electric lighting of this city. Particulars from Chilian Legation, 29, Queen's Gate-terrace, S.W. Tenders by June 28.

**Greenwich.**—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19

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**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Whitby.**—The Urban District Council invite tenders for the supply and delivery of feeding and distributing mains. Specifications, etc., from the Electrical Engineer. Tenders by 10 a.m. on 25th inst. See advertisement.

**Pontevedra (Spain).**—Tenders are invited for the construction of an electric tramway from Mondariz to Porrino. Particulars may be seen at this office, or obtained from the Public Works Department, Madrid. Tenders by Feb. 12.

**Camberwell.**—The Borough Council invite tenders for the maintenance of electric bells and private telephones. Forms of tender from Mr. W. Oxley, borough engineer, Town Hall, Camberwell, S.E. Tenders by 5.30 p.m. on Jan. 18.

**Cardiff.**—The Corporation invite tenders for the manufacture and supply of about 400 tons of steel tramway rails, fishplates, bolts, and nuts. Specifications etc., from Mr. W. Harpur, M.I.C.E., Town Hall, Cardiff. Tenders by Jan. 21.

**Avila.**—Tenders will be received by the Municipal Council (Ayuntamiento Constitucional) for installation and working of electric lighting until Jan. 22, 1904. The estimate for the total work is 1,739,539·42 pesetas, and specifications, etc., may be seen at this office.

**Wallasey.**—The Urban District Council invite tenders for the supply and delivery of about 7,100 yards concentric armoured cables, together with joint boxes and section boxes. Specifications from Mr. J. A. Crowther, Electric Supply Works, Sea View-road, Liscard. Tenders by Jan. 16.

**Christchurch (New Zealand).**—Tenders are invited for the complete installation of electrical tramways, other than buildings Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement in former issue.

**Manchester.**—The Tramways Committee invite tenders for the supply of electric tramcar bodies, electrical equipments of cars, and tramcar trucks. Specifications, etc., from Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 5 p.m. on 18th inst. See advertisement.

**Leyton.**—The Urban District Council invite tenders for the electrical wiring and fittings and hot-water heating apparatus required at Norlington-road Schools. Specification, etc., from Mr. William Jacques, A.R.I.B.A., 2, Fen-court, Fenchurch-street, E.C. Tenders by Feb. 2. See advertisement.

**Enniscorthy (Ireland).**—The District Lunatic Asylum Committee invite tenders for the following works: generator and motor-generator converter; motor and motor pumps; accumulators; main switchboards; overhead conductors and telephone; gearing and shafting; wiring asylum. Specifications, etc., at the Asylum Office. Tenders by Jan. 20.

**London, N.**—The Hornsey Borough Council invite tenders for (Section A) two dry-back or water-tube boilers; (B) smoke-consuming apparatus; (C) two 300-kw. steam dynamos, one 100-kw. steam dynamo, two motor-generators. Specifications, etc., may be obtained of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by 10.30 a.m. on Feb. 8. See advertisement in last issue.

**Brighton.**—The Town Council invite tenders for the supply and delivery of steel poles, trolley wire, bases and section pillars, cast-iron fittings, pole brackets, overhead line fittings, span and guard wire, switchgear, feeder, distributing, and telephone cables, bonds, etc. Specifications, etc., from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by 10 a.m. on 18th inst.

**Fire-Alarm Wiring.**—The May-Oatway Fire Appliances, Limited, invite tenders for wiring the following installations of May-Oatway compensated automatic fire alarms for direct connection with the fire brigades at Paisley and Dundee: Messrs. Brown and Polson, Cornflour Mills, Paisley, and Messrs. John Ireland and Sons, Shuttle Factory, Dundee. Particulars from Managing Director, 49, Queen-s treet, Glasgow. Tenders by 20th inst. See advertisement.

**Erith.**—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings, and steam feed pump; steam, exhaust, feed, air and circulating, blow-off, and drain pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam-engine of 500 kw. capacity; extensions to main switchboard and cable connections. Tenders by Jan. 18. See advertisement in former issue.

**London, S.W.**—The London County Council invite tenders for the roadwork and platelaying required for the reconstruction, for the electrical traction on the conduit system, of the existing double line of cable conduit tramways from a point in Brixton-road, near Handforth-road, to the present terminus at Streatham; and for the construction, for the same system of electrical traction, of a portion of the authorised tramways in High-street, Tooting, Merton-road, and Defoe-road. Specifications, etc., from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Feb. 2.

## RESULTS OF TENDERS.

**Salford.**—The tender of W. F. Smith and Co., Chapel-street, Salford, has been accepted for the supply of 1,000 yards of trolley wire, at 7·3672d. per lb.

**Worthing.**—The Hart Accumulator Company, Stratford, London, E., have received the contract for replacing the existing B.P.T. and L. battery in use at the electricity works with 264 standard lighting-type cells.

**Aberystwyth.**—The Town Council have accepted the tenders of the Aberystwyth and Chiswick Electric Lighting Company for lighting the promenade and certain streets under a new arrangement.

**Brighton.**—The Council have accepted the tender of Babcock and Wilcox, Limited, Oriel House, 30, Farringdon-street, London, E.C., at £28,140, for six water-tube boilers, a system of steam, exhaust, feed, blow-off, and suction pipes, and cast-iron storage tanks.

**Todmorden.**—The Corporation have accepted the following tenders: Yates and Thom, steel boilers; Green and Son, economiser; Electric Power Storage Company, Limited, storage battery; Worthington Pumping Company, condenser, pumps, and injectors; B. Thomas, switchboard; W. T. Glover and Co., cable work; Bruce Peebles and Co., steam dynamo and engine; Rodgers and Hay, Bradford, crane.

**Whitby.**—The following tenders have been received for fitting-up the Whitby Temperance Hall with electric light:

| | | | |
|---|---|---|---|
| E. Cox Walker, Darlington (accepted) | £70 | 0 | 0 |
| Walker and Hutton, Scarborough and Whitby | 99 | 10 | 0 |
| I. Stephenson, Whitby | 120 | 0 | 0 |
| J. O'Connor, Whitby | 114 | 5 | 2 |
| G. F. Wells, Scarborough | 79 | 10 | 0 |
| T. B. Watson and Son, Stockton-on-Tees | 93 | 16 | 4 |

**Wiring.**—The Scottish Office of the May-Oatway Fire Appliances, Limited, have accepted the following tenders for wiring installations of May-Oatway automatic fire alarms for direct connection with the fire brigade headquarters of Edinburgh and Glasgow: St. Cuthbert's Co-operative Society, Edinburgh, W. Douglas, Limited; Duncan Flockhart and Co., Edinburgh, J. Milne and Sons; Shaw, Walker, and Co., Glasgow, Allen, Arthur, and Ure. Also tenders for wiring the premises of the Northern Co-operative Company, Pratt and Keith; Eadley Bros. and Co., J. Kilpatrick and Sons.

# BUSINESS NOTES.

## TRACTION.

**Long Eaton.**—A sub-committee has been appointed to consider the question of tramways.

**Ripon.**—The question of a light railway from Ripon to Kirby Malzeard has been reopened.

**Dundee.**—The Town Council have agreed to support the scheme for a tramway to Broughty Ferry.

**West Fife.**—The Fife Electric Power Company have in contemplation a tramway scheme for West Fife.

**Swindon.**—The work of contructing the proposed tramways will be commenced in about two or three weeks' time.

**Erith.**—The District Council are taking up two loans of £5,000 each in connection with the tramways undertaking.

**Liverpool-Southport Railway.**—A successful trial trip has been made on the above line with one of the new electric trains.

**Manchester.**—A town's meeting has approved the Tramways Bill which the Corporation are promoting in the ensuing session.

**Wallasey.**—A public meeting convened by the District Council has recorded a hostile vote in regard to the proposed tramways scheme.

**Audenshaw.**—The Local Government Board have extended the time for the completion of Audenshaw-road tramway till Dec. 9, 1904.

**Barton Regis.**—The Rural District Council have approved the proposed tram extension from Westbury-on-Trym to Henbury, and from Horfield to Filton.

**Down (Ireland).**—The County Council have sanctioned the proposal of a syndicate to apply for powers to construct a tramway between Belfast and Holywood.

**Burnley.**—The Manchester-road and Townsley tramway routes are ready for inspection by the Board of Trade, and will be opened for public traffic very soon.

**Leith.**—The Board of Trade have given their consent to the sale of the tramways in Leith belonging to the Edinburgh Street Tramways Company to the Corporation of Leith.

**Soothill Nether.**—A meeting of the ratepayers has assented to the Council's proposal to apply to Parliament for a Bill empowering them to construct tramways within the township.

**Salford.**—A sub-committee of the Tramways Committee has been appointed to confer with the Electricity Committee with regard to the charge for electrical energy for the tramways.

**Scarborough.**—The work of constructing the tramways has now been in progress two months, and 1½ miles of route have been laid, there still remaining 2½ miles to be dealt with.

**Derby.**—An arbitration has been opened in the town in regard to the compulsory purchase of property by the Town Council in connection with their tramway electrification scheme.

**Tynemouth.**—A committee of the Rural District Council has been appointed to consult with the Newcastle Tramways Committee with reference to the proposed extension of the tramways to Benton.

**Sunbury.**—The District Council intend to oppose the application of the London United Tramways Company for an extension of seven years for the construction of the proposed tramways in this district.

**Royton.**—At the last meeting of the District Council it was announced that an agreement had been arrived at in regard to the tramways which it is proposed to construct in Royton and Crompton.

**Wigan.**—The Town Council have decided to grant an honorarium of £100 to the borough engineer and £50 to the members of his staff for

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extra services in connection with the construction of the tramways in the borough.

**Stoke-on-Trent.**—The Town Council are calling upon the tramways company to contribute half the cost of widening High-street, on which a sum of £5,500 had to be spent before the double line of tramways could be laid.

**The Cardiff Outrage.**—The man Fred Parks, who was accused of wilfully disconnecting the traction cables behind the switchboard at the power station on Christmas Eve, has been sentenced to nine months' imprisonment.

**South Bank.**—At the monthly meeting of the District Council, it was agreed to consent to the scheme of the Imperial Tramways Company for the extension of their lines from Middlesbrough through South Bank to Grangetown.

**Portsmouth.**—With regard to the assessment of the tramways undertaking, the committee have decided to enter an appeal. In a few weeks' time it is expected the construction of the Gosport-Fareham tramway will be commenced.

**Worcester.**—The tramways company propose to seek an extension of 12 months from Feb. 3 next for the construction of the proposed tramways, but the Town Council have agreed only to consent to a three months' extension of time.

**Branksome.**—The Urban District Council have approved a suggestion to proceed at once to arbitration to decide the price to be paid by the Bournemouth Town Council for the Poole and District Electric Company's undertaking.

**Middlesbrough.**—The Town Council have decided to oppose the scheme of the tramways company for extending their lines from Middlesbrough to Grangetown, and constructing a road bridge at the present terminus in North Ormesby-road.

**Lytham.**—The tramway company propose to double the lines along Church-road to Market-square. This is the only section of single line on the entire route, and, for the convenience of the public, it is hoped that the Council will sanction the scheme.

**Cardiff.**—A proposal has been made to the committee to extend the Cowbridge-road section of the tramways. The cost of other proposed extensions is estimated at £19,200. Tenders have been received for cars for the Penarth-road route.

**Musselburgh.**—The Town Council on Tuesday signed the agreement with the promoters of the local electric lighting and tramway schemes, under which the promoters bind themselves to complete the installation of the tramways within 12 months from date.

**Newport (Mon.).**—The Town Council have approved the scheme prepared by Mr. H. C. Bishop, the borough electrical engineer, for a single tramway to Stow Hill, the estimated cost being £17,300. The Town Council have decided on a three months' trial of penny fares on all routes.

**Watford.**—The Board of Trade have confirmed an order made by the Light Railway Commissioners, and entitled the Watford and District Light Railways Order, 1903, authorising the construction of light railways in the county of Hertford, in the parish of Watford Urban, and the urban district of Watford.

**Dumbarton.**—The County Council have discussed the various provisional orders which are being promoted for electric tramways in the county, and it has been unanimously agreed to remit to the Road Board to consider the advisability of the County Council themselves applying for a tramways provisional order.

**Preston.**—A Bill has been deposited for next session by which it is proposed to incorporate a new company, with powers to construct a tramway from Preston to Blackburn, 6½ miles in length. The line is to be a single line for just over five miles, and to be worked by electricity. The capital of the proposed company is to be £200,000.

**Devonport.**—It is proposed that the Town Council shall themselves carry out the construction of Harbour View and Camel's Head Embankment lines by direct labour. The town clerk has been instructed to prepare and lodge objections to the application of the Plymouth Corporation for a light railway order to construct a light railway to Crownhill.

**Islington.**—The Borough Council at their last meeting decided to ask the London County Council whether they would be prepared to take the electricity required for running the tramcars under their control from the metropolitan borough councils who are also electric lighting undertakers, provided the latter are prepared to supply such electricity under suitable conditions and at reasonable rates.

**Bournemouth.**—The Town Council have authorised a committee to take all necessary steps for acquiring the undertaking of the Poole and District Electric Traction Company. The ratepayers at a public meeting have unanimously consented to the Town Council proceeding with their parliamentary Bill to obtain powers to construct an electric tramway to Southbourne, the estimated cost being about £50,000.

**Johnstone.**—Mr. Murphy, in answer to enquiries by the Town Council, has sent a letter stating that the section of electric tramways from Church-street to the end of the burgh is a separate contract from the work completed, and that the section will be proceeded with. Mr. Murphy makes the further statement that he intends to seek powers to connect Kilbarchan with the Johnstone and Paisley tramway system.

**Middlesex.**—The Board of Trade have confirmed an order made by the Light Railway Commissioners, and entitled the County of Middlesex Light Railways Order, 1903, authorising the construction of light railways in the parishes of Acton, Edgware, Edmonton, Enfield, Finchley, Friern Barnet, Hendon, Hornsey, Little Stanmore, Southgate, Tottenham, Wembley, Willesden, and Wood Green, in the county of Middlesex.

**Wakefield.**—A start was made on Monday with the laying of the tramway lines from Newton towards Wakefield. The route will be along the Leeds-road, and will be pushed as far and as speedily as the new sewer will permit. The next portion to be undertaken will probably be that from Kirkgate towards Sandal. It is then proposed to start somewhere near the Wakefield and Barnsley Bank in Westgate, and work towards Horbury.

**Pontefract.**—The District Council on Saturday gave a general consent to the proposals of the West Riding Tramways Company, but they decided to require the promoters to give a written promise to vary the position of any of the rails in the Council's district if requested, and to indemnify the Council against any expense they might be put to in any way whatever, including legal expenses and the cost of obtaining expert advice which might be necessary.

**Walsall.**—The financial result of the first week's running of the trams under municipal control is said to have been eminently satisfactory. Over £500 was taken in fares, and it is stated that in some of the districts newly opened up a difficulty was found in coping with the heavy traffic. The Tramways Committee, in a report issued on Saturday, expresses the belief that the new service will prove a boon to the public, and tend to the prosperity of the town and district.

**Ashton.**—The Town Council have had the tramways question under consideration, and have decided that the draft agreement with Manchester, as amended, should be submitted to the Manchester Corporation for approval and discussion between representatives of the two authorities if necessary. Mr. Alfred Dickinson, consulting engineer, of Birmingham, has been retained to act for the Corporation in the forthcoming arbitration with the Manchester Carriage and Tramways Company.

**Shoeburyness.**—At a meeting of the Council on Tuesday it was stated that owing to difficulties with the landowners the proposed extension of electric tramways from Southend to the town was at a standstill. A resolution was carried unanimously that the Southend Corporation be written to asking if it were their intention to proceed with the work. If not, the Shoeburyness Council should take into consideration the provision of motor trains to run between Southend and the garrison town.

**Lowestoft.**—The general manager reports the total receipts from July 21, 1903, to Jan. 2, 1904, amounted to £5,644. 9s. 1d.; passengers carried, 1,242,829; total mileage run, 117,840 miles; average receipts per day, £33. 16s. 2d; average receipts per car mile, 11·49d. For the week ending Jan. 2 the receipts were £154. 11s. 4d., and on Sunday, Jan. 3, the receipts were £17 4s. 11d. The Park and Denman-road route is now completed, and the Town Council are pressing the Board of Trade to inspect the line.

**Keynsham.** The proposal of the Bristol Tramways Company to extend their line from Brislington to Keynsham was considered by the Rural District Council at a special meeting this week. Eventually it was resolved, "That this Council assents to the principle of the Bill, provided that the tramways company consent to wood blocks between the tramlines, without prejudice, nevertheless, to their right to oppose the same for the purpose of securing terms and modifications and otherwise as the Council may deem desirable in the public interest."

**Wolverhampton.**—At the monthly meeting of the Town Council on Monday it was proposed that application be made to the Board of Trade for their sanction to a loan of £15,221 for the reconstruction of the Dudley-road tramway from the Fighting Cocks to Temple-street. Also for sanction to a loan of £1,293 for the construction of the Snow-hill tramway from the Villiers statue to the corner of Bilston-street; and, further, for authority to construct a single line of track upon that portion of the Willenhall-road between Coventry-street and Stowheath-lane.

**Wrexham.**—The prolonged dispute between the Rhos and Wrexham Councils and the British Electric Traction Company with regard to the non-completion of the tramway line from Johnstown to Rhos, in accordance with statutory powers, reached its climax at a conference held in Rhos Public Hall on Tuesday. The chairman of the company stated that should there be any further opposition the company would abandon the line altogether, and would not ask the Board of Trade to inspect the portion already constructed. The result is awaited with keen interest.

**Swansea.**—The Sub-Tramways Committee have further discussed the proposal of the Corporation to obtain the ruling of the courts in the matter of the acquisition of the Swansea Tramways Act. Certain sections of the tramways can by law be acquired in 1906, and the necessary notices have been given the company, but the contention is that the Corporation are bound to re-lease to the tramways company. This would at once destroy the possibility of the Corporation eventually acquiring the whole system. The sub-committee decided to take the case into the courts.

**Coventry.**—At this week's meeting of the General Works Committee a letter was read from the Coventry and District Electric Tramways Company, accompanied by plans showing the proposals of the company for the laying of tramways to Earlsdon and Chapel Fields in accordance with their Act of 1903. It asked for the Corporation's approval, and also for their consent to the reconstruction of the Hales-street junction and the construction of tramways along High-street and Earl-street. The committee referred the communication and plans to the Streets Improvement Sub-Committee.

**Stockport.**—On Monday a special meeting of the Tramways Committee was held to consider the steps to be taken in connection with the position of two officials of the department, the manager of the tramways (Mr. H. McCormick) and the chief clerk (Mr. J. Sykes) who, it was alleged, had been guilty of a dereliction of duty. At a previous meeting the committee received a report from the Mayor, who is chairman of the committee, and the two officials in question were interrogated as to their conduct. It was now decided that Messrs McCormick and Sykes be requested to send in their resignations and that the positions be advertised as vacant.

**Sheffield.**—The Corporation are taking steps to limit their liability in the event of passengers being injured while travelling upon the

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tramways through any accident which may occur. The following is the text of the proposed regulation: "Passengers are being carried at less than the maximum authorised charges, and every passenger is notified that, in consideration thereof, a passenger is only carried on the terms that the maximum amount recoverable from the Corporation, on account of any injury or damages suffered by a passenger, and for which the Corporation is legally liable, is £25. Except as above, every passenger travels at his own risk. Passengers can only travel subject to being bound to observe the by-laws for the time being."

**Bath.**—As stated in our last issue, the tramway system was opened to the public on Saturday, the 2nd inst. When the full service is running there will be 40 cars at work. The gradients at Bath are excessive, the maximum being 1 in 12 As will be readily understood, the question of efficient braking is of primary importance in tramway work. The Bath cars are fitted with the Westinghouse magnetic brake, one of the features of which is that it will automatically bring the car to rest on the severest gradient even should the trolley leave the wire. This, as well as other points, were repeatedly demonstrated on Saturday, the trolleys being purposely removed from the line when the cars were on a gradient of 1 in 12, and the cars were brought to a stop in a few yards.

**West London.**—On Wednesday two accidents occurred on the London United Tramway Company's system in West London. The first happened at Acton, where two cars collided, both being thrown off the rails. Fortunately no one was injured, although both cars contained a number of passengers. The Uxbridge-road line was blocked for about an hour, when the cars were restored to the track, and the through running resumed. The other mishap took place at Brentford, where one of the trolley wires snapped and falling came in contact with the rails. Two horses attached to a coal wagon unfortunately became entangled in the wire and were killed. The driver of the wagon escaped. A breakdown gang from the depôt was soon on the spot, and speedily repaired the wires.

**Buenos Ayres.**—It is stated that the German Transmarine Electricity Company, which recently absorbed the electrical department of the Primitiva Gas and Electric Lighting Company, after having previously purchased the works of the French electric lighting company in Buenos Ayres, has now concluded an agreement with the Anglo-Argentine Tramways Company for the supply of electric power to the latter for the whole period of its concession. As soon as the City of Buenos Ayres Tramways Company has obtained the necessary authority to convert its lines to electric traction and the work has been completed, the German company will also supply power for the working of these tramways. The two tramway companies are said to have established a working arrangement.

**North Riding.**—The Imperial Tramways Company, Limited, have deposited a Bill for next session, under which they seek power to construct just over six miles of tramways under the title of the Middlesbrough, Stockton-on-Tees, and Thornaby Tramways. The proposed lines will form junctions with the company's existing system in North Ormesby-road, Middlesbrough, and in the Middlesbrough-road and the Ayresome-road, in the borough of Thornaby-on-Tees. The total cost of constructing these lines is estimated at £124,075, which includes the cost of two new roads and the construction of a bridge over the Guisborough branch of the North-Eastern Railway. The tramways, which will be worked by electricity, will, with the exception of one furlong, be constructed as double lines.

**Additional Traffic Returns.**—Anglo-Argentine, £1,878 increase; Barcelona Ensanche y Gracia, £109 increase; Barcelona, £30 increase; Brisbane, £101 increase (month of December, £11,915, increase £371), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £33 increase (month of December, £15,057, increase £1,099); Calcutta, £590 increase; Cape Town (month of December), receipts £18,088, expenditure £8 235; Isle of Thanet Electric, £26 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of December), receipts £47,600, expenses £27,400; Perth Electric, £226 increase; Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**Scotch Private Bills.**—All the provisional orders under the Private Legislation Procedure (Scotland) Act, 1899, have been deposited at the Private Bill Office, and will come before the examiner on Standing Orders in due course. The Lothians Electric Power Company are seeking fresh capital powers to the extent of £600,000, and the Dundee, Broughty Ferry, and District Tramway Company £73,500. Borrowing powers are sought as follows: Glasgow Corporation, £250,000; Kirkcaldy Corporation (tramways), £65 000; Leith Corporation (tramways), £225,000. The Paisley District Tramway Company are asking for an extension of time for carrying out their authorised undertaking, and seek to issue half their authorised capital (£300,000) as preference capital, bearing interest not exceeding 5 per cent.

**Leeds.**—The net car receipts for the 12 months ended Dec. 31 show a gain of £19,735 over the previous year. The total amounted to £275,229. By the Bill which is being promoted in the coming session of Parliament the Corporation seek powers to extend the tramways from Kirkstall Abbey to Horsforth, while at the present time the Tramways Committee are making extensions from Elland-road to Domestic-street and Churwell, and from Whitehall-road to the boundary of Drighlington. The ballot of the tramway men to decide either for or against a trial of the "split turns" system closed on Tuesday, pretty nearly all the employés turning up to vote, and although the result has not yet been made public, it is thought that the men have decided, by a very substantial vote, against the proposed trial

**Aston.**—It is proposed to borrow £10,500 for alterations to the Witton-lane depôt to provide accommodation for 44 cars. A meeting of the Town Council was held on Wednesday, when a letter from the Board of Trade was read consenting to the laying of double lines in Park-road, Victoria-road, and Witton-lane, subject to the widening of those thoroughfares. A discussion took place on the refusal of the Birmingham Tramways Committee to sanction the continuance for two months of the steam traffic over Aston-road and Corporation-street into the Old-square, pending the electrification of the lines between the city boundary and Aston Cross. The committee are of opinion that it is desirable that the line between the city boundary and Aston Cross should be reconstructed and electrically equipped forthwith, and that the contractor should be instructed to proceed with this part of the work as quickly as possible. The committee is also of opinion that the traffic from the city boundary to Aston Cross should be entirely suspended during such reconstruction, but that until the commencement of the work the ordinary steam traffic be continued to Phillip's-street. To this proposal, however, the lessee company objected on the ground that serious inconvenience would be caused to the public and permanent injury to the traffic receipts. The committee had therefore referred the question to a sub-committee to further discuss and determine with the company.

**Lambeth.**—The question of contributing towards the cost of street improvements in connection with the London County Council's scheme for acquiring the London Southern Tramways, and converting them to electrical working, was discussed at a special meeting of the Borough Council last week. There was a motion on the agenda to rescind a resolution by the Council on Dec. 10 with reference to a contribution of £20,000 towards the cost of street widenings, and asking the Highways Committee to bring up a recommendation for a contribution for one-third, not exceeding £40,450, of the total expenditure to be incurred by the London County Council. Several petitions were handed in, and the Council received a deputation who urged them to support the proposal. Mr. Hubbard, in moving the resolution, said the County Council expected a profit out of the tramways, and it was in no way a speculative matter. They must remember that in one end of Lambeth they had 10,000 people who lived in one-roomed tenements, and the borough hitherto had always been generously treated by the County Council. An amendment was moved that the County Council, as the tramways authority, should be asked to at once exercise their powers and buy the tramways in question with the object of bringing them under one control. The mover said that the County Council had departed in the case of Lambeth from a policy of taking over the tramway system when they had the opportunity. The amendment was carried by 31 to 29.

**Finsbury.**—The Board of Trade have transmitted a communication, which has been considered by the Works Committee of the Borough Council, applying for that Board's consent to the adoption on the existing tramways in City-road (from Finsbury-square to Old-street), Clerkenwell-road, Finsbury-pavement, and Old-street of the underground conduit system of electrical traction, already approved by the Board in respect of certain County Council tramways in South London, and asking for the observations of this Council thereon. The borough surveyor has now reported that the system proposed to be adopted in regard to the thoroughfares referred to corresponds in all respects with that already considered by the Council in connection with the authorised tramways in Rosebery-avenue, St. John-street, and St. John-street-road. The following was sent: "That the Finsbury Council advocate the adoption of, and strict adherence to, the proposal to place insulator boxes inside the rails, but where the placing of such boxes outside the rails is absolutely unavoidable, the covers be filled with the same material as the paving outside the rails, and that all points should, as far as possible, be operated from the levers placed on refuges rather than in the carriageway. That, having regard to the fact that the portion of the carriageway of Old-street, maintainable by the Council, is already paved with wood, the Council urge that consideration be given to the question of the practicability of wood paving being used there between the rails in place of stone. Except so far as affected by the foregoing representations, to generally approve the proposals of the London County Council in this matter, and to inform the Board of Trade and the London County Council accordingly."

**St. Marylebone.**—At the last meeting of the Borough Council, the Legal and Parliamentary Committee reported having considered a communication from the London County Council referring to previous correspondence on the subject of the construction of a double line of tramways from the present terminus in Hampstead across Euston-road and along Tottenham Court-road to a point in that street near its junction with Oxford-street, and stating that, in view of the undoubted benefits which a tramway along this route would confer upon the travelling public, the County Council had decided to seek powers in the next session of Parliament for the construction of a tramway with an electrical conduit system of traction, and asking whether the St Marylebone Council would be prepared to give the consent required. The committee also reported the receipt of a letter from the town clerk of Holborn, stating that the Holborn Borough Council and its predecessors—the Board of Works—had absolutely declined to consent to the introduction of a Bill for the construction of a tramway along Tottenham Court-road, believing that the thoroughfare was not suitable for an above ground tramway, a view which they had every reason to believe was shared by the whole of the frontagers. As the small portion of Tottenham Court-road in St. Marylebone was, by arrangement, under the charge of the Holborn Borough Council, he suggested that the St. Marylebone Council would perhaps see their way, under the circumstances, not to prejudice the matter by complying with the London County Council's request for consent, and the committee recommended the Council to inform the Holborn Borough Council that they agreed with them in their decision as to the proposed tramway, and also advised the Council to inform the London County Council that the St. Marylebone Borough Council adhered to their previous resolution not to give their consent to the proposed tramway.

**Greenock.**—Mr. J. A. Robertson, burgh electrical engineer, has reported to the Corporation on the financial effect of the recent arbitra-

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tion award by the Board of Trade as between the Corporation and the tramway company. The appeal for arbitration was made by the company, and the questions submitted were: (1) to decide from which date the company were bound to fulfil their obligations under the lease to take electrical energy from the Corporation, at the rate of 500,000 units per annum; (2) the price to be paid for all energy in excess of the minimum amount of 500,000 units per annum; (3) the rent to be paid by the company to the Corporation for the use of the cableways. The arbiter's decisions were (1) that Aug. 1, 1901, is the date from which the first year commenced in which the company were bound to take 500,000 units of electricity; (2) that $\frac{7}{10}$d. is the price to be paid for all energy in excess of the minimum guaranteed amount of 500,000 units per annum; (3) that £125 per annum is the sum to be paid for the rent of the cableways. The Corporation had claimed that May 15, 1901, was the date instead of Aug. 1; that it was inexpedient to make any reduction in the price to be paid for excess energy; and that the rent of cableways should be £150. Mr. Robertson's conclusion is that the loss to the Corporation through supplying the company during the first year is £474. 10s., and during the second year £559, or a total loss of £1,033. After the most careful consideration of all the circumstances, Mr. Robertson thinks that, even when due allowance is made for extension of business and decreased works' costs, it will be quite impossible to show any profit as a result of supplying the tramway company with energy during the next two years, and he is of opinion that when the time comes for revision in 1905 every possible effort should be made to reverse a decision which has undoubtedly inflicted a serious injustice on the Corporation.

**North-Eastern Railway.**—In the course of the next fortnight the North-Eastern Railway will have settled the final details of the service of electric trains which are to be run on the Newcastle suburban lines recently electrified. The whole of the installation is not yet completed, but the Board are considering the advisability of beginning a service of trains for the completed portions. The sections of lines which are being supplied with electric traction are the line from Newcastle to Tynemouth, and round through Monkseaton, Benton, and Gosforth back to the Newcastle Central Station, the main line from Manors to Benton, and the riverside loop from Byker to Percy Main, as well as the railway now in course of construction from Gorforth to Ponteland. The aggregate length is about 40 miles, but as the line from the Central Station to Heaton South Junction consists of four tracks, and the greater part of the remainder of two tracks, the approximate length is altogether 80 miles. On the main lines the local traffic only will be electric. It will be possible to run the ordinary main-line passenger service in alternation with the local electric trains. The energy is being obtained from the supply station of the Newcastle Electric Supply Company at Wallsend, and the new station which is being erected at Carville. The train will attain an average speed of 22 miles an hour, it being intended that they shall complete the journey from Newcastle to Tynemouth in 23 minutes, including stops, while quick trains, running through, will reduce the time to 15 minutes. Nearly the whole of the open corridor carriages required are now completed. Some preliminary trials to ascertain adjustments for the adaptation of autocars to the regular train service took place over a section of the main line going north at York this week. The new car was run to Skelton Bridge and back with satisfactory results. It is proposed shortly to conduct a further series of trials on the light railway between Selby and the village of Cawood. The new autocar is between 50ft. and 60ft. long, and is fitted at one end with an engine chamber accommodating a Wolsey petrol engine. A dynamo generates electricity and supplies energy to a four-wheel bogie underneath the engine compartment. Seating accommodation is provided for 52 passengers. The car is lighted and heated by electricity. A speed of 30 miles an hour can be reached.

## LIGHTING AND GENERAL.

**Armagh.**—The County Council will not oppose the Ulster electric power scheme.

**Aston.**—Cables are being extended at a cost of £980, £67, £98, and £1,450 respectively.

**Taunton.**—The connections during the past quarter were equivalent to 977 8-c.p. lamps.

**Cupar.**—We learn that steps are being taken for an improved telephone service at Cupar.

**Globe Telegraph and Trust Co.**—A quarterly interim dividend of 2s. per share is announced by the directors.

**Grantham.**—The Bill of the Lincolnshire and Yorkshire Electric Power Company is before a committee of the Council.

**Consett.**—The Cleveland and Durham County Electric Power Company intend to lay electric cables in the urban district.

**Birkdale.**—Permission has been granted to the Birkdale District Electric Supply Company to adopt a flat rate of 5d. per unit.

**Whitby.**—The Urban District Council have received sanction to a loan of £2,000 for electric lighting purposes without an enquiry.

**Bray.**—With regard to the building of transformer pits, we understand that the engineer is about to get quotations from local builders.

**East Ham.**—An enquiry has been held into the Urban District Council's application for sanction to borrow £15,000 for electric supply purposes.

**Barnet.**—The Board of Trade have agreed to defer consideration of the revoking of the Council's electric lighting order for a further period of 12 months.

**Rhymney.**—Mr. A. S. Tallis, manager of the Tredegar Iron Company, has promised to submit terms for the lighting of Abertysswg with electricity.

**Worcester.**—The Council have authorised the provision and gradual fixing of 24 disconnecting high-tension fuses in the cables at an estimated cost of £100.

**Montrose.**—The Angus Electric Light and Power Company, Limited, are about to lay cables in a large number of streets throughout the town.

**Chesterfield.**—In their Improvement Bill the Corporation propose to borrow £23,641 for land, £85,000 for tramways, and £8,980 for electrical undertakings.

**Amble.**—The proposal of the promoters of the Amble Electric Lighting Order, 1902, to make earth connections in part of their electrical circuits has been agreed to.

**Dewsbury.**—The agreement with the National Telephone Company, Limited, for the laying of underground wires in certain highways within the borough has been sealed.

**Tunbridge Wells.**—The failure of electric light at Tunbridge Wells Institute on Saturday evening is reported to have been due to a failure of the private supply in the building.

**Sligo.**—The Irish Electric Supply Syndicate, which we have already mentioned, has also offered to treat with this Corporation. The matter has been referred to a special meeting.

**Farnham.**—The Urban District Council have replied to the Board of Trade that they did not propose at present to carry out the obligations under their Electric Lighting Order, 1900.

**Salford.**—The Council intend to apply for sanction to borrow £25,000 to cover the anticipated expenditure on the installation of service cables, etc., during the next two or three years.

**Northfleet.**—The District Council have deputed the clerk and surveyors to confer with the engineer of the Kent Electric Power Company, Limited, with regard to the company's provisional order.

**Belfast.**—An enquiry will be held on the 26th inst. into the application of the Corporation for sanction to a loan of £4,350 for the purpose of extending the electric mains in the Knock district.

**The Lothians Electric Power Provisional Order.**—At a special meeting of the County Council of Mid-Lothian on Tuesday it was decided to oppose the Lothians electric power provisional order.

**Hetton-le-Hole.**—The Urban District Council have agreed not to oppose the application of the Sunderland and District Tramway Company, Limited, who propose to light the district by electricity.

**Ewell.**—The County of Surrey Electrical Power Distribution Company are applying to the Board of Trade for a provisional order to supply electricity in the parishes of Cheam, Cuddington, and Ewell.

**Dalkeith.**—Some time ago Messrs. Crompton and Co. undertook to lay down an electric lighting installation and to supply current for public lighting at 3d. per unit. In about a month the street-lighting will be commenced.

**Lowestoft.**—During the past month 16 new consumers were connected to the Corporation's mains, representing 702 8-c.p. lamps. There are now connected to the mains 458 consumers, representing 22,501 8-c.p. lamps.

**Wakefield.**—Mr. Cyril M. Shaw, the city electrical engineer, last week delivered an interesting lecture before the members of the United Lecture and Debating Society, dealing chiefly with electrical energy as a transmission agent.

**Kinghorn.**—A public meeting was held at Kinghorn Mills on Friday for the purpose of considering the introduction of electric light and power into the burgh. The proposal of the Fife Electric Power Company was discussed.

**Longton.**—The output of electricity for the past month was 10,315 units, being an increase, as compared with the previous year, of 778 units; 102 additional 16-c.p. lamps have been connected to the Corporation mains during the month.

**Morley.**—The last report of Mr. J. E. Ellis, borough electrical engineer, shows that the output of electricity for the month ending Nov. 30 was 19,105 units, as compared with 15,749 the same period in 1902, or an increase of 3,356.

**Dundee.**—A start has now been made with the work of improving the electric mains in the centre of the city. The scheme, which is estimated to cost £9,843. 12s., consists of the relaying of 8,300 yards of cable on an improved system.

**Aberdeen.**—The Streets and Roads Committee and the Finance Committee have decided to recommend the Council to grant the National Telephone Company permission to lay their wires underground under certain conditions.

**Sale of Plant.**—In another column will be found particulars of an important sale of alternating and direct current arc lighting plant (series system), for which Mr. C. W. Rocher, the town clerk of Launceston, Tasmania, invites an offer.

**Leek.**—The Urban District Council have decided, in response to the application for current for power purposes, to quote 1½d. per unit, providing a quantity not less than 225,000 units per annum be guaranteed by the applicants for at least three years.

**Aberfeldy.**—A deputation has been appointed to wait on the Marquis of Breadalbane to ascertain what would be his attitude in reference to a proposal by the Town Council to introduce a system of electricity and an improved water supply by the burgh.

**Stepney.**—The question of the proposed extension of the Osborn-street station and the distributing system has been agreed to. The estimate is £78,280, and the proposed expenditure will be defrayed out of a loan to be taken up in portions as and when required.

**Brixham.**—The Dartmouth Electric Lighting Company have approved the draft agreement for supply purposes at Brixham, near Kingswear, on condition that the Board of Trade's consent thereto is

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waived, and the Council resolved to seal the agreement omitting the clause referred to.

**Tonyrefail.**—Some time ago the Council unsuccessfully tried to obtain a provisional order to erect plant for the supply of light, and they are now applying for urban powers. An electric lighting company has recently been formed with the intention to supply electric light at Tonyrefail and Gilfach Goch.

**Crewe.**—The electrical engineer of the Corporation in his last report states that during the past month 21,149 units were used by customers, and 27,002 on public lighting. It has been decided to charge 4½d. per unit as the standard rate for electricity for the future, with the rebate system as an alternative.

**Woodworking Machinery.**—The British Westinghouse Company are supplying through Messrs. John Petrie, Son and Co. a number of their new "S. B." direct current enclosed type motors for driving an extensive woodworking plant at Christchurch, New Zealand. The motors are direct-coupled to the various machines.

**Direct United States Cable Co.**—The directors have resolved upon an interim dividend of 3s. per share free of income tax, being at the rate of 3 per cent. per annum for the quarter ended Dec. 31, 1903. Payable on Jan. 30. It has been resolved to set aside £8,000 to reserve fund account, and to carry forward a balance of about £2,479.

**Plymouth.**—The electrical engineer has been asked to report as to the extensions of machinery, plant, etc., which, in his judgment, should be undertaken. There are now considerably over 500 consumers. A meter reader and clerk is to be engaged. The salaries of the charge engineers have been increased from £120 to £132 per annum.

**Tynemouth.**—Through the firing of a fuse at the borough of Tynemouth electric power station, North Shields, a few days ago, Mr. C. Turnbull, the engineer, and one of his assistants received burns about the arms. They were taken to the Tynemouth Victoria Jubilee Infirmary, and after having their injuries attended to were removed to their homes.

**Keighley.**—The Electricity Committee in their last report state that during December 20,821 units of electricity were sold, as compared with 16,022 units in December, 1902; the increase being 4,799 units. From July 1 to Dec. 31, 1903, the Corporation sold 89,443 units, the increase being 22,287 units, which is equal to 33·2 per cent.

**Tavistock.**—At a ratepayers' meeting last week a resolution was passed supporting the Tavistock and District Electric Supply Company in their application for an electric lighting provisional order. It was stated that the price would be 7d. per unit for the first hour and 4d. per unit for any other quantities for private lighting, and 3d. per unit for public lighting.

**Macclesfield.**—During last month representatives from the British Westinghouse Company, Limited, and Mr. Scott-Moncrieff, representing Messrs. Crompton and Co., Limited, and Mr. Rigby, representing Messrs. Crossley Bros., Limited, attended the Town Council and explained in detail their respective schemes for laying down an installation of electricity in the borough.

**Air-Compressors.**—Messrs. W. H. Bailey and Co., Limited, Salford, Manchester, have secured a license from Mr. E W. Köster, of the firm of Messrs. Pokorny and Wittekind, Frankfort, for the sole right to manufacture in the United Kingdom his patent positive-valve air-compressors and vacuum pumps, which were awarded a gold medal at the recent Düsseldorf Exhibition.

**Derbyshire.**—By the new Bill for the session of 1904 promoted by the North-Western Electricity and Power Gas Company, it is proposed to secure two pieces of land in the borough of Glossop for the purpose of erecting electricity and power gas stations. The company also seeks power to take over by agreement electric lighting provisional orders for other undertakings in its area of supply.

**Islington.**—The following estimates will come before the Council to-night for approval: Provision and laying down of low-tension distributing mains in Mercers-road, £60; provision and laying down of low-tension distributing mains in Holloway-road, Hornsey-road, Wellington-road, and Crinan-street, £379; provision and laying down of mains, etc., for arc lighting in Wallace-road, £190.

**British Boiler Fluid and Engineers' Stores Co.**—The Lords Commissioners of the Admiralty have just renewed their contract for the supply of "Dejecoline" boiler-scale removing fluid to his Majesty's dockyards during the ensuing 12 months. This is the fourth year in succession which the Admiralty have continued the use of this firm's boiler-scale removing fluid for the Royal dockyards, etc.

**Morriston.**—The Swansea Corporation Electricity Committee have adopted a report by the engineer (Mr. Prusmann) in which he referred to the high-tension alternating scheme for supplying Morriston, and suggested it should be done on the double-phase instead of the single-phase system. He suggested that the energy required for Morriston could be coupled with that required for electric traction on the Morriston ection.

**Scarborough.**—On Monday afternoon Mrs. Steble performed the ceremony of switching on the electric light which has been installed at the School of Art, she having promised at the recent bazaar held in connection with the School of Art to give the whole of the proceeds of her stall to the installation of the greatly-needed improvement, and to make up the balance from her private purse. The installation comprises 74 lamps.

**Change of Addresses.**—Mr. Douglas Wells, M.I.E.E, is enlarging his business in cables, steam-engines, boilers, economisers, heaters, ventilators, etc., and has removed to 10, Rue de la Pépiniére, Brussels. The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E., inform us that their telephone number has been altered to 823 East. Messrs. Robinson and Horsfall have removed to 13, Castle-street, Liverpool.

**Long Eaton.**—Mr. Mirfield in a recent report on the electric lighting undertaking for 1903 states that the total capital raised was upwards of £18,000, and the expenditure nearly £15 500. The gross revenue earned was £1,939, and working expenses £1.064. After the interest and repayment of capital there was a net profit of £96, and £330 was the sum repaid of capital.

**Dorchester.**—The recommendation of the Electric Lighting Committee, that application be made for sanction to a loan for carrying out the scheme of electric light having been defeated by a majority of two votes, the whole scheme comes to a deadlock. The matter has been referred back to the committee for further consideration, with the object of giving a company the opportunity of coming in to carry out a scheme with private capital.

**Middlesbrough.**—The Corporation have not yet obtained sanction to borrow the sum of £15,000 for the proposed extensions of the electric lighting plant and buildings, but they are proceeding with their arrangements for the work, as they would require additional lighting next Christmas. The electrical engineer's last report states that the plant had worked successfully during the past month. They had received 11 applications for 505 additional lights in the future.

**Hammersmith.**—Owing to the setting back of the pavement at various places, and the alteration of the levels, it will be necessary to relay the pipes and cables in portions of Askew-road, Paddenswick-road, and Dalling-road. The number of ducts will be increased by using Sykes's earthenware conduits, instead of 2½in. cast-iron pipes, the total extra cost not to exceed £50. The total estimated cost of the alteration with cast-iron pipes is £664. 15s., or with conduits £591.

**Wrotham.**—The Urban District Council have received formal notice of Mr. C. G. Holden's intention to apply at the earliest possible date for a provisional order for the purpose of supplying electric light and power within the Board's area, and also of their intention to apply to the Light Railway Commissioners for an order to construct a light railway from Wingfield Mills to Stanstead, *viâ* Borough Green and Wrotham, with a physical junction at Wrotham and Borough Green Station.

**Woolwich.**—In order to popularise its electric light undertakings, the Borough Council has decided to adopt a scheme which provides that the cost to the consumer of an installation for lighting, heating, or cooking apparatus shall be spread over a stated period, to be determined according to the cost of the installation. All the work of wiring is to be done by direct labour, a foreman canvasser is to be appointed to organise the method of supply, and showrooms are to be opened to advertise the electricity.

**Ayr.**—The Lighting Committee have entered into an agreement to supply the Glasgow and South-Western Railway Company with electric light from the Corporation works for the lighting of Ayr Station and Hotel. The railway company will pay 3d. per unit annually on a minimum consumption of 30,000 units per annum, and if the consumption in the year exceeds 50,000 units the cost to remain at 3d. per unit up to 59,000 units, and 2½d. per unit for the quantity consumed beyond that limit. The arrangement is to last for not less than three years.

**St. Marylebone.**—The following notices of motion were down for the last Council meeting: "That the engagement of Mr. Arthur Wright, the electrical expert, be determined, and that the necessary notice be given him terminating his engagement"; and further, "That returns be presented of the cost of obtaining the Act of Parliament allowing the Council to purchase, of the entire cost of the arbitration, for counsel's opinion, and other matters connected with the electric light purchase." The proposer is out of England, and the notices were ordered to be struck off the agenda.

**Keynsham.**—The following resolution has been passed with regard to the application of the Keynsham Electric Light and Power Company by the Rural District Council: "That it is not desirable that consent be given by the Rural District Council to the making of the proposed provisional order; that it is desirable for the Rural District Council to themselves apply for such an order, taking power to manufacture and supply electric current and energy, or to take it in bulk from the said company, the Somerset and District Electric Power Company, the Bristol Tramways Company; or any corporation or person who may be in a position to supply it, and act as distributors of current or energy so taken in bulk."

**Metropolitan Asylums Board.**—The Board have obtained sanction to enter into contracts with Messrs. Belliss and Morcom, Limited, and Messrs. Drake and Gorham, Limited, for work in connection with the electric lighting of the Fountain Hospital at an estimated cost of £1,136 and £2,792, and with Messrs. Meldrum Bros., Limited, for the installation of a refuse destructor at the Park Hospital at a cost of £320, without first advertising for tenders. Application will be made for an order authorising an expenditure not exceeding the sum of £4,350 on the extension of the generating plant of the Grove Hospital and the wiring of the Fountain Hospital in connection with the proposed lighting of the latter by electricity.

**Stock Exchange Settlements.**—The Stock Exchange Committee have appointed Wednesday, 20th inst., a special settling day in Buenos Ayres Electric Tramways Company (1901), Limited, £200,000 5 per cent. debenture stock, and have ordered the said securities to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in West London and Provincial Electric Supply Company, Limited, further issue of 5,763 ordinary shares of £1 each, fully paid, Nos. 19,892 to 25,654 and 5,763 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 41,915 to 47,677; and to allow the London United Tramways (1901), Limited, further issue of 17,500 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 82.501 to 100,000, to be quoted in the official list.

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**Bournemouth.**—At the last meeting of the Town Council the Telephones Committee reported on a letter from the National Telephone Company, stating that the company agreed to Bournemouth having similar rates to those then in force in Portsmouth, and this had been carried out; and they would be prepared to apply to Bournemouth the omnibus rate, for which service a subscriber pays £1. 5s. per annum to cover 600 free calls, and afterwards ½d. per call, inward calls being free. This service is supplied by means of a common circuit, to which a number of persons are joined. This was agreed to.

**Canterbury.**—After the expiration of the quarter ending March 31 next the charges for the supply of electricity for lighting and power purposes will be as follows: for private lighting 5d. per unit, or 7d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator; 2d. per unit for all consumption during the quarter beyond the above; for power and heat, 3d. per unit. Discounts on power and heat supply will be allowed quarterly as under: for quantities at the rate of 1,000 units per annum and upwards, 5 per cent.; 2,500, 15; 5,000, 20; 7,500, 30; 10,000, 40; 20,000, 50 per cent.

**Hampstead.**—A 20-kw. exciter is to be provided for the new 1,000-kw. plant at the central electric lighting station at a cost of £140. The Lighting Committee reported last week that, in answer to a letter of complaint, they had given instructions for the Hampstead Board of Guardians to be informed that the electric light connections with the workhouse had been examined and the voltage tested, and both found to be in order, and that the bad light had therefore nothing to do with the Council's supply, and was probably due to the blackened condition of the lamps in use. Four tenders for the supply of plant for utilising superheated steam for the engines at the electric lighting station have been referred to the Lighting Committee for consideration and report.

**Southwark.**—The Council have adopted a report by Councillor Dawes, chairman of the Finance Committee, stating that his committee had considered the letter referred to them by the Council from the Local Government Board confirming the district auditor's decision as to the disallowance of the sum of £795. 1s. 1d. in respect of the Newington electric lighting undertaking in his audit of the accounts of the Council for the year ended March 31 last, on the ground that the deficiency should be chargeable to the parish of Newington, and not to the borough as a whole. The committee had therefore directed the town clerk to make application to the London Government Act Commissioners, in accordance with the resolution of the Council of July 22 last, to issue a scheme under Section 10 (4) of the London Government Act, 1899, making the expenses of the undertaking chargeable to the whole borough.

**Greenock.**—It will be remembered in regard to the recent arbitration case between the Corporation and the tramway company that the Corporation held that it was inexpedient to make any reduction in the price to be paid for excess energy, but the arbiter decided that ¾d. instead of 1½d., as claimed by the Corporation, was the price to be paid for all energy in excess of the minimum 500,000 units per annum. Mr. J. A. Robertson, the burgh electrical engineer, in his report estimates that during the first and second years the loss to the Corporation through supplying the company amounted to £1,033. 10s. He has reported that, in his opinion, it would be quite impossible to show any profit as a result of supplying the tramway company with energy during the next two years, and suggests that when the time comes for revision in 1905 every possible effort should be made to reverse a decision which had undoubtedly inflicted a serious injustice on the Corporation.

**Stoke-on-Trent.**—At a special meeting of the Town Council a communication was read from the Local Government Board stating that they had had under consideration a report made by their inspector (Colonel Durnford) after the enquiry made by him with reference to the application for sanction to borrow £30,640 for the purpose of electric lighting and the provision of a refuse destructor in connection with the proposed electric lighting works. The Board approved generally of the proposals, but they observed that the scheme included the provision of mortar-making plant. The general question of municipal trading had recently been under the consideration of Parliament, and pending a decision on the question the Board were not prepared to sanction a loan in respect of the proposed mortar-mill unless the Town Council gave a formal undertaking by resolution not to manufacture mortar for sale, but only to sell such surplus products of the plant as were not required for their own use. A resolution giving this undertaking was adopted.

**Hackney.**—The Lighting Committee of the Borough Council recently instructed their borough solicitor to prepare a case for the opinion of counsel on the subject of the agreement with Mr. Hammond in the matter of the electric lighting undertakings. The following opinion by H. H. Asquith, Esq., K.C., and Thomas Bevan, Esq., has been received: "We are of opinion that Mr. Hammond is appointed by the contract consulting engineer for the whole of the works necessary for 'the supply of electricity within the parish under the electric order.' The instalment of scheme B is introductory only to the execution of the complete undertaking to which the borough is committed, and which is defined by the contract. We can suggest no better course than to accept Mr. Hammond's terms." As already reported, the committee have entered into a supplemental agreement with Mr. Hammond in accordance with the advice of counsel, accepting his rebate of 1 per cent. on the distributing system, and recognising his position as consulting engineer for the whole of the works necessary for the supply of electricity within the borough under the electric lighting order.

**Worthing.**—Since the installation of the electric lighting undertaking 18 extensions have been carried out at a total capital outlay of £2,092. In eight of these cases the works have been completed a full 12 months, the collective guarantees amounting to £140 for the year. The income for that period from the current supplied in these cases amounted to £232, or an excess over the required guarantee of £92. In one case, however, the Sussex-road Schools, the income does not reach the guarantee, and the sum of £7. 16s. will be payable in respect of the insufficiency. In the case of the Theatre Royal the consumption has been largely in excess of the guarantee. In the remaining nine extensions, the first one of which was put down in March, 1903 and the last one in November of same year, the collective guarantees amounting to £115, and the income from these extensions estimated to date is £197, or an excess already of £86. It is satisfactory to state that of the foregoing 18 extensions it is anticipated that in not more than two cases will it be necessary to make any call upon the guarantors to make good deficiencies.

**Portsmouth.**—At the recent enquiry into the application of the Corporation for sanction to borrow £24,000 for electric lighting purposes, the Town Clerk explained that a loan of £23,000 was granted on the Corporation's application for the same purpose to meet the expenditure of the years 1901-2-3. This amount had been exceeded by £2,350. Alderman Ellis, the chairman of the Electric Lighting Committee, said that it was thought three years ago that £23,000 would be sufficient to meet the expenditure for the three years. No doubt they would have done so but for the fact that the Admiralty suddenly and unexpectedly required the Corporation to light the naval barracks and part of the dockyard and gunwharf. This entailed considerable expense, but which would prove to be a very profitable investment. The loan ran out on Sept. 30, and it was then decided to apply for a further loan. Since then over £2,000 had been spent, but this amount, of course, would come out of the new loan. In asking for £24,000, the Corporation believed that was sufficient to meet the demands for the next few years. There was no opposition.

**Opposed Private Bills.**—The following memorials have been deposited alleging non-compliance with the preliminary regulations in the cases of the first 100 private or local Bills in promotion for the ensuing session: London County Council (Tramways and Improvements) Bill, memorials from the metropolitan borough of Holborn and from Maple and Co., Limited, and James Shoolbred and Co.; Rotherham Corporation Bill, from the Rotherham Rural District Council; Leeds Corporation (Consolidation) Bill, from the Yorkshire Electric Power Company and from the West Riding County Council; London United Tramways Bill, from the Middlesex County Council; London United Tramways (Railways) Bill, from the London County Council; Llanelly Tramways and Improvement Bill, from the British Insulated and Helsby Cables, Limited; Aylesbury Gas Bill, from the Aylesbury Urban District Council, and others; North Wales Electric Power Bill, from Sir R. H. Williams-Bulkeley; Selby Urban District Council Bill, from the Company of Proprietors of Selby Bridge. The first sitting of the examiners to take proofs of compliance with Standing Orders is to be held on the 18th inst. in the committee-rooms of the House of Commons.

**London Gazette.**—The partnership subsisting between George Robert Marson, Harold Wilmott Burbury, and Joseph Marson, gas and hot-water fitters and electrical engineers, Coventry, trading as Marson Brothers and Burbury, has been dissolved by mutual consent. The partnership subsisting between James Haydon Bartlett and Daniel Herbert Ogden, electricians, 17, Grafton-street and 12A, Avery-row, Middlesex, trading as Perry and Co., have been dissolved by mutual consent. The creditors of the City and Suburban Electric Carriage Company (1903), Limited, are required to send their names and addresses and particulars of their debts or claims to Mr. William Barclay Peat, 3, Lothbury, before Feb. 17. At an extraordinary general meeting of the members of the South-Western Electrical Company, Limited, held at 2, Palace-terrace, Fulham, on Jan. 1, a resolution was passed: "That it has been proved that the company, by reason of its liabilities, is unable to continue its business, and that the company be wound up voluntarily." Mr. Charles Edward Peebles, 31, Kenilworth-court, Putney, was appointed liquidator. At an extraordinary general meeting of the members of the Electrical Supplies, Rubber, and Ebonite Company, Limited, held at Yorkshire-chambers, Sheffield, on Dec. 2, the resolution was passed: "That it has been proved that the company cannot, by reason of its liabilities, continue its business, and that the company be wound up voluntarily." Mr. C. Frederick Elles, F.C.A., of 1, Oxford-court, Cannon-street, was appointed liquidator. Mr. Frederick Gittins has been released from trusteeship in the estate of Alfred Percy Archibald Hunt, electrical engineer, 49A, Lord-street, Southport, Lancaster, lately of 62, South Castle-street, Liverpool, and in the estate of Robert Henry Thomas, medical electrician, 17, Canning-street, Liverpool, Lancaster.

**Bo'ness.**—In the agreement between the Town Council and the National Electric Construction Company, Limited, of London, for the fitting up of the installation for the lighting of the burgh by electricity, the profit to be allowed the company upon the necessary material was adjusted at 7 per cent. The Town Council understood this 7 per cent. was to be applied to makers' prices as charged to the contractors, who are the Construction Company. The clause in the agreement is vague, and merely says that a profit of 7 per cent. is to be allowed on material supplied by "fair" competition. The company contended that they had all along in view a construction profit of 7 per cent., in addition to the profit or premium of 7 per cent. The tender submitted to the Town Council for the whole plant and machinery was £20,787, to which the company added the cost of the site—£1,100—a sum for office expenses, for plans and specifications, travelling expenses, clerk of works, etc.—£600—and a further sum for contingencies—£587—and 7 per cent. on these sums, which was £1,615, bringing out the total estimate to £24,689. According to the Council's understanding of the agreement, the contractors were only entitled to 7 per cent. on £21,887—equal to £1,532—instead of which they had charged £2,802, or a difference of £1,270. The Town Council disputed their right to this sum, and the company offered an abatement of £535 from their contingent profit, thus reducing the

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difference between parties to a sum of £735. On Thursday the Council decided to accept the Construction Company's offer, and to agree to the scheme specification and tender, subject to the abatement of £535 offered by the company, subject, further, to the deduction of £1,100 for the site of the power station already paid by the Council, and, further, to any saving on the estimated cost of the buildings which may turn out on the actual accepted tenders for same, and, lastly, subject to the deduction of the cost of any item of machinery or plant which it may be mutually agreed to dispense with. It was further agreed to apply to the Secretary for Scotland for authority to borrow £25 000 to defray the cost of the electric lighting scheme, and thereafter to execute the necessary bonds.

**Yarmouth.**—On Tuesday the Council *in camera* discussed a report upon the subject of the electric cable across the river, in which the borough surveyor stated that should the negotiations for the transfer of the Gorleston tramways be proceeded with and the Council become owners of the same during the next few months, there would be a desire to reconstruct and electrify them at the end of the next visiting season. The most convenient time for crossing the river, either over or under, is in the spring or early summer. He was certain that the overhead method would be the best as to economy of construction, maintenance, and safety. The electrical engineers (Messrs. Preece and Cardew) also urged that the overhead method would be the best, and explained that if the cables were to be placed under the bed of the river, there should be at least three separate cables, considerable distances apart, if a safe and continuous supply was to be maintained. The Local Government Board had given their assent to the raising of loans of £1,000 for the overhead work and £2,000 for the underground method, but circumstances had somewhat altered since those sanctions were obtained. He was of opinion that the overhead method would now cost £1,150 and the underground method £2,500, the latter sum allowing for laying two cables 30ft. apart in one trench, while to lay three cables in three separate trenches would cost not less than £4 000, and perhaps as much as £5,000. It might be asked why they did not take the cable over the shallow part of Breydon, where the soil and other conditions would be in favour of the work being done at less cost. The point from which the current could be most economically distributed was in the neighbourhood of North Gorleston, and to reach that point from the electric lighting station, round by Breydon, would mean a cost of at least £6,000 for cable, to which would have to be added the cost of crossing Breydon. The Port and Haven Commissioners have resolved that by carrying the cable over the river by steel masts, the minimum height of the masts should be 150ft. above high water and ordinary spring tides. The committee recommended the Council to adopt the overhead system. A sub-committee was also appointed to deal with the question of the purchase of any necessary ground at Gorleston in which to insert the requisite stays to the steel masts on that side of the river.

**National Electrical Contractors' Association (Northern Section).**—Successful meetings of this association were held at the Metropole Hotel, Newcastle-on-Tyne, on Saturday, Jan. 9, 1904, under the chairmanship of Mr. E. C. Wallis, of Leeds, supported by Mr. Rawlings, of London, the president of the National Electrical Contractors' Association. Many points of importance to the electrical trade were discussed, and it was felt that the association is in a satisfactory condition and doing good work. A model specification is being drawn up and a system of registration of workmen is in use, and is found very useful to the members, and many other matters of interest are being brought forward by members of the association. At the dinner given by the members of the Newcastle and District Association of Electrical Contractors to the delegates from the different towns in the North of England attending the meeting, the president of the National Association (Mr. Rawlings) and the president of the London Association (Mr. Berry) were present. Mr. Cross (Falconar, Cross, and Co.) presided, and about 20 covers were laid. The others present were Mr. Wallis, of Leeds; Messrs. McDermott and Steinthal, of Manchester; Messrs. Sutton and Harford, of Liverpool; Mr. Tattersall, of Middlesbrough; Mr. Andrews, of Sunderland; Mr. Shaw, of Stockport; Mr. Armstrong, of Carlisle; Messrs. T. G. Usher (vice-chairman), Gowdy, Andrews, Coleman, Beilby, C. Usher, and R. Robson (hon. secretary), of Newcastle. After the usual loyal toasts, "The National Association" was proposed by the Chairman, and replied to by Mr. Rawlings, who, among other remarks, mentioned that he would like to see the paper of the "Electrical Contractor" become the property of the National Association; and whereas the London Association was great in numbers, the Newcastle Association could make up for it in enthusiasm. He also spoke on the agreements made with the Manufacturers' Association. Mr. Usher (the vice-chairman), proposed "The Northern Section," to which Mr. Wallis (the chairman of that section) replied. "The Newcastle Association" was proposed by Mr. Berry, Mr. Robson replying; "Our Guests" by Mr. Andrews, Mr. McDermott replying. The health of the chairman being proposed, and he suitably responding, brought to a close a very pleasant and successful evening, several songs being given by the members present.

## PROVISIONAL PATENTS, 1904.

JAN. 1.

12. **Improvements in electric dynamos and motors.** Thomas William Stainer Hutchins, 17, St. Ann's-square, Manchester.

33. **Improvements in or relating to the trolley wires of electric tramways.** George Hall, 385, Rochdale-road, Manchester.

45. **Improvements in and connected with electrically-controlled lifts.** Joseph Richmond and Robert Falkland Carey, 173, Fleet-street, London.

74. **Improvements in electric bell indicators.** Walker Moseley, 23, Trossachs-road, East Dulwich, London.

JAN. 2.

97. **Electric car trolley sheave guide for finding the current-conducting wire.** John Rose, Thomas Henwood, and John Squire, 8, Cambridge-terrace, Torpoint, Cornwall.

107. **Improvements in high-tension electric generators.** Sydney Evershed and Evershed and Vignoles, Limited, 1, Queen Victoria-street, London.

113 **Improvements in or relating to telephones and time recorders therefor.** Gustav Fürst and Theodor Kragl, 111, Hatton-garden, London. (Complete specification.)

121. **Improvements in gas or vapour electric apparatus.** Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

124. **Improvements in apparatus for electrically transmitting, receiving, and checking signals, orders, and the like.** Martin Barbará, 55, Chancery-lane, London. (Complete specification.)

131. **Improvements in and relating to the regulation of electric currents.** Poulla Cour, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 5, 1903, being date of application in Denmark. (Complete specification.)

135. **Improvements in and relating to alternating-current generators and motors.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London.

137. **Improvements in and relating to alternating-current distribution systems and apparatus therefor.** William Bradley Woodhouse, 18, Southampton-buildings, Chancery-lane, London.

JAN. 4.

157. **An improved method and means of electric traction.** Arthur William Murray, Plevna, Sidney-parade, co. Dublin.

193. **Improvements in the equipment of electrically-propelled railway cars.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

214. **Improvements in electric batteries.** Pierre Joseph Kamperdyk, 18, Buckingham-street, Strand, London.

226. **Improvements in electrical conductors.** Isader Ladoff and James MacNaughton, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

JAN. 5.

232. **Improvements in or relating to the trolley wires of electric tramways.** George Hall, 4, Corporation-street, Manchester.

233. **An improved system for connections to switchboards, mains, and electrical machinery and improvements in electrical switches.** Henry William Clothier, 108, Gilda Brook-road, Eccles, Manchester.

253. **A new or improved device for facilitating the laying of electric wires, casing for wires, piping, and the like.** Henry Forster Clough, trading as the Virginia Electric Company, and Algie Robinson, 4, St. Ann's-square, Manchester.

257. **Improvements in magnetic compass needles.** Short and Mason, Limited, and Henry William Short, 57D, Hatton-garden London.

266. **An electrical alarm for railway carriage and other doors.** Arthur Holt Stewart, Pegwell-avenue, Pegwell Bay, Ramsgate.

291. **An improved electric incandescent lamp.** Charles Clare Regnart, 29, Anson-road, Cricklewood, London. (Complete specification.)

306. **Improved trembler for induction coils.** Francis Claude Blake, 60, Queen Victoria-street, London.

JAN. 6.

318. **Improvements in electric lamp fittings, lampholders, and the like.** Hugo Hirst and Thomas Henry Bacon, 71, Queen Victoria-street, London.

319. **Improvements in electric cables.** Michael Birt Field, 72, Clyde-road, West Didsbury, Manchester.

327. **Electrical hammer or tool for use in removing scale from boilers, which tool is applicable to the boring of rock and other purposes.** Ernest Digby Hopcroft Erceldonne, Cambridge-road, King's Heath, Worcestershire.

330. **Improvements in and connected with electric fuses.** William Walker Lackie and William Tannabill Calderwood, 154, St Vincent-street, Glasgow.

341. **Improvements in the overhead equipment of electric tramways.** Charles Naylor and Joseph Naylor, 6, Bank-street, Manchester.

351. **A safety device for use on vehicles propelled by electric traction on the stud-contact system.** William Griffiths and Benjamin Harry Bedell, 22, Southampton-buildings, Chancery-lane, London.

2053A. **Improvements in and connected with electro-capillary relays and the like.** James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London. (Date applied for under Patents Rule 9, Jan. 28, 1903.) (Complete specification.)

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JAN. 7.

**402. Improvements in electric apparatus for therapeutic use.** Frederick Courtenay Fisher, 64, Hampton-park, Redland, Bristol.

**429. The electro-gyroscopic compass.** Cecil Vivian Usborne, 6, Craven-street, Strand, London.

**455. Improvements in telautograph apparatus.** Foster Ritchie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**456. Improvements in the manufacture of chlorine by electrolysing sodium chloride solution and apparatus therefor, part of which may be used for other electrolytic purposes.** Sidney Leetham and Edward George Paul Bousfield, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**460. Improvements in wireless telephony and in apparatus therefor.** Samuel Lifschitz, 65, Chancery-lane, London.

**472. A new or improved method of testing for grounds and/or short-circuits in electrically-operated cars or trains.** Charles Ashley Carus-Wilson, Norfolk House, Norfolk-street, Strand, London.

**474. Improvements in or relating to electric batteries.** Malcolm Sutherland and Elias Marcuson, 18, Montpelier-road, Twickenham.

JAN. 8.

**498. An improved form of jointing ball body for electric light fittings.** Charles Thomas Arnold Henshaw and Thomas McIntyre, 42, Gorgie-road, Edinburgh.

**501. Improvements in electric trolleys.** Robert Simpson Baxter and David Wilson, Broughty Ferry, N.B.

**511. Improvements in electric storage batteries or accumulators.** Alfred Francis Rubery and George Laxton, 15, Verulam-street, Gray's-inn-road, London.

**534. Improvements in or relating to electrical fuses and fuse boxes.** Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, 3, Greenland-place, Camden Town, London.

**547. Improvements in and connected with systems of electrical conductors.** Béla Gáti, 6, Lord-street, Liverpool.

**550. Improvements in telautograph apparatus.** Foster Ritchie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**552. Improvements in microphenes for telephonic apparatus.** Louis Theophile Bassompierre and Leon Joseph Mathurin Dardeau, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 15, 1903, being date of application in France.) (Complete specification.)

JAN. 9.

**571. Improvements in the means of connection between brush-holders and pillars of dynamo-electric machines and electric motors.** Edmund Scott Gustave Rees, Prince's-chambers, Wolverhampton.

**574. Improvements in the construction of the armatures of dynamo-electric machines and electric motors, with a view to facilitate the mounting of the same upon their shafts.** Edmund Scott Gustave Rees, Prince's-chambers, Wolverhampton.

**582. Improvements in or connected with electrical accumulators.** William Sillery and Meldrum Bros., Limited, 15, Water-street, Liverpool.

**628. Improvements relating to electric incandescent lamps.** Joseph Schwab and Leopold Vogel, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Jan. 28, 1904.*

1903.

**25. Trolley electric tramways.** Hall.

**117. Commutators for polyphase currents** Heyland.

**174. Appliances for electrically controlling lifts, hoists, and the like.** Richmond and Carey.

**1259. Electrical motors, dynamos, and the like.** Logan.

**1540. Means for metering and registering electrical energy to be charged for under varying conditions of supply.** Electric and Ordnance Accessories Company, Limited, and Aron.

**2284. Starting and regulating gear for electric motors.** Hall.

**2669. Electric arc lamps.** Lewis.

**2746. Electric service main and other switches for breaking and closing electric circuits.** Craig.

**2930. Couplings for conduits for electric conductors.** Munro.

**3080. Combined telephone transmitter and automatic switch.** Brander.

**3444. Luminous gas or vapour electric lamps.** Le Tall. (Cooper-Hewitt Electric Company.)

**3572. Electrical measuring instrument.** Groves.

**4069. Automatically-operated electric block signalling or brake-operating device for railways.** Dobrzanski and Huschak.

**4388. Electrical resistances.** Paul.

**4727. Resistance regulators and starting switches for shunt motors.** Mechwart, Coltri, and Co. (Date applied for under International Convention, Aug. 29, 1902.)

**4973. Collapsible electric light fitting or bracket.** Collet and Somervell.

**5169. Electric rheostats.** Carolan. (General Electric Company.)

**5480. Electric gaslighters.** Boult. (Electric Contract Company.)

**6102. Electricity meter.** Ziegenberg.

**7955. Electric couplings.** Dauncey.

**10772. Electric heaters and stoves.** Binko.

**11323. Switches for electric batteries.** Boult. (Electric Storage Battery Company.)

**14934. Process and apparatus for obtaining direct-current impulses from a high-tension alternating electric current source, particularly applicable for use with Rontgen and similar tubes.** Boult. (Koch.)

**16190. Prevention of electric shocks in systems of electric distribution.** Lake. (Compagnie de l'Industrie Electrique et Mecanique.)

**21306. Electric lamps.** Burke.

**23226 Electrically-illuminated signs.** Goehst.

**23647. Electric arc lamps.** McLaughlin.

**24914. Engaging devices and magnetic lifting contrivances for cranes and other lifting devices.** Reuter.

**25053. Electric lighting and power systems.** Milne.

**26248. Telephone transmitters.** Randall.

**26380. Safety fuses for electric circuits.** Johnson. (Elektrizitäts Aktien-Gesellschaft vorm. W. Lahmeyer und Co.)

**16792. Electric sanitary closets.** Wilson.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5¾ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 4¼-4⅜ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 94-97 xd |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 11-12 |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 5 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures ..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 5 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures ..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 71-76 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 98-101 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 13¼-14¼ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18-19 |
| —— 4 per cent. Debentures ..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance ..... | 12 | .. | 34-37 |
| —— 5 per cent. Bonds ..... | 100 | .. | 100-103 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 10-11 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 xd |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary ..... | 5 | .. | 10-10¼ |
| —— 7 per cent. Preference ..... | 5 | .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7⅛ |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14¼ |
| —— " " £10 Ord. .... | 6 | .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 6¼-6⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¼-5 xd |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 103-105 |
| Chelsea Electricity Supply ..... | 5 | .. | 5¼-6 |
| —— 4½ per cent. Debentures ..... | 100 | .. | 105-108 |
| City of London, Ordinary ..... | 10 | .. | 10¼-11 |
| —— 6 per cent. Cumulative Pref. ..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary ..... | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 10¼-11¼ |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 100-106 |

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| Name. | Amount paid. £ | Last price. £ |
|---|---|---|
| Kensington and Knightsbridge and Notting Hill | 100 | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9¾-10¼ |
| London Electric, Ordinary | 3 | 1⅞-2¼ |
| —— 6 per cent. Pref. | 5 | 5¼-5⅝ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 97-100 |
| Metropolitan Ordinary | 10 | 17-18 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 96 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 98-101 |
| —— Preference | 4 | 100 103 |
| Notting Hill Electric Lighting | 10 | 12½-13¼ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 407-14,310 | 5 | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 | 98-101 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | 99-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | 85 90 |
| South London, Ordinary | | 3¼-3⅜ |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | 14½-15½ |
| —— 7 per cent. Pref. | 5 | 8 9 |
| —— 3½ per cent. Deb. | 100 | 98-101 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4¼-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4¼-5¼ |
| Westminster, Ordinary | 5 | 12 13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 6-6½ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 91 94 |
| —— 4 per cent. Pref. | 100 | 98-101 |
| —— ,, ,, deferred | 100 | 91-94 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 115-118 |
| City and South London, Consolidated Ordinary | 100 | 47-50 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 126-129 |
| —— ,, ,, ,, '96 | 100 | 123-126 |
| —— ,, ,, ,, '01 | 100 | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7½-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-250,007 | 5 | 4¾-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | 13¼-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10¼-10¾ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 102-104 p.c. |

| Name. | Amount paid. £ | Last price £ |
|---|---|---|
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | 11¼-11⅝ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | 11¼-11⅝ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 4¾-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-107 |
| —— Prov. Cert., all paid | 100 | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-1¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 5-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 98-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | ⅛-¼ |
| New General Traction, Ordinary | 5 | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | 89-94 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8¼-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 102-104 |
| —— Deferred Stock | 100 | 77-80 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 13-14 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 96-97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 100-102 |
| Oriental Telephone and Electric Company | 1 | ¼-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week: Ending | 1904. £ | 1903. £ | Increase or decrease: Week. £ | Current year. £ | Miles of single track open: 1904. | 1903. | Accounts for past year: Ending | Total receipts £ | Passengers carried. | Car miles run. | Receipts per: Pass'nger d. | Car mile. d. | Mile of track. £ | Cost per car mile. d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aberdeen Corporation | Jan. 9 | 1,239 | 818 | + 420 | + 7,343h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | — | — | — | — | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 8 | 722 | 676 | + 46 | + 1,383 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 896,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 7 | 295 | 319 | − 24 | − 222 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 4 | 188 | 192 | − 4 | − 48 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 10 | 1,666 | 1,561 | + 105 | + 8,424 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,847 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 6 | 857 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | — | — | — | — | — | 41 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 10 | 743 | 743 | — | + 2,590h | 6½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 8 | 4,448 | 4,346 | + 102 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 9 | 815 | 675 | + 140 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 10 | 234 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 9 | 1,823 | 1,535 | + 288 | + 20,880 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | — | — | — | — | — | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 9 | 7,054 | 6,967 | + 87 | 5h | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,871a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 10 | 3,133 | 3,411 | − 278 | − 442h | 6⅔ | 6⅔ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 7 | 415 | 455 | − 40 | — | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 1 | 259 | 257 | − 18 | − 248 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 9 | 171 | 182 | − 11 | − 45 | 3 | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 10 | 125 | 130 | − 5 | h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 159 | 7·68 |
| Dublin U. T., electric cars | ,, 8 | 3,715 | 3,657 | + 49 | } — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 8 | 685 | 667 | + 18 | | | | | | | | | | | |
| Dundee City Tramways | ,, 6 | 1,125 | 1,061 | + 64 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 9 | 584 | 482 | + 102 | + 7,623 | 10·75 | 10·75 | March 31g | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 9 | 14,019 | 12,025 | +2,594 | +45,685h | 124 | 124 | May 31g | 655,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | — | — | — | — | — | 30½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 9 | 1,093 | 1,013 | + 80 | — | 34 | 34 | March 31 | 56,631h | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 16·32 |
| Hull Corporation, E. S. | ,, 9 | 2,037 | 1,761 | + 276 | + 5,290 | 19 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 7 | 105 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 6 | 342 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 9 | 4,795 | 4,571 | + 224 | +13,630 | 77 | 77 | March 25g | 232,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 2 | 9,696 | 9,707 | − 11 | − 11 | 101 | 101 | Dec. 31 | 534,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 10 | 1,598 | 1,502 | + 96 | + 163h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — c |
| London County Council | — | — | — | — | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 9 | 136 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 9 | 93 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 9 | 3,467 | 2,944 | + 523 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | — | — | — | — | — | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 4 | 102 | 116 | − 14 | — | 4½ | 4½ | March 31g | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 7 | 383 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 11 | 3,569 | 2,879 | + 690 | +44,575 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 10 | 4,037 | — | — | — | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 7 | 845 | 875 | − 30 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 10 | 1,035 | 909 | + 126 | + 2,323 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 9 | 584 | 540 | + 44 | + 3,427 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## METHODS OF CHARGING FOR ELECTRICAL ENERGY.*

BY ELLIS H CRAPPER, MEMBER.

*Introduction.*—This subject has received so much attention during recent years at the various conventions and Institution meetings, as well as by the technical Press, that it is with considerable diffidence that the author presents the following paragraphs for the consideration of the members of this local section of the Institution of Electrical Engineers. The frequency with which the tariff question has been brought forward is probably due to the radical divergence of opinion which exists among electrical engineers as to what constitutes a rational and practical system of charging, equitable alike to the undertaker and consumer. The number of distinct methods which have been introduced to fix the price to be charged for electrical energy is quite large, and it is probable that some merit attaches itself to each, from one point of view or another.

The present state of indefiniteness as regards the systems of charging for electricity is no doubt the result of attempts made to reform the primitive, unscientific, and uncommercial methods which were introduced in the early days, before the electric light business was established on a thorough business basis, and nothing but frequent discussion will replace the present want of uniformity by a system of tariff which is applicable to all concerned.

At the outset it must be conceded that the evolution of a general principle from the present state of chaos is a problem of no mean order, inasmuch as both the investment of capital per lamp installed in the shape of *readiness-to-serve costs* and the *actual cost of service* at variable periods of time varies greatly. It is, however, not too much to hope that in the near future the problem will meet with a full and adequate solution; but this solution must be sought for in a scientific manner, so that the fundamental law connecting together every factor which has to be included in the general expression of that law, may receive its due significance. The writer regrets that, in addition to stating the principles of the methods in use at the present time, he cannot do more than indicate some elementary principles which may be of use in tackling the problem quantitatively.

It is somewhat disappointing that whilst the man in the street acknowledges the excellent qualities of the electric light as an illuminant, its hygienic properties, as well as its economical value as regards decoration and diminished deterioration of stock, the load factors of the various central stations are not what they ought to be. The chief competitor is gas, and it is approximately correct to state that electricity at 4d. per unit is dearer than incandescent gas lighting at 2s. Furthermore, as a manufactured commodity, electricity suffers materially from the natural conditions of stress of working, which, as regards production, storage, and distribution, are different to what they are in the case of gas. There is no doubt that, in the corresponding period of the early history of gas lighting, the gas engineer had to face difficulties as momentous as the electrical engineer experiences to-day, and if efficient and economical storage of electrical energy were possible, and the demand from by-products was at all substantial, the electric light business would soon be in a more satisfactory condition.

*The Nature of an Electric Supply Business.*—The central-station engineer and manager has charge of a business which comes within the category of monopolies; consequently whilst he receives some measure of protection, he is very much fettered by undesirable and, in many cases, unnecessary conditions and restrictions which are imposed by the iron hand of a Government department. To be brief, and to give an outline of some of the conditions imposed, the author cannot do better than give the following quotation from Gay and Yeaman's "Central-Station Supply": "Where a general supply of electrical energy is provided in any area, anyone within that area is entitled to a supply on the same terms as anyone else, and no undue preference must be shown to any consumer, but if the charges made for energy be not paid supply can be discontinued. The prices charged shall not exceed those given in the provisional order, but an agreement may be entered into with any consumer as to price and mode of charging, and the undertakers may require any consumer to pay a deposit or to give security for payment of charges against him. The charges may be based upon either the quantity of electrical energy supplied, or by the quantity of electricity contained in such supply—*i.e.*, coulombs or ampere-hours—or by any other method which has been approved. It is, however, necessary to make a general fixed charge per unit, or to adopt some scale that will be equally just and fair to all classes of consumers; and whatever method is finally decided upon, it must be applicable to the public generally, and not confined to any individual or class. From the undertakers' point of view, it is important that the revenue should equal the gross cost of maintaining the service of supply, plus a percentage of profit in the case of companies, and for repayment of capital where the works are in the hands of a local authority."

The ultimate object of the engineer may be briefly stated to be as follows: (1) to produce electric energy as cheaply as possible; (2) to supply electric energy as and when demanded; (3) to evolve a system of charging for electrical energy equitable to all concerned, and thus enable electricity to compete with its competitors—gas, steam, etc.—and at the same time to produce a profit; (4) to popularise and encourage the use of electricity for as long as possible, and for as many purposes as possible.

The problem of devising a rational system of charging is not a simple one, since the operating expenses of an electric supply station are peculiar and dependent upon a number of variable factors, and obviously the price at which electricity can be profitably sold must take into account the nature, as well as the magnitude, of the operating expenses. The determination of the true basis of the cost of production of electrical energy is a complex problem, involving questions depending upon variable demands made at, and for, indefinite and variable periods of time, and taking into account economy of production, plant capacity and efficiency, which may vary with the variable load conditions: and it must be borne in mind that the supply must be available at all times.

The theoretical principle underlying the determination of the operating expenses was first announced by the late Dr. John Hopkinson, F.R.S., in his presidential address before the Junior Society of Engineers, Nov. 4, 1892. He showed, when dealing with the cost of electrical supply, that the expenses of an undertaking may be broadly divided into two classes—*i.e.*: (1) Costs which are quite independent of the extent to which the undertaking is used, but for which capital must be invested. (2) Costs which are absent, unless the undertaking is used, and which increase in proportion to the use. As is well known, it is characteristic of the electric supply business that electricity is practically only produced at the rate that it is used.

Since Hopkinson enunciated these principles no one has dealt more fully and thoroughly with the question of the cost of supplying electricity commercially than Mr. Arthur Wright, of Brighton, who, at various conventions, and by his paper on "Some Principles Underlying the Profitable Sale of Electricity," read before the Institution of Electrical Engineers, Dec. 12, 1901, has placed all central-station engineers and managers under a debt of gratitude for the clear exposition of the fundamental principles involved in this important subject. In one of his addresses Mr. Wright expressed himself as regards the Hopkinson principle as follows: "Dr. Hopkinson in his classical paper very clearly proved that the cost of supplying electricity cannot be correctly defined at so much per unit, unless the *rate of* supplying that unit be also stated, and showed that the cost depends much more on the *greatest rate* at which the electricity has to be supplied than it does on the *amount supplied*. He, moreover, urged that it is both morally unjust and commercially inexpedient to always charge a uniform rate for a manufactured commodity, which in one case might very obviously require 10 times as much plant for manufacturing it as it would in another, owing to its having possibly to be supplied at 10 times as great a rate." The two divisions into which the cost of supplying electrical energy from a central station may be grouped are generally

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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termed *preparation* and *production costs* respectively; the former takes into account the cost of *getting ready to serve*, and the latter the actual cost of *continuing to serve*. For a complete discussion of these items members are referred to Mr. Wright's Institution 1901 paper, already mentioned.

*Systems of Charging for Electrical Energy.*—The problem of standardising central-station rates is beset with difficulties, as will be evident when we consider some of its essential features, and it is interesting to discuss the merits and demerits of the methods which have been proposed. The complete problem involves several distinct elements—*i.e.* (1) the accurate determination of the cost of supply, including every item of expense; (2) the apportionment among the individual consumers of the items of expense, not directly proportional to the cost of the production of the energy supplied; (3) the elaboration from the data at hand of a tariff equitable both to the undertaker and consumer; (4) the popularisation and acceptance of the system thus devised by the public.

To assist members to better grasp the advantages and disadvantages of the systems mentioned below, it will not be out of place here to enumerate some generally accepted theorems: (*a*) it is more profitable to sell continual use of the plant than kilowatt-hours; (*b*) the theory of equity requires that each kilowatt-hour sold should bring a uniform profit to the undertaker; (*c*) a rational system of tariffs must be based upon, and be in conformity with, the costs' curve of the station, from which it is clear that the charge made for the energy supplied must be graded and not uniform; (*d*) in the case of a long-hour consumer of $h$ hours consumption, the *readiness-to-serve* costs are distributed over $h$ times the number of units as compared with a one-hour consumer, provided each takes the same number of kilowatts; (*e*) the price charged for a commodity controls to a great extent the demand for it; (*f*) the more diversified is the demand, both as regards nature and period, the less pronounced will be the peak load

Every station has its own peculiarities according to local conditions, which are seldom so identical as to render the data collected at a particular place precise enough to form the basis upon which a system of charging for another place may be built up; but whilst no one rule as regards price may be devised, still the same principle may be almost universally applicable. The price of gas varies considerably in different towns, but one system is almost universally adopted as to the method of charging. The systems which have been introduced for fixing the price to be paid for electricity may be grouped into distinct classes as follows: (1) flat rates, rentals, and contracts; (2) uniform meter rates, commonly termed flat rates; (3) meter rates with discounts and rebates; (4) sliding scale of charges; (5) two-meter rates; (6) Hopkinson's method; (7) Andrews's method; (8) differential meter rates based on maximum demand; (9) power rates and special rates for cooking and heating.

The most primitive method of charging was to contract to supply electrical energy at so much per lamp installed per annum, or for so many lamps installed. Obviously the long-hour consumer pays less than cost price, and the short-hour consumer more; and, whilst the income is constant, the accounting a minimum, and meter costs absent, there is possibility of fraud and waste, and, excepting when street-lighting is undertaken at contract price, the system has become obsolete, and is a relic of the past.

*The Uniform Meter Rate*—often termed a flat-rate system—is, no doubt, a great improvement upon the old flat-rate system, and is in use to a great extent at the present time. At a fixed price the quarterly account is proportional to the consumption, and the undertaker is paid for what he supplies. The large short-hour consumer, however, does not pay his proper proportion of the readiness-to-serve costs, whilst the long-hour consumer pays more than his just portion of the same. The latter, although he may take less kilowatt-hours, is more profitable than the former. The system is readily understood by, and acceptable to, the public, and although a fixed rate has the recommendation of simplicity, it is difficult to offer inducements to the most desirable customer. The price per unit varies from 4d. to 6d. From the nature of the demand the engineer could well afford to supply the long-hour consumer with some rebate, but unfortunately it is the short hour consumer—of which the early closing drapery establishment of considerable dimensions is an example—who expects and demands a reduction on his account, because the kilowatt-hours consumed is large. Discounts, however, are favoured by some undertakers, and discount granted may be based upon the number of units consumed. If the duration of service be ignored, then the wrong individual—*i.e.*, the large short-hour customer—reaps the benefit, since it is the rate at which the supply is given, more than the quantity supplied, which augments the costs' curve; the principle, in such cases, is therefore irrational, and the long-hour consumer would be unfairly treated. It would, in fact, be extremely difficult to exactly apportion the proper amount to be deducted between the individual consumers when the magnitude and duration of the demand vary so considerably with different classes of consumers.

The principle of granting discounts is so prevalent in everyday commercial practice that not only have they been offered to the more profitable customer, but some engineers maintain that discounts should also take into consideration the period of the year. M. de Fodor, for instance, proposed in his paper read at the Paris Congress in 1900 to offer three scales of discounts according to the time of the year—one applying from October to February inclusive, another during March, April, May, and September, and a third one from June to August inclusive. It has been found at Budapest that the bills for current in the months of December and July respectively were in the ratio of 7 to 1, and as the generating station has a minimum load during the summer months, Fodor considers that greater discounts can be given during these months than during the winter months. As an example of his scale of discounts, it may be mentioned that a consumer having 20 lamps installed and using 440 lamp hours on the average, is supposed to use 1,200 and 1,000 lamp hours in January and February respectively, and would be allowed a discount of 20 per cent. for consumption in excess of these amounts. For the other months the scale is given in the following table:

| Month. | Consumption in lamp-hours before discount allowed. | | Percentage of discount for excess. |
|---|---|---|---|
| March | 720 | | |
| April | 580 | ... | 40 |
| May | 380 | | |
| June | 240 | | |
| July | 200 | ... | 60 |
| August | 280 | | |
| September | 580 | ... | 40 |
| October | 1,000 | | |
| November | 1,280 | ... | 20 |
| December | 1,340 | | |

The main idea is that this system will educate the public to understand the advantages of electric lighting during the period of low tariff; on the other hand, there must of necessity be some extra trouble in preparing the accounts. A similar system has been introduced at Les Halles, Paris, but in this case the customer pays a fixed amount with an addition proportional to the consumption.

The correct method of giving a rebate would necessitate the division of the consumers into groups of equal value to the station with regard to profitableness rather than the magnitude of the consumption. And this idea introduces the principle of a sliding scale of charges, which is justifiable from the point of view that the service demanded of the station may be more cheaply rendered to long-hour consumers than to large short-hour consumers. Sliding scales, however, have not been introduced to any great extent on account of the difficulty experienced in getting out the accounts. The best-known example of a sliding scale charge is the one which was in use at Ayr for some time, and consisted in giving discounts to the consumer according to the duration of their demands, which in the case of shopkeepers was fixed by the hour of closing. Shops closing at 7 o'clock received no discount; public houses, restaurants, etc., closing at 10 p.m. received 22½ per cent., and private houses 35 per cent.

*Two-Rate Meters.*—On the assumption that the production costs are less between certain hours of the day than at periods in the neighbourhood of the time of the peak, a system has been proposed by some engineers (and has

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been introduced to some slight extent) in the shape of a differential rate, depending upon the period of the day at which the demand is made, and electricity is offered at a low rate at periods of light load and at a higher rate at periods of heavy loads. Although by some this is considered a satisfactory principle, it appears to be unsound, and nothing more than a special inducement in the nature of bargain hunting to use lamps when the natural light is available with the exaggerated idea that the hollows of the load curve will be filled up and the curve be flattened. Now, whilst it is desirable to encourage the full use of all the lamps for as long as possible, and at times other than at the peak load, it ought to be remembered that, in a general way, the consumer only requires light when the natural light fails, and, except (1) in the case of basement property where artificial light is more or less necessary, and (2) at special times, as at the dawn of day, there appears to be no reason (omitting, of course, considerations of motor day loads) why a day supply should be fostered by selling electricity, say, at half-price, and introducing a more prohibitive rate when the natural demand should take place, whilst to the majority of consumers the inducement is offered when electricity is not a necessity. Surely, this is equivalent to offering a bounty to the low-load consumer, inasmuch as a two-rate system, as ordinarily used, tends to flatten the load curve by reducing the peak, instead of building up the low-load curve. The only *raison d'être* of the differential time-rate system is that an early morning consumer making a reasonable demand should meet with some encouragement in the shape of a diminished charge, since he then contributes less to the peak, and his charge may with advantage be based upon, and correspond to, the actual output of the station as a whole, provided such charge contributes something to the standing-by charges. It thus differs from the ordinary demand system, since the charge depends only on an individual demand. To differentiate between the alternative and recurrent periods of daylight and darkness necessitates the use of two-rate meters, or some clock-controlled metering device which registers at an increased or diminished rate according to the period of the day. Neither time nor space will permit anything like a descriptive account of the novel and ingenious devices which have been introduced for the two-rate registration, and it will probably suffice to mention some well-known examples which have been introduced or suggested, such as the Baron switch, Kapp's meter switch, the Norwich device, and the Wilson meter switch. An excellent account of most of these are given in Mr. R. P. Wilson's paper read before the Northern Society of Electrical Engineers on March 8, 1897. It is to be feared that many consumers would have little faith in a meter which could be made to run fast or slow as desired, according to the period of time and at the option of the undertaker.

Considerations of Hopkinson's fundamental principles as regards the total cost of production impress one with the fact that the ideal tariff should be based on a principle which apportions to each consumer an amount for his service which is commensurate with the total cost of the same, and with this end in view the systems numbered 6, 7, and 8 above have been introduced. Hopkinson's system is a rate which is composed of a fixed charge on the *demand installed*, plus a charge per unit actually consumed, whilst Andrews's system is a rate which is composed of a fixed charge on the *demand taken*, plus a charge per unit actually consumed, and the last, or Wright's maximum demand system, is a *differential* meter rate *varied by the time the maximum demand is used*. Hopkinson's, or the Manchester system, has not been adopted to any extent, as it is obvious that any scale which includes a fixed charge per lamp capacity seriously tends to restrict the number of lamps installed. It has also the defect that the number of lamps may be increased without notice being given of the change. At Burnley the fixed charge is £8 per annum per kilowatt of maximum demand, plus the charge of 2d. per unit consumed, with the option of a uniform tariff of 6d. per unit, with discount for prompt payment. The system introduced at Hastings by Mr. Leonard Andrews is a modification of the Hopkinson system, and embodies a fixed charge for the maximum number of lamps simultaneously lighted during the quarter, plus a fixed price per unit consumed. The actual rate is 10s. per annum per 8-c.p. lamp, paid quarterly, plus $1\frac{1}{2}$d. per unit consumed, with the option of a uniform tariff of 6d per unit. The maximum number of lamps in use simultaneously is ascertained by a demand indicator calibrated in lamps, a "lamp" being assumed to take 0·35 ampere at 100 volts.

Mr. Arthur Wright's system is an improvement of Hopkinson's method, and takes into account the actual maximum demand instead of the maximum possible demand, and in addition gives a rebate according to the customer's load factor. It probably more nearly approaches the ideal system than the others, in that the charge made to the consumer more nearly approaches the cost he occasions than they do. It has been adopted in many places with slight modifications and has received a fair measure of success. The actual charge made differs somewhat in different places, but the general principle may be taken to be 7d. per unit for the first hour's use (for 365 days per year) of the maximum demand, and 1d. per unit per hour afterwards. The demand is indicated by a demand or rebate indicator, which is a type of thermal self-recording ammeter, being essentially a differential air thermometer, and is calibrated to indicate the current in amperes; it also possesses a second scale or table of "the units to be consumed per quarter before the reduced price is charged." The value at which the higher rate is charged for any quarter is taken to be the average of the maximum demand readings for the three months, and the number of units to be charged at the higher rate may be calculated as follows

$$\text{Units at higher rate} = \frac{\text{amperes} \times \text{volts} \times 1 \text{ hour} \times \text{No. of days in quarter}}{1{,}000},$$

Although this system has been received so favourably, it has still met with a considerable amount of criticism,

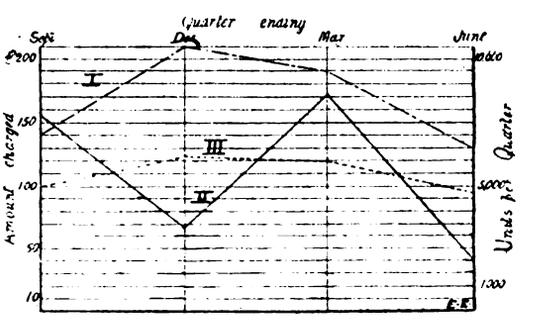


FIG. 1.

which is due probably to the fallacy of pushing the *preparation costs* argument too far. A little consideration shows that even if the central station is only to be held ready in its greatest capacity for the period of its maximum load, a certain part of it must also be held ready for other periods, and logically it appears reasonable to distribute the *readiness-to-serve* costs upon the consumers as a whole for each part of the central station, who in the course of the whole year make use of it, since for all of these it has to be kept ready in the same manner. It is also questionable whether a charge based on the maximum demand irrespective of the time which it occurs tends to improve the conditions of the load, and whether it does not discourage a liberal installation and consumption of current by keeping down the maximum demand. As evidence that the system is not quite perfect, it may be mentioned that when an abnormal and exceptional demand is made for special occasions or purposes exceeds and the normal maximum demand, permission is usually granted for cutting out of action the indicator, provided due notice be given to the officials beforehand and request be made for them to short-circuit the indicator for the occasion. Then, again, the large short-hour consumer is unjustly penalised, whilst the small shopkeeper who lives over his shop receives more than his just share of the benefits attending long-hour consumption. It is also somewhat difficult to get the layman to understand the principle upon which the charge is made, and considerable objection has been raised to the system on this score alone. And as Mr. Andrews has pointed out,

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there may, in some extreme cases, be considerable irregularity in the magnitude of the quarterly accounts, an example of which is shown in Fig. 1, in which Curve I. gives the units per quarter, Curve II. gives the charges per quarter according to the Wright system, whilst Curve III. gives the charges by the Andrews system. Some objection has also been raised against the system on account of expense and complication, and also that the readings of the demand indicator cannot be rectified if an error be made in taking the readings. The following statement was made by Mr. R. P. Wilson during the discussion of Mr. Wright's 1901 Institution paper: "The spirit of the method has to be departed from, because the indicated demands are not at all simultaneous; as a matter of fact, the sum of the demand indicator readings is 50 per cent. more than the actual demand as represented by the actual output of the station at Brighton. And although in making out the accounts this discrepancy is taken into consideration, all the consumers do not benefit in the proper proportion." It should also be pointed out that the charges may be modified according to the period of the year, and the indicator now has both a summer and winter scale of charges attached. It may be interesting to mention, however, that Mr. Louis A. Ferguson introduced a modification of the maximum demand system at Chicago in 1897 such that different hours' use of the maximum demand in the winter and summer was taken into account, but in 1901 he abandoned the different scales for the summer and winter rates.

The following are brief accounts of some rates of charges which have attracted some attention in America. At Cleveland (Ohio) the rate is 6½d. per kilowatt-hour for 50 hours' use of all the lamps connected, and 2·46d. per unit for all current used in excess of the 50 hours. The consumer guarantees such a use of his installation as will ensure to the company a gross sum equal to at least 7·38d. for each 16-c.p. lamp, or its equivalent. With the Doherty system, in use at Denver, Madison, etc., in the United States, every consumer pays 50s, plus 25s. for each meter more than one, plus 7s. 6d. per lamp connected, plus 2½d. per kilowatt-hour for current consumed. From the aggregate a discount of 20 and 10 per cent. is allowed. In the "Foresee" system, introduced by Mr. L. R. Wallis, the consumers contract with the company for a period of one year, agreeing to pay for the capacity demanded in 16-c.p. lamps, or their equivalent, at a certain definite tariff rate, plus a meter rate of 3d. per unit.

As Mr. Arthur Wright stated in his 1901 Institution paper: "There is generally in most controversies a substratum of truth underlying many of the strongly held opposing views," and it is noteworthy that a combination of two principles may be more just and equitable than either taken separately. Thus, the old flat rates resulted in loss with long-hour consumption, whilst a flat meter rate is unprofitable with short-hour consumption. By the former the standing-by charges are well covered, and by the latter a long-hour consumer obtains more than his proportion of the production costs; but the combination of the two systems forms the basis of the theoretical principle announced by Hopkinson. In fact, many of the accepted proposals are substantially correct theoretically, although attended in some cases by complications, if the principles of the Hopkinson tariff be included when deciding the basis of the charges. Discount and rebates for largeness or duration of consumption are certainly attractive, and give to a system something of the nature and merits of a sliding scale in the case of high initial flat meter rates; but several examples could be given where the committee of the municipal authority has fixed the initial flat meter rate so low as to render it impossible for discounts to be entertained, even with the most profitable consumer. Standard rates with discounts based on quantity used would be extremely satisfactory with stations of moderate size if there were no day or power load.

With respect to the special charges made for power, cooking, and heating, it is generally recognised that these items form the waste products of the electric light business, and in most cases a fairly low flat meter rate is adopted for electrical energy supplied for these purposes. Probably this is due to the fact that motor loads have to compete with gas, steam, and hydraulic power, consequently the price to be charged for electricity for power purposes has to be fixed more by the charge made for gas, steam, etc., than by its relation to the total costs of production. The rates for power purposes, in fact, must of necessity be so low that only a minimum amount, if any at all, can be placed to the credit of the *preparation costs*; in other words, Hopkinson's principle must practically be ignored. Since electrical energy may be produced for something like ¾d. per unit in the case of modern power stations in connection with large works, it is obvious how keen a competitor an isolated plant may become, and extreme care has to be exercised in fixing motor rates for power purposes. Another matter connected with power loads is that as the business grows there is the possibility of the lighting and power loads superimposing one another at the peak of the load curve, and the character of the load curve be not improved. This overlapping of the lighting and power loads in large manufacturing centres becomes particularly important in the winter time, and it is difficult to draw the line between discretion and rashness as regards accepting certain classes of consumer. One solution of this phase of the problem has been found to produce good results in Canada, and that is to offer such low rates for power during the daylight hours that manufacturers find it to their interests to close down their works before the heavy lighting load comes on. If a discount can be safely offered to a consumer taking considerable energy, it is surely to the one who has a motor load in the daytime. In such cities as Sheffield there will of necessity be some overlapping, and in all cases care must be taken that some profit is made for each kilowatt-hour sold; then the net earnings of the station may be increased, although, as in the case of power loads, the net earnings per kilowatt-hour of output may fall off. The writer firmly believes that it is more profitable to sell continuous use of plant, and secure an improvement in the profits upon the capital invested by offering electricity at such rates that the income per kilowatt is a minimum, than to permit 70 per cent. of the plant to remain idle The matter is one of tact, business capacity, and good management; surely, if a large power-house can be run more economically and with less aggregate capacity than a number of smaller ones, we ought to make a small margin of profit per kilowatt, even in the case of motor loads. It is on this principle that the promoters of the large power distribution schemes are expecting to make a profit, and central-station engineers in our towns and cities are called upon to effect such economies in their methods of working as will enable them to do likewise.

Motor loads must undoubtedly be encouraged, since the diversity factor of power loads is large, and the ratio of the energy thus consumed to maximum output of the station will, in consequence, be large. The above remarks refer more particularly to the case of supplying isolated large works with power; the case is much improved when a large number of consumers requiring power intermittently can be supplied from the mains. The competitor in such cases will probably be gas, and the rate to be charged for electricity should be more or less than 2d. per unit according as the gas is dear or cheap. Mr. Highfield states that a motor load at 2d. per unit works out as regards cost at very much the same rate as with gas at 2s. (for power), but that after two hours' motor service gas is cheaper and the price for current should be reduced. The author gives the following as an example of the relative cost of gas and electricity for power purposes: A 9-h.p. gas-engine, with gas at 1s. 6d., costs from 22s. to 26s. per week, including gas, interest, renewals, etc.; whilst a 9-h.p. single-phase motor which replaced the gas-engine, with electricity at 1½d. per unit, cost 14s. to 16s. per week. The superior qualities of the electric motor for intermittent service should be well advertised, and the author believes that were manufacturers better educated as regards motor service, better rates and profits would be secured. Our American cousins surpass us in this respect, and one American central station claims to supply eleven-fourteenths of all the power used in the town in which it is situated. At the University College, Sheffield, the compressor, blower, converter, cranes, and all the foundry machines in the metallurgical department are worked by two-phase motors, the current for which is taken from the town mains, and

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it is hoped to demonstrate how electricity may be applied efficiently and economically in ordinary steelworks.

A method of charging for current for power purposes recommended by some engineers is to make a fixed rental per horse-power plus a charge in proportion to the energy consumed. Thus, at Bristol the rental is £6 per annum per kilowatt and a charge of 2d. per unit. Calculation shows that advantage only occurs after 720 hours per annum, and with this number of working hours per year the annual cost of a kilowatt would be £12. There are now about 30 central stations supplying current to tramway systems, and as electric traction is but a special form of power service, it is satisfactory to note that the addition of a traction load has proved that with a lower average income per unit a central station may be in a more prosperous condition than with a higher average income per unit, and also that it is a safe as well as a bold policy to introduce low tariff rates, and diminish the difference between the operating costs and selling price provided there is a margin of profit. If a central station could operate at an approximately constant load for 24 hours per day the service would be an ideal one, and the commercial age of the electric light business would be realised. Then a uniform rate would be the ideal rate; but at present a uniform rate for all purposes and at all times is not only impracticable but unjust. A differential rate in some form, in the author's opinion, has certainly many points in its favour, and is the most workable system, provided the initial rate is not too high. A leading article in the *Electrician* some time ago referred to the Wright maximum demand system as a "tonic," and suggested that, as soon

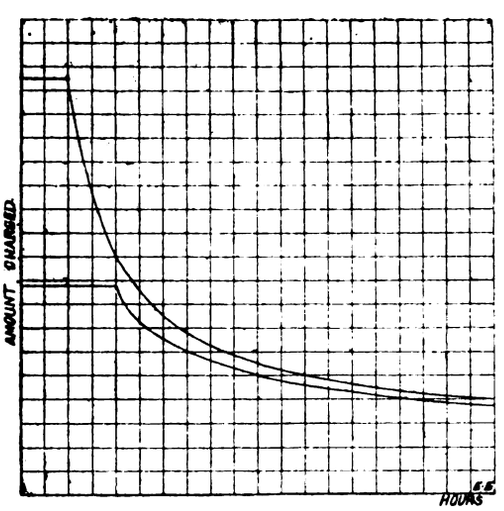


FIG. 2.

as developments and profits permit, the initial rate should be reduced, but that the period during which the maximum demand must be paid for should be increased. Fig. 2 gives two curves showing the effect of changing the rate from 7d. for one hour per day, with 1d. per unit afterwards, to 3½d. for two hours per day, with 1d. per unit afterwards. The natural result of this principle gives one the idea that, as the load factor improves and approaches unity, the tendency will be to introduce a uniform tariff rate, in which case the principle will be theoretically and commercially sound.

The problem of fixing an equitable rate may best be simplified by improving the load curve, and by introducing means to raise the central-station business to such a status as will make it commercially sound. The one great obstacle at present is the unsatisfactory state of the wiring question, which undoubtedly acts as a deterrent to the acquisition of the most profitable class of consumers for lighting—*i.e.*, the small householder. Until house mains for electric circuits occupy the same position as gas-piping for gas service, and become the property of the landlord, there is little possibility of inducing the small consumer to change from gas lighting to electric lighting. If the preparation costs principle be such an important factor in fixing the price of electricity from the supply point of view, should not an analogous principle be recognised (in the case of small householders) as an item to be dealt with in the endeavour to improve the lighting load? The first cost of wiring and fitting is often the stumbling block to the introduction of the electric light, and its removal would eliminate one of the causes of the backwardness of the electric light business. By tabulating, as in Appendix IV, the number of lamps installed per 1,000 inhabitants for the 12 largest cities and towns in England, clear indication of the present status of the industry is obtained, and there is no doubt that the acquisition of the small householder would not only improve the number of lamps per 1,000 inhabitants, but also the number of *lamp-hours used* per 1,000 inhabitants, and thus do more than any other element to settle the question of rates. The sooner the growth of the electric light business is such as to affect the supply of gas, the sooner will the question of charging settle itself. Some attention also ought to be given to the question of the efficiency of the incandescent lamp, as an improvement in this direction is much to be desired. Engineers are agreed that the incandescent gas mantle has enabled the gas people to maintain their position as successful rivals for the patronage of the public as regards lighting; they are also agreed that a demand for current for heating purposes would improve the load factor of a central station, but it is to be feared that the low efficiency of electric radiators also interferes with the growth of this

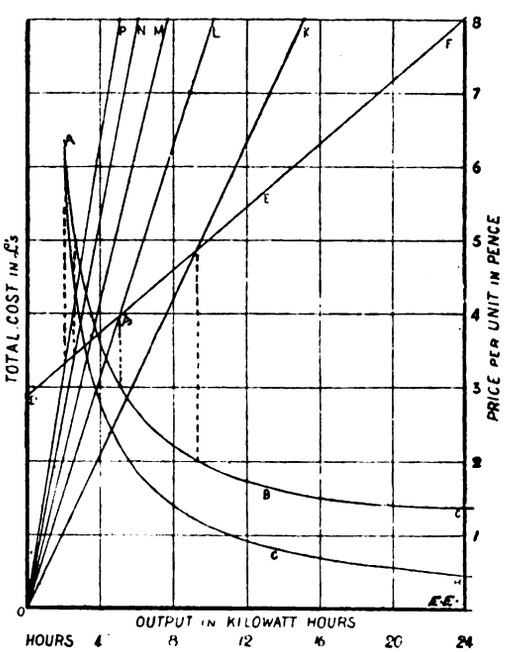


FIG. 3.

branch of electric supply. These and similar causes are at work tending to prevent the extension of the electric supply business. Engineers should not be content with 70 per cent. or more of plant lying idle, and it must be acknowledged that no detail is so slight as to be inconsequential, since each has its effect on the cost of production, and, therefore, on the price to be charged.

In conclusion, the author trusts that, although he has no system of his own to extol, the subject matter of the paper will not be without some interest to the members of this section, and that he has made it clear that, in his opinion, the electric supply business ought now to be considered as a straightforward trading concern, in which success depends just as much upon commercial tact and judgment as upon technical and engineering skill.

## APPENDIX I.

*Application of Elementary Principles to determine the Price of Electricity.*

A. Since the total cost of production of electrical energy is made up of two factors—*i.e.*, the preparation costs and production costs—we may, in searching for a method of fixing the selling price of electrical energy, consider each component separately, as if the other were absent. If the operating costs of a central station were wholly production costs, then on a diagram with cost per unit used as ordinates, and hours of daily use as abscissæ, the resulting curve

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would be a horizontal straight line, and indicate a uniform tariff, whilst if the operating costs were wholly preparation costs and constant in magnitude, the resulting curve would be a rectangular hyperbola. The former would naturally correspond to the load curve of a station, with an ideal service of full load for 24 hours per day, but as this ideal condition is not realised, the actual costs curve will be intermediate between the rectangular hyperbola and a horizontal straight line, and will indicate a differential tariff. Such a curve for a station of 5,000 kw. capacity is represented by the curve A B C in Fig. 3, which has been obtained from actual data of a certain central station. The ordinate O D represents the preparation cost for this station per month, and includes interest, depreciation charges, etc.; and the straight line D E F has been obtained by adding to the preparation cost a quantity directly proportional to the production cost (fuel, etc.) for different outputs in kilowatt-hours. The equation to the curve D E F is

$$y = a + m\,x,$$

in which $y$ is the total cost for $x$ kilowatt-hours per month, $a$ is the preparation cost per month (or the constant O D, and $m$ ( 82d. in this case) is the production cost per kilowatt-hour. By dividing the values of the ordinates of the curve D E F by the values of the corresponding abscissæ—by dividing the total cost by the corresponding output—the curve A B C is obtained, which represents the cost per kilowatt-hour, and the equation for this curve is:

$$y_1 = \frac{a + m\,x}{x} \quad \ldots\ldots\ldots \text{(A)}$$

$$= \frac{a}{x} + m \quad \ldots\ldots\ldots \text{(B)}$$

Equation (A) indicates that the cost per kilowatt-hour is a function which varies inversely as the use of the current, whilst equation (B) shows that if there were no production costs, and $m = o$, then $y_1\,x = a$ (a constant), which is the equation of a rectangular hyperbola, and which, for the case under consideration, is represented by the curve A G H. Again, if a uniform meter rate be charged for electrical energy, the equation of the curve representing the cost of a number of units consumed will be

$$y = p\,x,$$

since the curve passes through the origin, O. In the figure the five straight lines, O K, O L, O M, O N, and O P have been plotted by taking as values of $p$, 2d, 3d., 4d, 5d., and 6d. per unit, they are, therefore, the cost of output rates at 2d., 3d., etc., and it will be noticed that these lines intersect the line D E F at the points $k$, $l$, $m$, $n$, and $p$. Taking the case of the point of intersection of the curves O L and D E F, the co-ordinates of which are $x$ and $y$, the equation for the curve D E F is $y = a + m\,x$

and " " O L is $y = p_3\,x$,

from which $$x = \frac{a}{p_3 - m}.$$

Now, let $y_1$ = the cost per kilowatt-hour for the particular output of $x$ kilowatt-hours—*i.e*, the value of the ordinate of the curve A B C for $x$—and

$$y_1 = \frac{a}{x} + m$$

Substituting $\frac{a}{p_3 - m}$ for $x$ we obtain

$$y_1 = \frac{a\,(p_3 - m)}{a} + m = p_3.$$

As the result implies, and the diagram shows, the curves O K, O L, etc., intersect the total costs curve, D E F, at the same output that the curve A B C intersects the horizontal line giving the corresponding rate or price per unit. These curves give several other interesting relationships. Thus for the central station considered the maximum output for a month of 30 days when running at full load continuously is

Maximum output possible = (5,000 kw. × 24 hours × 30 days) kilowatt-hours = 720 K,

where K = capacity of station in kilowatts, and the curve D E F shows that for continuous work the cost will be 1d. per kilowatt-hour. Then, again, if the maximum output be divided into 24 equal parts, each portion would represent one hour's average daily use per month, and the rates for different lengths of service per kilowatt, as given by the curve A B C, are as follows:

| | |
|---|---|
| 5·4d. for 1 hour. | 1·97d. for 4 hours. |
| 3·13d. " 2 " | 1·75d. " 5 " |
| 2·36d. " 3 " | 1·60d. " 6 " |

B. In his 1901 Institution paper on "Some Principles Underlying the Profitable Sale of Electricity," Mr. Arthur Wright gives the following particulars for enabling the calculation to be made to find how much electricity any consumer has to pay for according to the principles of the maximum demand system before he is entitled to the rebate, and also how to determine the rebate price:

"If D = the consumer's demand in kilowatts;
K = the annual cost of standing-by in pence of each kilowatt demanded;
M = the maximum price allowed to be charged per unit;
$p$ = the production cost per unit;
$u$ = the total number of units expected to be sold in the year in question;
$\frac{1}{r}$ = the ratio of the net profit to the total charges against revenue account;
L = the total loss in pence expected to be made on the supply to the small load factor consumers;
D × H = the amount of electricity that has to be paid for at M pence per unit before the second price, P, is charged;

then $$\text{D} \times \text{H} = \frac{\text{D K}\,(r+1)}{\text{M}\,r - p\,(r+1)}$$

$$\text{P in pence} = p\left(\frac{r+1}{r}\right) + \frac{\text{L}}{u - \text{MD} \times \text{H}}$$

As an example, take the Brighton figures of 1900:

Here M = 7, K = 2,320, $p$ = ·6d., let $\frac{1}{r} = \frac{1}{10}$, L = 880,000d., $u$ = 3,726,000, and D = 1 kw.

Then D × H = 403 units,
or H = 403 hours,
and if M D = 2,950, P = 1d.,

or after a consumption equivalent to the use of the maximum demand for 403 hours, the price can be reduced from 7d. to 1d. to produce the required margin of profit."

In the same paper two forms are given, in each of which the maximum demand tariff can be stated. The first is: "A charge of 8d. per unit, or higher where possible, for that part of the consumption which is equivalent to the use of the consumer's demand for —— hours a year, or quarter, or month, whichever period is considered most suitable for the district, and —— pence for any further consumption in the said period. The second form (which is equivalent to the first in the case of all but the smallest load factor consumers) is stated in terms of a yearly or monthly charge per lamp demanded and a charge of —— pence per unit for the electricity consumed.

If L = the yearly rent in shillings of each demanded standard lamp;
M = the highest price allowable, and
P = the price per unit after consumption equivalent to H hours' use of the demand;
W = watts of standard lamp;

$$\text{L} = (\text{M} - \text{P})\,\frac{\text{W H}}{12{,}000}.$$

Thus if M = 8d., P = 1d., and H = 365 hours, and W = $33\frac{1}{3}$, then a tariff of 8d. for the equivalent of the use of a consumer's demand for one hour per day and 1d. afterwards is the equivalent to an annual rent of 7s. per lamp

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demanded and 1d. for every 30 hours' use of such standard lamps."

C. Mons. G. Claude has pointed out another principle for the determination of the rate to be charged according to the class of consumer. Even if the maximum demand system be adopted it may be advisable to differentiate between different classes of consumers. In the first place a consumer may take a large quantity, and upon the principle that the cost charged ought to increase less quickly as the demand increases, instead of directly proportionately, the initial price should be of the form :

$$p = \frac{k}{x+q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (C)$$

so that the total cost should be

$$y = \frac{k\,x}{x+q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (D)$$

in which $k$ and $q$ are suitable coefficients. Curves I. and II. (Fig. 4) have been plotted to give the tariff per kilowatt

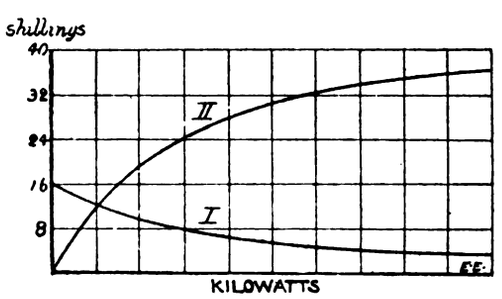


FIG. 4.

per month and the cost per month respectively, taking $k = 30$, and $q = 3$. Claude also introduces what he terms "a coefficient of consumption," and argues that the magnitude of the amount of energy taken per month as well as the maximum demand should be taken into account. Let C be the coefficient of consumption, which is defined as the ratio of the effective consumption to the maximum possible consumption according to the maximum demand indicated. Then the price of a unit as a fraction of C would be of the form

$$p_1 = \frac{k_1}{C+r},$$

and the total amount of energy consumed during the month (H hours) would be of the form

$$W = H\,C\,x \text{ units},$$

and the costs of these units would be

$$y_1 = \frac{k_1\,H\,C\,x}{C+r}.$$

Taking $k_1 = 0{\cdot}3$ and $r = 0{\cdot}4$ the curve in Fig. 5 has been obtained as the price of a kilowatt-hour as a function

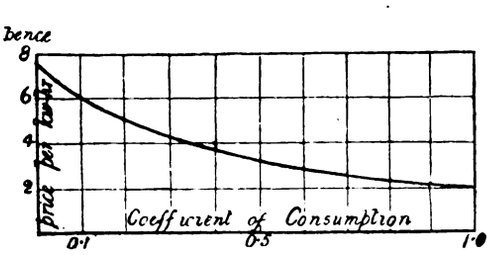


FIG. 5.

of the coefficient of consumption. The total cost to the consumer for his monthly consumption would amount to

$$Y = y + y_1 = \underbrace{\frac{k\,x}{x+q}}_{\text{Preparation component}} + \underbrace{\frac{k_1\,H\,C\,x}{C+r}}_{\text{Production component}}$$

The mean price per kilowatt-hour would therefore be

$$P = \frac{Y}{H\,C\,x}$$

$$= \frac{k}{H\,C\,(x+q)} + \frac{k_1}{C+r}$$

Taking the same values of $k$, $k_1$, $q$, and $r$ as mentioned above, H = 720 hours, the mean price per unit has been plotted in Fig 6 for different values of C, the coefficient of consumption.

## APPENDIX II.

### *Some Continental Flat Meter Rates.*

According to the *Electrical World and Engineer* (New York) of Nov. 14, 1903, and on the authority of Mr. F. H Mason, United States Consul-General at Berlin, the cost of electric current for lighting purposes at Berlin will be reduced from 6 6d. to 4 8d. per kilowatt-hour from Jan. 1, 1904. This change of price is made to meet the competition

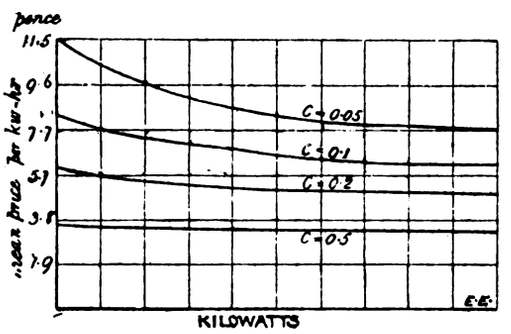


FIG. 6.

of gas, which is furnished for lighting as well as for heating and cooking purposes at 3·78s. per 1,000 cubic feet. The rate for lighting purposes per kilowatt-hour in some of the Continental cities is as follows :

| | | | |
|---|---|---|---|
| Budapest ..... | 11·56d. | Dresden ..... | 7·38d. |
| Cologne ..... | 9·1d. | Frankfort ..... | |
| Leipzig ..... | | Munich ..... | |
| Nuremberg ... | | Hamburg ..... | |
| Genoa ..... | 8·856d. | Vienna ..... | |
| Breslau ..... | 8·364d. | Christiania ... | 6·9d. |
| Rotterdam ... | | Copenhagen ... | |

For power purposes electric current is supplied at Berlin as low as 2·04d. per kilowatt-hour in large quantities during daylight hours ; this price is to be still further reduced to 1·68d.

## APPENDIX III.

### *Combined Traction Loads.*

With the object of eliciting the opinions of engineers conversant with the practice of supplying current from a lighting station for traction work, the following notes are added. Speaking generally, it may be stated when the mean load of a fair-sized tramway system is about 70 per cent. of the full load, and the running hours are 16 per day, the load factor is about 50 per cent., and there should not be much trouble in ascertaining the correct basis for charging for energy when the consumption is for traction purposes. Mr. C. H. Gadsby, in the discussion on Mr. Hammond's paper on "The Cost of Electric Energy," which was read before the parent Institution in 1898, stated that 500,000 or 600,000 units per annum ought to be supplied at less than at 1d. per unit, and he gave an equation by means of which, in his opinion, the charge to be made for current for traction purposes by a municipal electric lighting undertaking could be readily determined. It is an equation of a straight line law, and is as follows :

$$y = 0{\cdot}002\,x + 100,$$

in which $y$ = pounds sterling paid monthly for current and $x$ = number of units taken monthly. By applying this equation, and substituting the following values of $x$, the charges should be

| | | | | |
|---|---|---|---|---|
| 3d. | per unit when | $x =$ | 100,000 | units per annum. |
| 1½d. | ,, ,, | $x =$ | 400,000 | ,, ,, |
| 0·9d. | ,, ,, | $x =$ | 700,000 | ,, ,, |
| 0·75d. | ,, ,, | $x =$ | 1,200,000 | ,, ,, |

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It may be mentioned that there are nearly 30 traction systems in the British Isles taking current from lighting stations.

APPENDIX IV.

| | Population. | Lamps per 1,000. |
|---|---|---|
| London | 4,546.000 | 329 |
| Liverpool | 685.000 | 218 |
| Manchester | 543.000 | 294 |
| Birmingham | 522.000 | 120 |
| Leeds | 428,000 | 124 |
| Sheffield | 380,000 | 131 |
| Bristol | 328,000 | 139 |
| Bradford | 279,000 | 48 |
| Nottingham | 239.000 | 208 |
| Hull | 238,000 | 224 |
| Salford | 221,000 | — |
| Newcastle-on-Tyne | 214,000 | 174 |

## GAS POWER FOR CENTRAL STATIONS.

Before the American Institute of Electrical Engineers last month, Mr. J. R. Bibbins read a paper in which he claimed that on the score both of simplicity and economy in working gas power is more suitable for central-station service than steam power, and, secondly, that gasworks labouring under low load or output factor can profitably instal a gas-power electric generating plant, and become its own largest customer, selling both gas and electricity at competitive prices. The basis of the paper consists of data collected from various electric light and power plants in the United States using gas-engines as their principal motive power. The advantages which the author claims for the gas-engine for central stations are many, and among them are the following: minimum fuel and heat consumption; light load efficiency higher than steam-engine of corresponding size; low cost of operation and maintenance; simplification of equipment; small number of auxiliaries required; absence of "stand-by" losses; quick starting; waste heat in jacket water suitable for building heating; power can be stored during light loads at small cost in the form of gas in holder; and, finally, subdivision of units more easily accomplished, yielding higher all-day economy. An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat losses cease. Also, during operation no heat is lost by the gas in transit from the producer, and the plant is not hampered by inefficient auxiliaries. From the data given by the author, it seems that the average gas consumption of the stations considered is 39 cubic feet per kilowatt-hour. Assuming an average calorific value of 625 British thermal units per foot for coal-gas, water-gas, or mixed gas, the heat consumption is 24,400 British thermal units per kilowatt-hour, 18,200 British thermal units per electrical horse power hour, and 14,500 British thermal units per brake horse-power hour. The combined efficiency of the average station is stated to be 80 per cent. Tables are given showing the comparative cost of steam and gas power. The cost of coal in the steam plant was ·69d. per kilowatt-hour, against 0·37d. per kilowatt-hour in the gas plant, representing a saving of 45·5 per cent., although the cost per 1,000 British thermal units of gas was 3·4 times that per 1,000 British thermal units of coal. Assuming calorific values of 14,000 and 625 British thermal units per pound and cubic foot respectively, 92,000 British thermal units were required per kilowatt-hour in the steam station, against 29,100 in the gas station, or a saving in the latter of 68½ per cent. The general balance of economy is on the side of the gas station. The steam plant started operation on natural gas at 5d. per 1,000ft., with a minimum of £600 per year. It employed boilers fired by gas. One year after starting the gas plant this minimum was reached, and the company is now paying at the rate of over 8d. per 1,000ft. The saving in total cost amounted to 40·5 per cent. In the face of a 30 per cent. increase in station output the gas consumption has been reduced by 93 per cent. The author bases the theory of increase of profits from the operation of combined gas and electric plants upon the fundamental principle of reduction in cost per unit with increased output. He gives curves showing the cost of coal-gas, water-gas, and mixed gas for approximately 500 gas plants. These curves bring out the following points: (1) cost per unit decreases as output increases, most rapidly in coal-gas plant and less rapidly in water-gas plants; (2) decrease in cost per unit in small plants of 2,000,000 to 10,000,000 per year output is very marked, being greatest in water-gas plants and least in mixed-gas plants; (3) the greatest opportunity for increasing revenue from combined gas and electric stations appears to be in the case of small coal and water gas plants under 10,000,040 output. The smaller the plant the greater the profit. Comparing the operations of the gas station *per se*, previous to and following the acquisition of the electric station, there is a net revenue of £1,167 and £1,468 respectively, or an increase of £301 (25·8 per cent. of the original revenue). Figuring in the saving of 10 per cent. per 1,000, due to increased production, the total increase amounts to 43 per cent. of the net revenue upon the original gas station. Considering, finally, the combined works, the increase is £1,490, or 127 per cent. of the original revenue, and adding again the saving, 5d. per 1,000ft. on the cost of gas, the total increase is 145 per cent. of the revenue of the original gasworks. Although these percentages will be considerably reduced by the consideration of investment charges, depreciation, sinking fund, etc., the fact remains that the saving due to combined operation is material, and should appeal particularly to companies operating independent gas and electric generating stations.

## GROWTH OF CENTRAL STATIONS IN AMERICA.

In the last 20 years or so the increase in the number of central electric generating stations and proportionately the plant installed has been truly remarkable. Some statistics recently published by the Bureau of the Census give a good idea of the present magnitude of this branch of electrical application. These figures cover both private and municipal plaints, but they do not take into consideration electric railway stations and isolated plants, though a few of the stations classified supply power for railways. The report is made up to June, 1902, and on this date there were 3,620 electric stations in operation, the capital cost of building and equipment being £100,948,070. These stations furnished employment to 23,330 wage-earners last year, who received £2,996,622 in wages, or an average of £128 per man. There was installed in these stations power plant equipment consisting of 5,930 steam-engines with 1,379,941 i.h.p., and 1,390 water-wheels with a rated horse-power of 438,472. The generating plant consisted of 12,484 dynamos of every description, with a rated horse-power of 1,624,980. The total number of stations in the hands of municipalities was 815—a fairly good proportion of the grand total. They represent a capital outlay of £4,404,094. They gave employment to 2,467 wage earners last year, who were paid £284,468 in wages. While the number of municipal stations was large, being 22·5 per cent. of the total, it is curious to note that they represent only 4·35 per cent. of the total capital expenditure. From the private plants 334,903 arc lamps were being operated in June, 1902, and power was supplied for 16,616,593 incandescent lamps. Stationary motors represented an aggregate of 19,283 h.p., and electric energy was also being supplied to 2,370 street cars. Municipal plants operated 50,795 arc lamps, 1,577,451 incandescent lamps, 5,403 h.p. in motors, and nine railway cars. The gross income from private plants was for the year ended June, 1902, £15,747,100, and from the municipal stations £1 393,021, this figure including the estimated figure from public service. The report, it must be remembered, is 17 months old, and at the rate of increase indicated by the yearly figures, the number of stations in operation at the present time should be in the neighbourhood of 4,000.

**Rubber Supply.**—Looking over the past 12 months we find that there was great activity in the rubber market, and fluctuations in prices were more pronounced in 1903 than the previous year. The demand everywhere showed an increase, and the consumption of all rubber was beyond the supply. The demand for guttapercha during the year was weak, and very little was doing in that market.

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## NOTES.

**Northampton Institute.**—Lord Kelvin has consented to present the certificates and prizes at the annual prize distribution and conversazione of the Northampton Institute, Clerkenwell, on the 26th prox.

**Radium Extraction.**—The news comes from Paris that the operation of extracting radium from the ores has been considerably shortened. The preliminary process which reduces the material to laboratory dimensions now occupies one month, whereas it has previously taken three months. It is estimated that up to the present about 730 tons of ore have been used to produce about one-fifth of an ounce of radium.

**Belgian International Exhibition.**—An international exhibition of arts and manufactures will be held at Liège from May to October, 1905, under the auspices of the Belgian Government, which is making extensive preparations, in conjunction with the local authorities, to render the enterprise prosperous. The British Vice-Consul at Liège states that everything seems to indicate that the exhibition will be a success.

**Electro-Harmonic Society.**—Mr. Mervyn O'Gorman presides at the smoking concert of the above society to-night in the Crown Room of the Holborn Restaurant, when an excellent programme will be given. Messrs. Harold Wilde and Ivor Foster are the vocalists, and the orchestra will, as usual, give several renderings. Mr. Chas. Bertram, the clever conjurer, also figures in the list of performers. The chair will be taken at 8 p.m.

**Newcastle Local Section.**—At the ordinary meeting of the above section of the Institution of Electrical Engineers there was a long and animated discussion on Dr. W. M. Thornton's paper on "Experiments on Eddy Currents," which had been presented at the previous meeting. The paper by Mr. J. A. Anderson on "The Distribution of Electricity in Shipyards and Engine Works," which was on the agenda, had, therefore, to be postponed. It will be read at the meeting of the section on Feb. 8.

**The Light that Failed.**—An indignant correspondent complains of the verses which appeared in our last issue under the above heading. The gist of the complaint is that apologies should be sent to Bristol, and not to Mr. Rudyard Kipling. We quite agree if anyone takes the verses seriously, but it is obvious that the few facts covered by the effusion do not apply at all. "C. H. S." allowed poetic license to carry him rather too near a practical subject, and by so doing has given offence where we are sure none was intended.

**The Electrical Engineers Volunteers.**—Lieutenant E. Graham Sheppard, the hon. secretary of the Entertainments Committee of the Electrical Engineers (R.E.) Volunteers, informs us that a Bohemian concert will be held at headquarters, Regency-street, Westminster, on Saturday, the 30th inst. A talented array of artistes has been engaged to appear, and additional interest will be lent to the entertainment by contributions from several members of the Electrical Engineers Corps. The chair will be taken by the commanding officer at 8 p.m.

**American Institute.**—An unfortunate fire at the printing house of the American Institute of Electrical Engineers will interfere with the regular issue of the society's *Transactions* for a few weeks. Part of the November issue was completely destroyed, as well as many electrotype plates and a supplementary volume containing papers which were about to be published. The institute office has on file authors' corrected copies of all these papers, so that nothing has been lost that cannot eventually be reproduced. However, we may condole with the institute in the irritating delay and interruption which are unavoidable in the circumstances.

**Northern Polytechnic Institute.**—Last night the annual distribution of prizes and certificates gained by students during the session 1902-3 took place in the Great Hall of the above institute at Holloway. The prizes were given away by Mr. A. M. Torrance, the mayor of Islington, who was supported by the governing body and the principal of the institute. There was a large gathering of friends of the students, and after the distribution the visitors were given an opportunity of inspecting the several departments in which the educational work of the institute is carried on.

**De Forest Wireless Telegraphy.**—We note that the American De Forest Wireless Telegraph Company has been registered in the States with a capital of three millions sterling. This is a combination of the De Forest Wireless Telegraph Company and the International Wireless Telegraph Company, and has been formed to acquire the patents and exploit the system of wireless telegraphy which has been worked out by Mr. De Forest. It will be recollected that this inventor has been demonstrating the capabilities of his system to the English Post Office officials between experimental stations on either side of the Irish Sea, but although the tests are generally reported to have been satisfactory, no official pronouncement has yet been made.

**The Inverted Arc Lamp.**—What is known as the inverted arc lamp, and which has been used for illumination in some workshops for many years, is suggested for the artificial lighting of lawn-tennis courts on dull days and at evening time. An installation of these lamps has recently been put up at the tennis courts at Sheen, near Richmond, and was brought into use last week at a special tournament arranged to test the capabilities of the light. Four lamps of 1,500 c.p. each are arranged around the court, an even illumination being obtained with the aid of screen sheets, from which the light is reflected. The experiment is said to have been a success, the illumination obtained being only slightly inferior to daylight on bright days.

**Lighting the Paris Tuileries.**—Owing to differences of opinion between the State, the municipal authorities, and the owners of the Tuileries Garden in Paris, the electric lighting of the garden has been much delayed. The main question in dispute, as to who should direct the work, has, however, now been settled in favour of the State, and although the city engineers are actually conducting the operation of laying the wires, it is under the superintendence and direction of the Government. The type of lamp decided upon by the latter is known as "Arc Nouveau," and is far finer than that proposed by the city. The lamps will bear comparison with the four beautiful standards which now adorn the four corners of the Place de la Concorde, or with those others, different but equally handsome, around the Opéra.

**Marconi's Experiments.**—As we stated a few weeks ago, it is Mr. Marconi's intention to try a test of his wireless telegraph system at long distances overland. So much of his experimental work has been carried out between coasts, that it will be refreshing to watch the performance of the system across country. For this purpose Mr. Marconi is erecting a station at Fraserburgh, in Scotland, with a view to establishing communication with his Cornwall station at Poldhu. The Scotch station, however, will also be used for communication with ships, and it is ultimately intended to establish communication between the North of Scotland and Iceland. Mr. Marconi is now at Fraserburgh, but will shortly cross the Atlantic on a

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visit to his wireless telegraph installations on the St. Lawrence River.

**The Osiris Prize.**—This valuable prize has been divided between Madame Curie, in recognition of her part in the discovery of radium, and Prof. Branly, inventor of the system of wireless telegraphy which bears his name. The prize is worth £4,000, and was offered by M. Osiris in 1900 for any work which should be deemed useful for mankind by the members of the Syndicate of the Paris Press. The prize remained undistributed until it was recently suggested by the founder that the claims of the Curie family should be considered. It was then decided that Madame Curie and her husband should receive £2,400, and that the remaining £1,600 should go to Prof. Branly. The ceremony of presenting the respective amounts took place in Paris on Saturday, when the hope was expressed on behalf of M. Osiris that Madame Curie would be able to continue her researches in the interests of science.

**Electric Lighting at St. Louis.**—The illumination of the outside of the buildings and grounds at the World's Fair to be held at St. Louis this year will probably be the biggest piece of work of its kind that has yet been carried out. The contract provides for 300,000 incandescent lamps at a total cost of £8,160. These lamps are for lighting the exhibit places, grounds, and architectural features of the exposition proper, and do not include those for state, national, and private concession buildings. To give an idea of the distribution of the lamps, it is stated that 12,000 alone are to be placed on the Palace of Education, which building furnishes an excellent setting for night effects produced by the electric light. The illumination of the grounds is to be carried out on very ambitious lines. Each monumental standard will carry 24 incandescent lamps, so distributed that 12 will hang on each arm of the supporting post. The lighting of the inside of the buildings will be accomplished entirely with arc lamps.

**Zinc Amalgam Electrode.**—Mr. H. B. Ford, of New York, has patented the construction of a zinc amalgam electrode for use in secondary batteries. According to the *Electrical World*, he fills a thin porous wooden cup partly with mercury and places into it a thin copper plate plated with zinc and corrugated in a vertical direction. For the other electrode he uses a copper plate covered with peroxide of manganese. As electrolyte dilute sulphuric acid of 25deg. Baume is used. The charging current causes the mercury to act upon the zinc and copper plates in the usual way and also forms by the absorption of hydrogen a mercury sponge containing also some zinc, which expands upwardly until (if the preparations be correct) the porous cup is practically filled. In the discharge of the battery there is double action of the oxygen upon the zinc and upon the absorbed hydrogen respectively. The action upon the hydrogen is first completed, resulting in the disappearance of the sponge. So long as the latter remains the voltage is about 2·5. Upon its disappearance the E.M.F. drops to about 1·5 volts.

**The Pioneer of Street Tramways.**—The death is announced from New York of Mr. George Francis Train, whose eccentricities are probably as well known as his pioneer work as a railway and tramway contractor. It was Mr. Train who in 1859, after a varied career in America, came to England, and in the face of violent opposition was successful in introducing street tramways, which were then wholly unknown in this country. His first line in London was from Marble Arch to Bayswater, which was soon followed by others from Victoria Station to Westminster Abbey and from Westminster Bridge to Kennington-gate. The deceased gentleman was on one occasion arraigned on a charge of manslaughter, a boy being killed on one of his tramways, and, although he was acquitted, the prejudice set up against him was probably the cause of the rejection by Parliament of his further proposals for tramways. Mr. Train, however, was entitled to the credit of laying the first street tramway in this country, while he was also the pioneer of this means of locomotion in America. He passes away at the ripe age of 74, and in comparative poverty.

**European Editions.**—One or two of our American contemporaries have lately commenced to publish "European" editions of their journals. A few weeks ago *Power* of New York published its first number in London, which, besides embodying the whole of the information given in the American issue, also has several sheets set aside exclusively for European news. With the first month of the New Year another American contemporary, the *Street Railway Review*, has brought out a European edition, which is published at 82, Fleet-street, E.C. The practice in this case will be to publish such portion of the text appearing in the American edition as will be of particular interest to English and foreign readers, as well as special articles and information edited and printed in London. We notice that the first article in the present issue is a description of the works and plans of the Underground Electric Railways Company of London, written by Mr. James R. Chapman, chief engineer to the company. This article is the first official statement that has been given out concerning the engineering work which this company is carrying on.

**The Paris Metropolitan.**—The company which operates the underground electric railway in Paris is losing no time in carrying out the main recommendations of the committee appointed to enquire into the circumstances of the disastrous fire which occurred on the lines some months ago. The alterations and improvements which this committee advised have already been given in these columns, and it will be remembered that one of the chief recommendations was that the use of high-tension cables running through the train should be abandoned. In place of these it has been decided to adopt an electro-pneumatic system of control, one of the chief features of which is that compressed air is employed for actuating the controllers on all motorcars, and the control is effected by very low currents carried in wires throughout the length of the train at the low pressure of 14 volts. After a careful study of available systems, the engineers of the railway have adopted the Westinghouse apparatus because it entails the least fire risk, and has many other points of merit both from the point of view of safety and satisfactory operation. The system is the same as has been adopted by the London Metropolitan Railway for use on the Inner Circle. The installation on the Paris line will be made by the French Westinghouse Company, who will supply 100 complete equipments.

**Reinstatement of Pavements.**—The Law Courts will shortly be called upon to give a decision in a test case which is being brought to decide the respective rights of companies and local authorities in the above matter. The dispute in point has arisen between the Stepney Borough Council and the Commercial Gas Company, and as the question has reference to the use of concrete in reinstating pavement disturbed by the operations of the company, the ruling of the Court will equally apply to electric light, telephone, and other companies who lay their mains in the streets. We understand that in the present case the contention of the company, who took up some asphalt paving for the purpose of laying mains, is that they are only bound to reinstate the paving as it was found. The responsible committee of the local authority point out that they have

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no objection to excavations made by the company being reinstated with the same or similar materials of like quality and thickness, provided that "such materials are cemented and bound together in the same manner, or in an equally substantial manner, as those of which it was composed," as provided by the Metropolis Management Act of 1855. The whole question, therefore, is whether the company are bound to use cement, and as the committee hold that asphalt paving cannot be properly laid or reinstated without the use of this material, the point is to be submitted for judicial decision.

**Institution of Electrical Engineers.**—Practically the whole time at the ordinary meeting of the Institution last week was occupied with the adjourned discussion of Mr. P. V. McMahon's paper on "The City and South London Railway: Working Results of the Three-Wire System applied to Traction," but time was found towards the close for Prof. Silvanus Thompson to give a short abstract of Dr. Hans Behn-Eschenburg's paper, which he had translated into English, on "The Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines." During the evening the President made the interesting announcement that the Council had decided to award the Willans premium, in the gift of the Institution this year, to Mr. McMahon, both for the present paper and for his paper read before the Institution in 1899. The announcement was received with loud applause, and the President personally congratulated Mr. McMahon on his success. Mr. Gray also reported the receipt of a resolution of thanks from the Colchester Corporation for the presentation made to the borough on the occasion of the Gilbert tercentenary. The next meeting will be held on the 28th inst., when Mr. W. Hibbert's paper, read at the meeting on Nov. 26, will be discussed. On Feb. 11 Dr. Walmsley will present a paper on "Transatlantic Engineering Schools and Engineering," and Mr. A. R. Bennett has promised a paper for the following meeting.

**Copper Prospects.**—Prospects of a plentiful and steady supply of copper during the current year are encouraging. On a rough estimate an increase of 15,000 to 25,000 tons from the United States may be looked for, and the supplies from Canada, Australia, and Spain are also expected to be better than last year. Some shipments will probably be made from Rhodesia, but it will be some time before the large discoveries of copper in Central Africa can be exported to any great extent. Messrs. James Lewis and Son, in their annual report, anticipate that consumption during 1904 will fall off in the United States, but in England, France, and Germany a considerable increase is probable in connection with the development of electric traction, especially on existing railways, and of electric motive power generally. India is so prosperous that she will probably take more copper in 1904 than in 1903, and the quantity of sulphate of copper required for export and home consumption is likely to be larger than last year. The future of values mainly depends upon the quantity of copper available for shipment from the United States to Europe. An increase of fully 25,000 tons over the quantity sent in the past year will probably be required to maintain stocks even at their present low level, assuming that there is no increase in the European consumption and that there is no decrease in the supplies to Europe from Japan and other countries. The very small quantity of standard copper in the public stocks available for speculative purposes—not much more than 2,000 tons—lays the market open to easy manipulation.

**Coal-Cutting by Electricity.**—The growing importance of this subject may be gauged by the number of papers which have been brought before scientific societies of late dealing with the use of electrical appliances in modern coal-mining. There has been much controversy as to the relative merits of compressed air and electricity for this purpose, but the trend may now be said to be strongly set in favour of the latter. Some interesting statements were made last week before the Manchester Geological and Mining Society in a paper by Mr. Alfred J. Tonge. He described what is being done at the Hulton Colliery Company's mines, where there are six electrically-operated cutters at work daily. The total amount of coal cut by these machines at the company's pits in 1902 was 41,850 tons, or more than half the total cut by machinery in that year in the whole of the Manchester coal-mining district. At present this colliery is cutting at the rate of 100,000 tons a year. The crux of the saving in the use of electric cutters really lies in the question of "filling and drawing," and in the author's opinion the collier, as such, must cease to exist before coal-cutting finds its true level. The quality of coal obtained has been changed by the use of cutting machinery; the slack has depreciated, but the round coal has greatly improved. To sum up the benefits of electric cutters, it may be said that they attain such definite objects as (1) more output per man employed; (2) coal economically worked which previously had been unworkable to a profit by hand; (3) more systematic working; (4) better round coal in three out of four mines; (5) greater area exposed in same time in two out of four seams; and (6) premium per ton for risk of life reduced by one-third.

**Radium.**—Before the Röntgen Society recently Dr. G. B. Batten read a paper entitled "The Revelations of Radium." He dealt with the various researches which have led to the revelation of radium rather than with the secrets which it might be in the power of radium to reveal, and pointed out that much that had been stated of late as new concerning radium has been set out in the *Edinburgh Review*. According to the disintegration theory of radioactivity, the revelations of radium seemed to support the corpuscular-electron theories of matter and electricity, and, therefore, opened up a prospect of an immense storehouse of energy in the universe. Should we ever be able, asked the author, from the clue radium offered to coax lead and iron to give up their radioactive atoms for use as motive power? Probably the first commercial plant to be put down in this country for working radium ore will be in Cornwall, at the South Terras Mines. This property is owned by the Radium and Uranium Syndicate, Limited, to which Sir William Crookes, F.R.S, is technical adviser. Sir William has visited the mines, and reports that he has taken from them specimens of pitchblende broken off by himself from the face of the lode, and that they contain radium. Experimenting with half a ton of pitchblende he was successful in obtaining some grains of the rare metal. Reports from other mineralogists are to the effect that South Terras and Wheal Blencawé contain large deposits of uranium ores. It has, therefore, been decided to lay down a suitable plant and work the properties. Speaking of the properties of radium in the course of a lecture at Durham College this week, Sir Wm. Ramsay expressed his firm belief that we were getting nearer to the problem of the transmutation of elements. The transmutation of gold into silver would be only an instance, and the transmutation of other elements would be of greater significance, and would not disturb the stability of the world.

**German Electrical Developments.**—A German contemporary announces that the Allgemeine Elektricitäts-Gesellschaft of Berlin, which has a share capital of £3,000,000, and about a year ago entered into a community of interests with the Union Elektricitäts-Gesellschaft of the same city for the pooling of profits for a

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period of 35 years, now proposes to increase its capital by the issue of new shares, amounting to £1,150,000, for the purpose of completely absorbing the Union Company, and giving effect to agreements entered into with the General Electric Company of America and the latter's European subsidiary companies. It is further stated that the General Electricity (Thomson-Houston) Company has been formed with a capital of £240,000, which has been subscribed in equal halves by the Allgemeine Company and the Thomson-Houston de la Méditerrannée, the Italian company. This arrangement should have the effect of avoiding competition between the German and Italian interests in the future, while the absorption of the Union Company by the Allgemeine Company will bring the total capital of this group to £4,150,000. The other great German group—the Siemens-Schuckert Company—has a share capital of £4,500,000, of which about £500,000 has yet to be called up, but the two original firms still remain. Although the amalgamation of the heavy electrical branches of the two concerns for the first four months which terminate the financial year of the new company has proved to be profitable to the Berlin firm, the Schuckert partner has incurred a loss of £35,000. The report issued by the latter for the four months states that the British Schuckert Company has decided to go into liquidation in order to amalgamate with the London firm of Siemens Bros. and Co., Limited, and that the Russian companies bearing the names of Siemens and Schuckert also propose to make an arrangement for the regulation of business in that country.

**Engineering Standards Committee.**—We understand that arrangements have been concluded to hold a conference of consulting engineers to large power schemes and electrical manufacturers to meet the members of the sub-committee of the Engineering Standards Committee dealing with the question of standardising generators, motors, and transformers. The sub-committee have for a long time been hard at work upon the question of the standard rating of electrical machinery. They have issued several carefully drawn up circulars to the manufacturers, the replies to which have been collated and very fully discussed, and these have proved of the greatest assistance to the sub-committee in the difficult task they have in hand. Certain questions, however, relating to the standardisation of direct and alternating current motors have lately arisen upon which great diversity of opinion appears to exist, as evidenced by the replies received. The sub-committee, after carefully considering the replies sent in, came to the conclusion that the most practical course of action, and that best calculated to lead to the most satisfactory results to all concerned, would be to confer with the leading consulting engineers and manufacturers and investigate to the fullest extent the different points at issue. In view of the criticisms which have arisen as to the wisdom of adopting 25 and 50 periods per second as the standard frequencies, the sub-committee on generators, motors, and transformers have also deemed it advisable to invite the consulting engineers and those interested in large power schemes to be present at this conference and discuss this very important question of standard frequencies with them. It is to be hoped that the conference will be well attended by representative men, with the result that by carefully discussing these difficult questions in detail and from every point of view, the best interests of standardisation may be advanced by a distinct and substantial step. The place of meeting is the Institution of Civil Engineers, and there will be two meetings, on Tuesday and Wednesday, Jan. 26 and 27 respectively, at 2 p.m. The council of the Institution of Civil Engineers have nominated their president, Sir William Henry White, K.C.B., F.R.S, to fill the place of the late Sir Frederick Bramwell, Bart., as one of the representatives of that institution on the main committee.

**The Arnold Electro-Pneumatic Railway System.** It was in June, 1902, that Mr. Bion J. Arnold described before the American Institute of Electrical Engineers his proposed system of single-phase electric traction in combination with compressed air for regulation in starting and stopping. Since then he has worked out the system and secured a line on which to try the same. This is a new railway running from Lansing, the capital of Michigan, northward through St. Johns, Alma, and St. Louis, a distance of about 60 miles, but up to the present time only that portion extending from Lansing to St. Johns, some 20 miles long, has been constructed. The line has been built in accordance with ordinary railway practice, so that steam locomotives can be used over it until the electric system is perfected. Unfortunately, the electrical equipment has been seriously delayed by the burning of a locomotive on Dec. 17. The first locomotive was tried in June, 1903, with considerable success, but the new locomotive, equipped with one motor for each axle, had only been got into working condition on the evening previous to the fire. We gather that it was the car-shed that caught fire, and as a result not only the locomotive but also a large number of instruments for testing purposes were destroyed. Mr. Arnold has, in consequence, contributed to our American contemporaries a short description of the locomotive which has been destroyed, together with a few photographs and drawings. From this the following outline description is prepared, but, unfortunately, no particulars as to the results obtained on trial can be given. Each of the motors appears to have acted as an independent unit. They were of the single-phase induction type, so arranged that both the rotor and what is commonly called the stator could revolve. The rotor was geared in the usual way to the car axle, and was also used to drive the piston of an air-compressor. The other element of the motor, also free to revolve, was connected to the piston of a second air-compressing cylinder. These cylinders were equipped with electrically-controlled valves, by which they could be made to act either as compressed-air engines or as air-compressors. The object of the design is that the electric motor should always be running at practically a fixed speed, and the regulation effected entirely by the air-compressing cylinders. With the car at rest the rotor of the motor would be fixed, and the stator would press air and deliver it into the reservoirs carried on the car. In starting up, the air-compressing cylinders connected on to the rotor would be used to assist in providing a starting torque, and the regulation would go on until the stator was fixed and the rotor driving at normal speed. If higher speeds than that of synchronism were required, the stator cylinders would act as an engine and drive the stator in the opposite direction to the motion of the rotor. The whole arrangement as illustrated and described is exceedingly ingenious, but information as to its economy could only be obtained from actual trials. The loss of the locomotive is the more to be regretted, as it was to have been used to determine the best possible voltage on which to work the system. We trust that a further experimental equipment will be quickly got together.

**St. Marylebone Electric Light.**—The St. Marylebone Council are rapidly getting to the end of their tether. Matters approached something like a crisis on Tuesday evening, when hundreds of the parochial electors of St. Marylebone assembled in the Queen's Hall, Langham-place, to discuss the situation, and record a vote either for or against the Bill which the Council have lodged in Parlia-

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ment, and which, if passed, would vest in them the necessary powers to raise the money for the purchase of the Metropolitan Electric Supply Company's St. Marylebone property. The electors were in full possession of all the facts of the case, copies of the recent proceedings in the High Court having been distributed among them some days before, as well as a circular by the Marylebone Ratepayers' Committee advancing a number of reasons why the electors ought not to support the local authority in their present action. The result was that from the first the majority of those in the hall exhibited a hostile attitude towards the Council. The Mayor's explanation that the Council were bound to take every possible step to carry out the terms of the arbitrator's award failed to obtain a responding note in the large audience, and beyond the mover of the resolution in favour of the promotion of the Bill scarcely one speaker supported the Council. The subsequent orations in opposition to the resolution were characterised by noisy interruption and expletive, and many intending speakers were shouted down. The end of it all was that the resolution in favour of the parliamentary measure was rejected by a large majority, the result being greeted with loud cheering. As a last resource, the Council have the right to demand a poll, which in all probability they will do. Should this, too, fail to authorise them in going on with their Parliamentary Bill, it will have to be dropped for this session at least. On the other hand, the Council have been in negotiation with the Electric Supply Company, and the latter have made certain proposals to them, which were published in our last issue. The gist of these proposals is that, in consideration of the company accepting stock for the £1,212,000, to be redeemed in 42 years, the Council shall grant them a lease of the undertaking from Jan. 1, 1905, to Dec. 31, 1931, and at the end of that time purchase a portion of the company's Willesden works and compensate the company for the capital to be expended by them in the borough during the term of the lease. This proposition was literally laughed at when first put before the members of the Council, but at the special meeting on Thursday last week it was discussed with more becoming gravity. Mr. E. R. Debenham construed the company's offer as an attempt to make the Council pay the full amount of the award while giving up their profits for a number of years, and another objection was that the Willesden plant was not such as the Council would think of adopting. It was an extravagant system. If the Council accepted the company's proposals, they would either be bound to purchase the Willesden generating plant or buy energy in bulk from the company. Even those members who have been opposed to the Council throughout this business were now hostile to the company's proposals, and such men as Sir E. Galsworthy and Alderman Elgood delivered speeches in favour of the rejection of the terms offered. On the other hand, several members voiced the opinion which has been expressed outside the Council-chamber, that the acquisition by the Council of the company's concern would result in disaster, and the hope was expressed that the negotiations with the company would be continued in order, if possible, to obtain the offer of more favourable terms. The resolution was eventually carried, and the company will be informed that the Council are unable to accept the proposals contained in their letter.

**Electric Pumps in South Africa.**—It will be remembered that in our issue for the 8th inst. we commented on the remarkable durability shown by some electric motors used for pumping purposes in South Africa, which, after having been under water for some 2½ years, were brought out, dried, and set to work again. Through the courtesy of the British Thomson-Houston Company, of Rugby, we are able to give some further information about the interesting event. It seems that the installation was at the Knight's Deep Mine, in Johannesburg, and was carried out by the South African General Electric Company. It consisted of 12 three-phase, 50-h.p., slow-speed induction motors and 36 15-kw., type H, transformers for operating pumps, all manufactured by the General Electric Company of America. When the war broke out it was found impossible to remove the plant before allowing the shaft to fill up with water, and consequently they were left under between 500ft. and 1,000ft. of water. Two and a-half years later, when peace was declared, the shaft was unwatered, and the apparatus removed to the surface. Three of the motors were completely rewound at Johannesburg, but the others were simply dried out in an oven heated by steam coils, and then soaked in oil. This was done as an experiment to see whether the insulation had perished, and, contrary to expectation, it was found that the motors had not suffered during their long immersion sufficiently to make it necessary to rewind them, and they were put back into service. Then the type H transformers, which had also been under water, were treated in the same way, and it was found that they did not need rewinding. Shortly after some of them were put back, six out of nine 50-kw. transformers of another manufacture burned out just after having been installed. They were replaced by an equivalent number of type H G.E. transformers which had been under water, and which operated satisfactorily. Subsequently the South African General Electric Company, on the excellent showing made by their apparatus, were commissioned to supply nine 50-kw. transformers to replace those burned out. Another instance of the satisfactory working of electrical machinery after immersion in water occurred recently at Des Moines, Iowa, in the United States, when two 1,000-kw. 575-volt G.E. railway generators were under water for some 30 hours. When the flood went down and the building was pumped dry, steam radiators were put in the generator pits, and salamanders placed near the generators on the engine-room floor. The engines were run at half speed for one or two days until the generators seemed to be perfectly dry on the surface. Then the armatures were short-circuited with full-load current through the switchboard ammeter, the shunt fields being separately excited from an 80-volt generator, and reversed with reference to the series field. The field coils were so saturated with water that they acted like water rheostats, and as much as five times the normal current was applied before they were warmed up. As the water was driven out from them the resistance increased, and the full current was gradually reduced. After running for a few days with full-load current on the armature the current was increased to 50 per cent. overload, or to about 2,500 amperes. This warmed up the armature very well, but the commutators ran so cool that this large current did not heat them sufficiently to drive out the moisture. Salamanders were placed in the generator pits, and sheets of asbestos used as deflectors to throw the heat from the salamanders on to the iron ring of the commutator spider, also to protect the engine eccentric, the brush-holder rigging, and commutator from the heat. This scheme proved very effective. Every other bolt was taken out of the commutator clamping flange in order to allow the moisture and steam to pass out through the bolt holes. Practically all the machinery has now been put in running condition again, but the experience illustrates in a striking manner the durability of these particular machines.

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## THE GREAT NORTHERN AND CITY RAILWAY.

*(Continued from page 90.)*

The electric generating station is situated in Poole-street, New North-road, which is about a mile north of Moorgate-street Station. It is alongside the Regent's Canal, from which its water supply for condensing and other purposes is drawn, and is amply provided with spare plant to handle any heavy loads that may come upon it. The internal arrangements are difficult to show by photographs, as space round the machinery is limited. Its connection with the Regent's Canal also enables coal to be delivered cheaply alongside in barges. From these it is lifted by a grab into a weighing hopper, and passes from there into the coal bunkers, which are situated over the boiler-house. The Hunt conveyor used for this purpose is capable of handling 30 tons per hour. The illustration (Fig. 1) shows this conveyor at the point at which it is driven by an electric motor. The conveyor on its return from the coal bunkers passes through the ashpit under the boiler-house floor and picks up the ashes. These are delivered into barges for removal.

The steam is generated in 10 Davey-Paxman "Economic" boilers (Fig. 2), each having effective grate area of 40 square feet, and capable of evaporating 11,200lb. of water per hour at 212deg. F. when using coal, with 13,300 British thermal units per pound. The boilers are all fitted with Vicar's automatic stokers. Two British Thomson-Houston motors are provided for these stokers, each able to drive the whole number. The coal is delivered by gravity from the coal bunkers into the hoppers of these stokers, as can be seen in the illustration. Thus no hand labour is required in connection with the coal from the time the barge comes alongside the wharf until the ashes are discharged by the conveyor.

Owing to the limited space available, the main engine-room is not unlike in appearance an engine-room of a steamship. The four main engines are of the vertical, cross-compound type, by John Musgrave and Sons, Bolton, running at 100 revolutions per minute, and having a normal capacity of 1,250 i.h.p., with a steam pressure of 150lb. They are direct connected to four standard British Thomson-Houston railway type generators (Fig. 3), rated at 800 kw. each, but capable of taking at any time during continuous service a load up to 1,200 kw. for two hours without objectionable heating. These generators will further stand momentary overloads of 100 per cent. without injurious sparking. They are compound-wound to give 525 volts at no load and 575 volts at full load. There are four Wheeler surface condensers, one for each engine. They each have a cooling surface of 2,400 square feet, and are arranged with steam-driven combined air and circulating pumps. They are capable of maintaining a 26in. vacuum when dealing with 22,000lb. of steam per hour. Automatic relief to a common atmospheric exhaust pipe is provided.

FIG. 1.—The Hunt Motor-Driven Coal Conveyor at the Station of the Great Northern and City Railway.

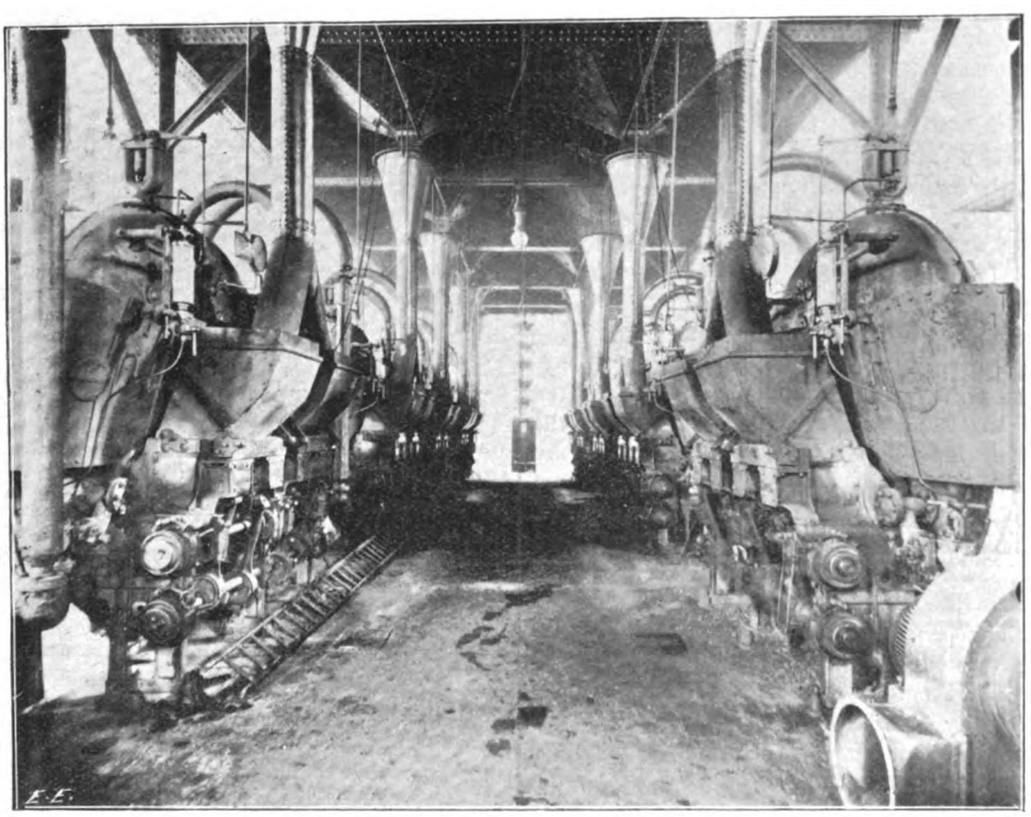

FIG. 2.—The Boiler Room Firing Floor, showing the Davey-Paxman Economic Boilers and Vicars Stokers

Two smaller sets, to act as auxiliaries to the main engines and dynamos, have been installed. They consist of two

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Peache engines by Davey, Paxman, and Co., with normal rating of 170 b.h.p, of the single-acting tandem compound type, driving two British Thomson-Houston six-pole 120-kw. generators at 375 revolutions per minute. They are com-

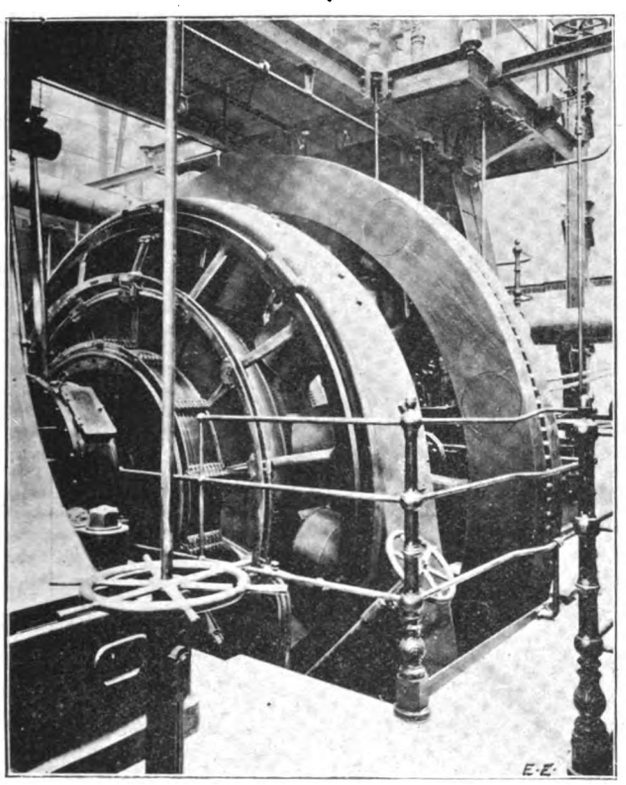

FIG. 3.—One of the four 800-kw. British Thomson-Houston Company's Generators, coupled to Musgrave 1,250-i.h.p. Engine.

pound-wound for the same voltages as the main generators, and have an overload capacity of 50 per cent. for two hours. They will supply power for lighting of power-house, etc., and operating the electrically-driven auxiliary plant when it is not convenient to take power from the main generators for this purpose. These plants also work condensing, and discharge the condensed steam into a common hot-well.

A Masson-Scott plant is used for the removal of oil and grease from the water of condensation before it is returned for boiler feed purposes. This plant is capable of dealing with 10,000 gallons per hour. The oil and grease which has passed through the steam-engines in the course of working when the steam is condensed is in the form of a finely-divided emulsion, so fine in its character that it is impossible to remove it by mechanical filtration alone; chemical treatment is, therefore, essential, as well as filtration. The apparatus is thus a combined plant for first treating chemically and finally filtering every gallon of water which leaves the surface condensers. The make-up water taken from the canal is treated by a Desrumaux plant. This is capable of treating 8,500 gallons per hour, giving water having hardness reduced to 5deg. and alkalinity of about 6deg., free from solids. An automatic arrangement is adjusted between the softener and storage tank, whereby the softening process is suspended and recommenced as occasion may require. In addition to the supply from the canal mentioned previously, water can be obtained from the city mains. A storage tank has been provided, connected directly to the latter.

The switchboard is placed on a gallery which is on the same level as the platforms round the engines at the cylinder level. Access is provided from the switchboard gallery to these platforms, and the drivers are also within view of the switchboard attendant. The main switchboard (Fig. 4) is of the British Thomson-Houston standard type, with 16 panels. These respectively control the four main generators, the four feeders, the two auxiliary generators, three auxiliary power circuits, and three auxiliary lighting circuits. The circuit breakers are the British Thomson-Houston M K and M L magnetic blow-out type, and the measuring instruments of the Thomson astatic type, with illuminated dials. Cables run from the switchboard along the outside of the boiler-house wall, and then down a special cable shaft into the tunnel. The 'bus bars on the board are so divided that the auxiliary generators, station lighting, and auxiliary motor panels can be isolated from the main generator and heavy feeder panels by the operation of one switch, ensuring the passenger station lighting remaining on if any accident occurs to the other parts of the switchboard, etc Separate paper-insulated feeding cables are provided for traction, for lighting, and for lifts, and rubber-insulated cables for lamp circuits and connections. The length of line and position of generating station are such as to enable the system to be economically operated, using a convenient section of collector rail, without feeding at any other points than just under the works.

After this brief *résumé* of works, which are well laid out and should be most economical in working, we pass on to the equipment of the line and of the trains. The power is conveyed to the motors on the cars by means of two insulated rails per track. These are placed 2in. higher than the running rails, and one on either side of the track. The conductor rails are of channel section, weighing 80lb. per yard, and rolled to about 42ft. lengths. They are of a

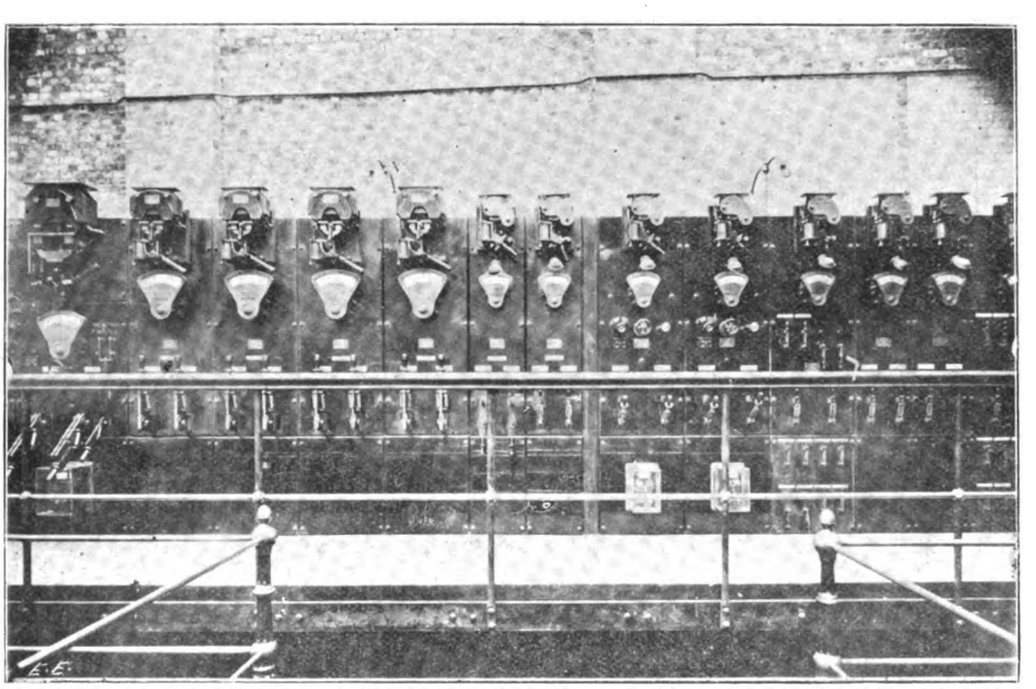

FIG. 4.—The Main Switchboard at the Great Northern and City Railway Company's Power Station.

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special quality of low carbon steel having a specific conductivity 14 per cent. of that of pure copper. These rails are supported 10in. outside of the running rails on earthenware insulators carried on spindles supported by cast-iron brackets fixed to the sleepers. The system of conductor rails is divided up into four sections, fed independently from the generating station, and the rails of the up and down tracks are interconnected through circuit breakers at different points to equalise the currents in the two pairs of rails. At the cross-overs, of which there are three, the conductor rails are not cross-connected. Thus, if a train were to run off the rails at such a point, leaving one line clear, this line could still be worked, as the short-circuiting of the conductor rails could be confined to the side the train was derailed in. The running track consists of 85lb. flanged rails laid through the tunnels on longitudinal timbers and rolled-steel chairs; as it carries no current it is not bonded, and this greatly assists platelaying operations.

The rolling-stock used on this line was fully described in our issue for Dec. 25, 1903, in which, however, we did not give many details of the electrical equipment. Each train normally consists of three motorcars and four trailer cars, one motor being at each end of the train and one in the centre. The seating capacity of the motorcars is 54, and of the trailer cars (Fig. 5) 56 passengers. The cars are of the corridor type, the seats being arranged transversely, and are 50ft. 6in. in length over the buffers. The motorcars are carried on two trucks per car of the McGuire type

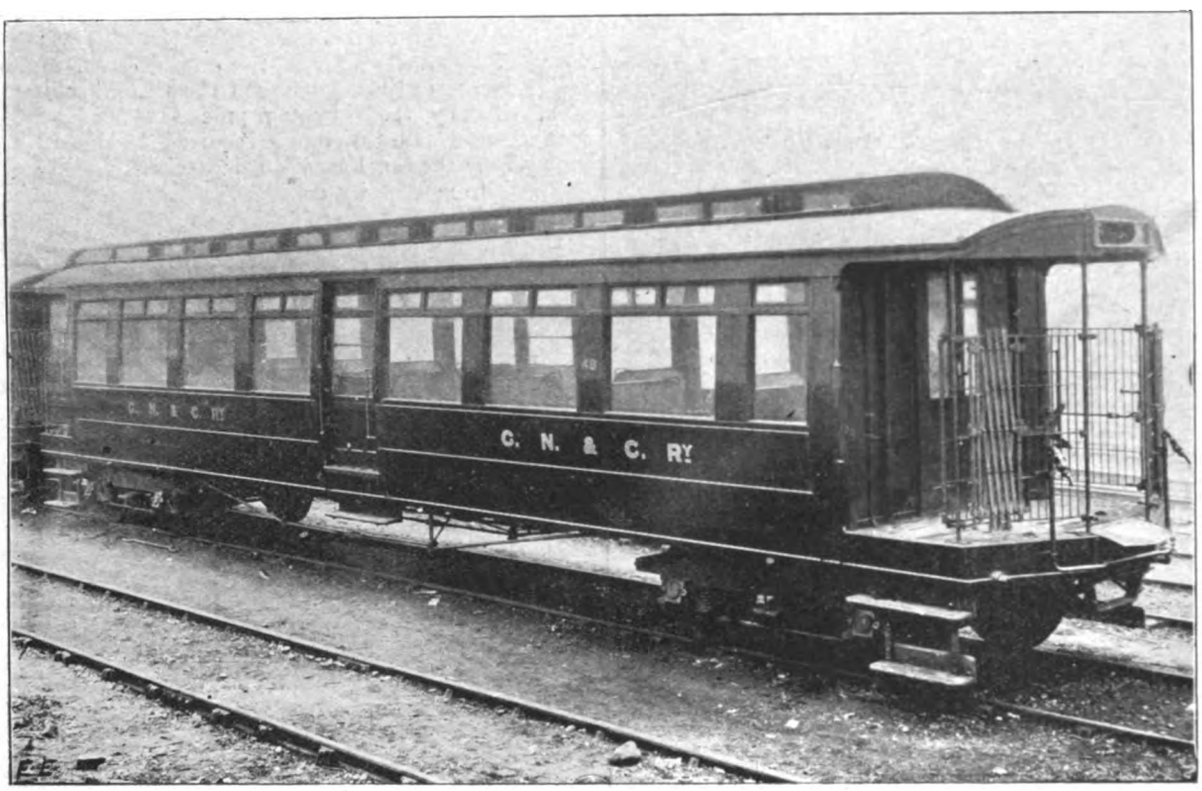


FIG 5.—One of the Carriages used on the Great Northern and City Railway.

(Fig. 6), having driving wheels 36in. in diameter, the trailer cars being mounted on Brush trucks. The cars were supplied by two firms—the Brush Manufacturing Company and the Electric Tramway and Carriage Works, Preston. On each truck of the motorcars is mounted one British Thomson-Houston series-wound, direct-current, geared motor, operating at approximately 550 volts, current being collected by four collector shoes per truck. The capacity of each motor is 125 h.p., rated on the standard British Thomson-Houston basis of 75deg. C. rise in temperature above the surrounding air after one hour's run on full rated load. The gear is of steel, machine cut, and enclosed in a waterproof gear case.

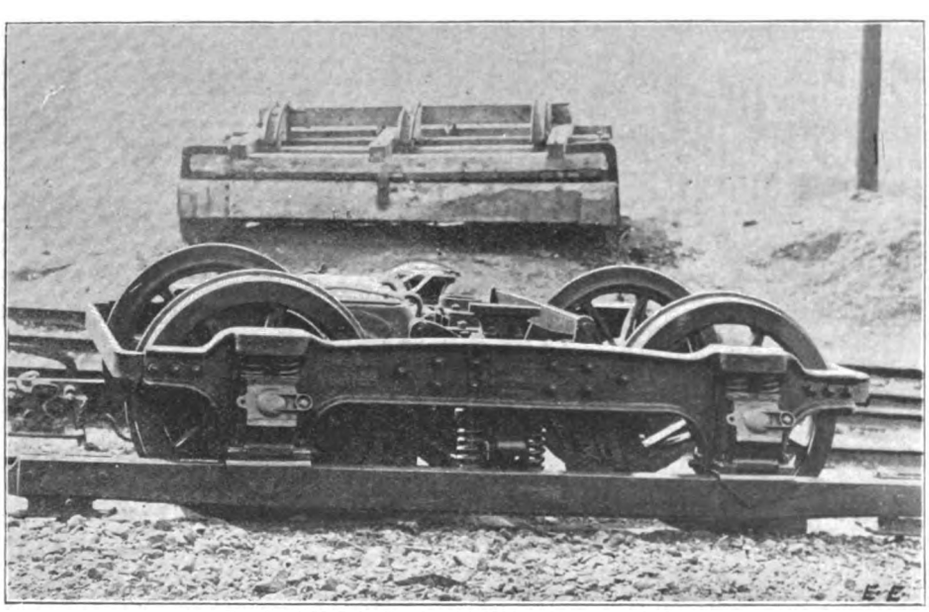

FIG 6.—A McGuire Truck, with 125-h.p. Motor attached.

All the six motors on the train can be controlled from a number of points by means of the multiple-unit system of

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the British Thomson-Houston Company. As certain of our readers may not be conversant with this system, we give in Fig. 7 a general view of the apparatus used, and in Fig. 8 a diagram of connections. The system may be summed up by saying that the two motors on each of the motorcars are provided with a series-parallel controller as on a tramcar, which can, however, be worked from a distance. The master controllers are then arranged to operate the motors on the three motorcars exactly in the same way and simultaneously. In working out the details of the system the company have replaced the ordinary series-parallel controllers on each motorcar by a number of electrically-operated switches which they term contactors. As the contactors illustrated in Fig. 7 are not of the most recent type, we reproduce in Fig. 9 the latest form of handles are provided, one of which is used for driving, and the other for operating the reversing switch. These handles are, of course, interlocked. The actual current required to work the contactors is about 2½ amperes per motorcar, and it is taken from the line at 550 volts. The cable which runs throughout the length of the train to connect up the master controllers and the contactors, is provided with an ingenious coupling which completes the nine con-

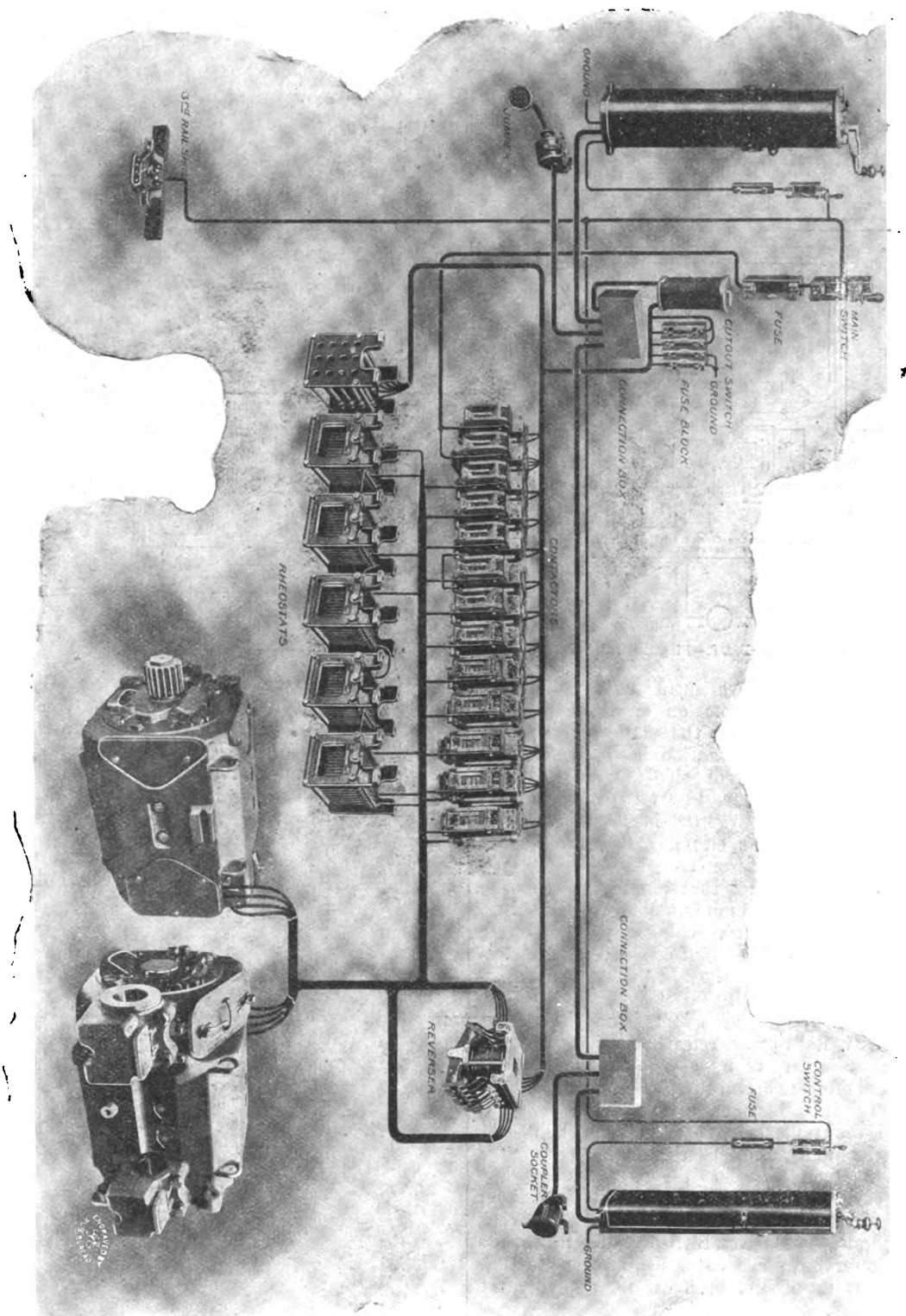


Fig. 7.—General View of the Apparatus used on one Car for the B.T.H. Multiple Unit System of Control.

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nections at the same time. The coupling is so arranged that an incorrect connection is impossible. This cable is of small diameter, and the cores are built up of a number of fine wires stranded together so as to give great flexibility.

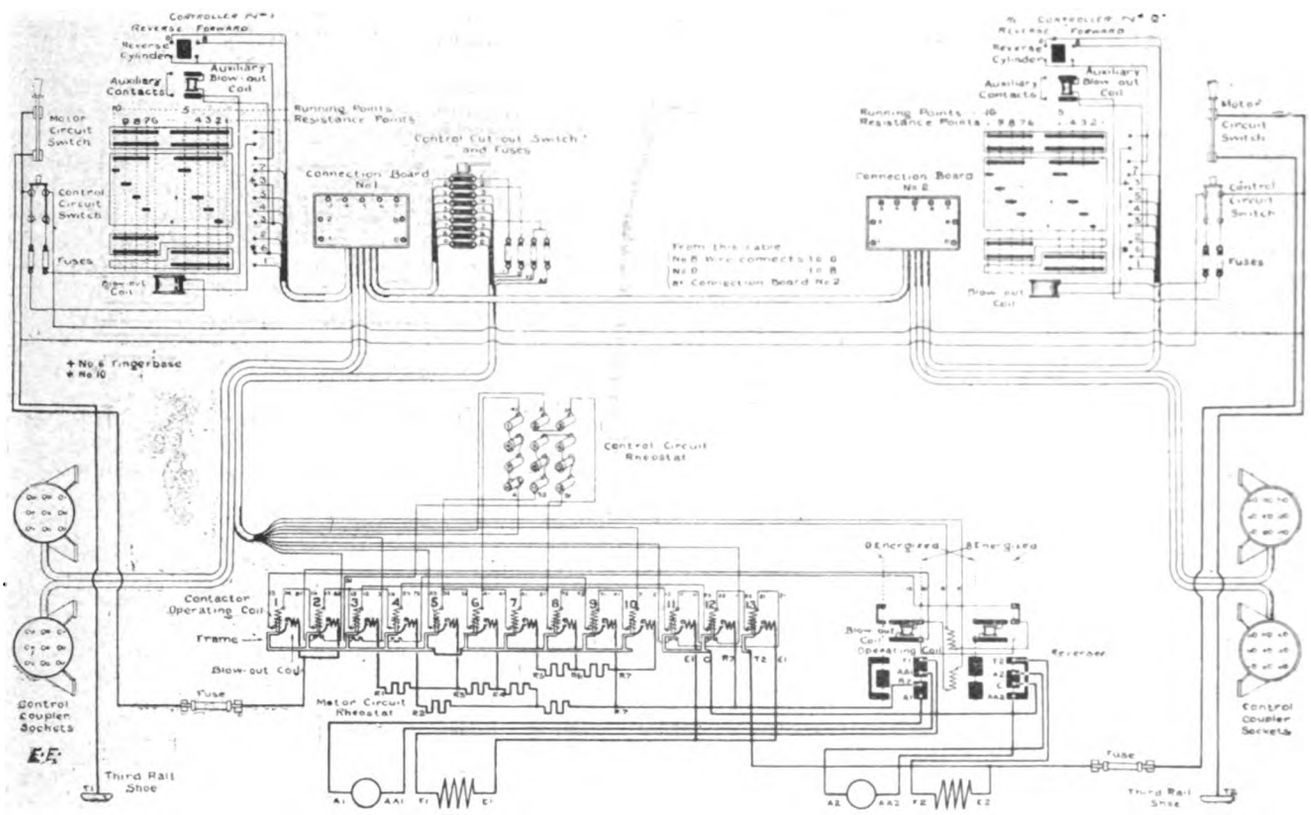


FIG. 8.—Diagram of the Connections for the B.T.H. Multiple Unit Control System.

The contactors and the reversing switches are placed in two small compartments, one on either side of the central gangway leading out of the motorcar; they are easily accessible, and every precaution has been taken to render the compartments fireproof. To this end the compartments are lined with sheet iron over a backing of uralite. All the cables have fireproof insulation and they are supported on earthenware cleats. The wiring under the car is contained in sheet-iron troughing. These precautions, coupled with the fact that the motors are completely enclosed, reduces to a minimum the chance of an arc from the electrical circuit reaching any inflammable material. These precautions are not confined to the electrical work on the tramcars, as the whole electrical equipment in the tunnels is iron-clad.

The multiple-unit system as adopted on the Great Northern and City Railway is remarkable for the small space occupied by the controlling apparatus. In fact, the platforms of the motorcars are not impeded in any way by the presence of the small master controller and brake gear. It also allows of the trains being broken up in the middle of the day and the number of coaches reduced, so as to save the cost of driving empty coaches during the time when the traffic is slack. The trains are equipped throughout with air-brake apparatus of the quick-acting type, each motorcar carrying a motor-driven British Thomson-Houston air-compressor, reservoir, etc. There are also conductor's emergency cocks at the end of each car for applying the brake in case of need.

All the lighting circuits are carried in screwed iron tubes, and the tunnels are provided with lamps every 100ft. The passenger stations are lighted on the rail and street level by British Thomson-Houston enclosed arc lamps, and station switches are fixed which control the incandescent lamps in the tunnel half-way to the next station in each direction, the lamps being five in series, and the circuits are run so that there is never more than the voltage of one lamp between two wires in the same iron pipe. The current for lighting the tunnels and passenger stations is supplied through special sets of lighting mains direct from the power-house switchboard. Special throw-over switches are provided to take current from the conductor rails at any time when the lighting cables are not charged, thus giving a duplicate service.

With the proposed three-minute service the seven-coach trains will be able to deliver 10,000 passengers per hour at the termini, or a larger number if the seating accommodation is exceeded. The time for the complete journey with three intermediate stops is 13½ minutes. The trains will be worked on the shuttle principle at the termini, avoiding shunting, and it is intended to complete the double journey in 30 minutes. With this service there will be 11 trains running.

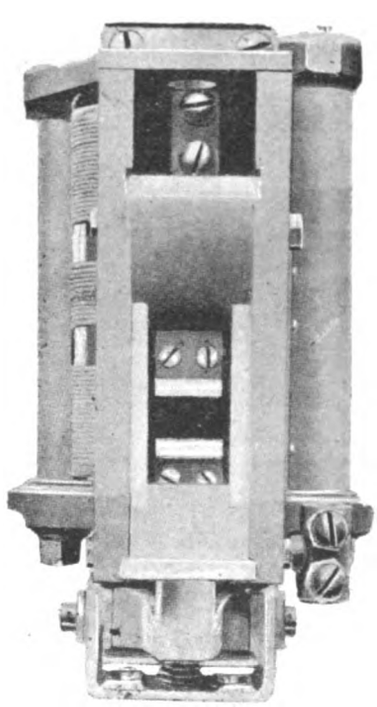

FIG. 9.—A Contactor or Electrically-Operated Switch as used on the above system.

The whole of the engineering work done by the British Thomson-Houston Company, Limited, was carried out under the direction of Mr. A. H. Walton, the manager of their heavy traction department, assisted by Messrs. Winkfield, Dundas, and Thomas.

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## WORKS' VISITS.

### IV.—The General Electric Company's Peel Works, Salford, Manchester.

So much has been heard of late about the Witton establishment of the General Electric Company, Limited, that we have come to instinctively relegate their Salford works to a position of minor importance in our mental comparisons Judged by the respective areas covered, the premise is correct, but in regard to the number of hands employed the works now under notice are easily first. To be specific, these works, covering but a bare acre of ground, find employment for some 1,600 workpeople, whereas scarcely half that number suffices for present needs at Witton; while the firm's Birmingham and London establishments are also constrained to subordinate positions as a result of comparison in turn with the same standard. The disparity is, however, satisfactorily accounted for, and by no means signifies that slackness prevails at Witton, on which point we have evidence to the contrary. But even were that not so, the apparent contradiction is at once explained by a casual glance at the two factories. What do we find? That the Witton factory consists largely of one-floor buildings, in which the operations incidental to the manufacture of dynamos, motors, heavy electrical accessories, and arc lamp carbons, etc., are carried on; while, on the other hand, the Salford factory is of the sky scraper type, telephone and telegraph apparatus, with the attendant multitude of accurately-made parts, bulking prominently in its many productions. We have the required explanation, then, in the different character and variety of the operations involved

The Peel Works have been established some ten years, during which period their organisation has undergone considerable change. It would be tedious, however, to trace the gradual evolution to the present state. Suffice it to say, it is within a comparatively recent date that the works have been devoted exclusively to the manufacture of electrical apparatus of the lighter order. There was a time when dynamos and motors figured in the list of productions, but all that has been changed since the opening of the firm's Witton branch, which is far better adapted, both by reason of its position and equipment, for the construction of heavy machinery. Nevertheless, some good pioneering work, so far at least as this country is concerned, was accomplished at Salford—notably in the case of the 300-kw. two-phase alternators now installed at Fulham. These represent the largest machines ever undertaken at Peel Works, and the first of their kind constructed in this country. The manufacture of three-phase plant was also taken up at Salford, and developed to meet the home demand. But the time came when the accommodation available was insufficient to satisfy the increasing needs of the establishment, hence the removal of the dynamo and motor branch to new works. The space thus gained at Salford has now been completely absorbed by the rapid extensions of the remaining departments, each of which was a veritable hive of industry at the time of our recent visit. In fact, we found a few hours spent at these works well calculated to convey some idea of the enormous demand which exists for telephone, telegraph, and bell apparatus, not to mention the numerous electrical accessories of the General Electric Company's manufacture. And we welcomed the opportunity afforded of viewing the process of repetition work carried out on a wholesale scale with that marvellous ease and rapidity which is born of perfect organisation.

Our tour of inspection commenced at the cabinet-making shop—needless to say, a very important section of the works. Here we saw parts repeated with mathematical precision by machinery and subsequently put together to form casings, etc., for telephone or telegraph apparatus, cut-out boards, electric bells, medical coils, etc. The work turned out appeared to be of uniform excellence, especially noticeable being the perfect dovetailing of the joints. We also found it interesting to watch the sandpapering of the embryo casings by means of revolving reciprocating cylinders fitted to iron-topped tables, and the expeditious removal of the sharp edges. In turn our attention was diverted to the machines employed in moulding beadings to different standard patterns, circular saws screeching their way through baulks of seasoned timber, planing machines adding smoothness, and lathes engaged in turning and drilling blocks for telephone apparatus, ceiling roses, bell pushes, etc., each machine representing the latest pattern of its particular class. We were impressed by the cleanliness and order of this shop. The former state is largely due to the means employed for removing waste. This consists of a system of ducts connected with a common main and receiver, in which latter is placed a powerful exhaust fan. A branch duct is taken to each of the wood-working machines, the opening being arranged to receive the waste as it is formed. By the action of the exhaust fan a partial vacuum is created in the system whereby shavings, sawdust, and scrap wood are drawn into the receiver, from which they gravitate through the funnel provided to the stoking floor in the works boiler-house, where they are used as fuel. Besides effecting the cleanliness of the shop, this system, no doubt, improves its ventilation, and so contributes to good hygienic conditions in a double sense. The artificial lighting is by means of the firm's well-known Angold arc lamps—which have a reputation of their own for steady burning—supplemented with incandescents where local light is required. The arcs are inverted, a well-diffused light by reflection from the white surfaces provided being thus ensured. Raw material in the shape of boxwood, mahogany, walnut, and the other varieties of timber employed is fed into this shop through a hot-air drying chamber, in which the seasoned logs and planks from stocks are made to part with any superfluous moisture they may possess.

Polish is given to the productions of the cabinet-making machinery in a separate department, employing a large staff of French-polishers. It was here where we began to appreciate the method by which the General Electric Company are enabled to turn out a cheap article of equal soundness in every essential respect to its higher-priced counterpart. The price of an article turned out at these works may be said to be governed by the finish given to the embryo parts, this finish being imparted by quick and superficial methods when it is desired to keep the cost of production at a minimum figure. Our attention, then, was first called to this rule in the French-polishing department, through which a volume of telephone work of first-class finish for the Post Office and various municipalities was passing, besides various works of first and second rate finish for stock.

Adhering as closely as possible to the proper order of progression from the raw materials to the finished apparatus, we next paid a brief visit to the foundry, which is equipped with modern furnaces and other requisites for dealing with brass, aluminium, and light castings generally. Attached is a shop set apart for toolmaking and repairs. Drills, planes, lathes, slotters—in fact, all kinds of metal-working machines are installed here. Proceeding we came to a shop occupied in part by an array of stamping and punching machines These were engaged in the rapid production of parts to stock, the destined components of telephone apparatus being mostly of aluminium. By far the most interesting to watch was the action of the machines turning out complicated stampings of brass for tumbler switches. Near by we noticed a row of gas-heated furnaces used for hardening and tempering permanent magnets for magneto machines. In another department hands were busy preparing work for the electro-plating process, with the aid of metal grinding, polishing, and buffing machinery of the most up-to-date description The electro-plating baths, contained in an adjoining room, were principally occupied in nickelling parts for Angold arc lamps, etc, at the time of our visit, but their work with copper and silver was also in evidence, the former in connection with electric kettles and radiators which were being prepared for lacquering.

We next visited the main switch department, which is provided with an equipment of milling machines, lathes, drilling and cutting machines, etc., of its own, and is thus practically self-contained. The work which was being turned out here was of uniform high quality. Indeed, it

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would be difficult to suggest improvement so far as the mechanical design of the firm's standard type switchgears are concerned, for the simple reason that there is little or no room. Loose contacts are rendered a matter of practical impossibility in these gears by the method of construction employed, whereby the solidity obtained also ensures perfect electrical continuity. Copper of a special toughened quality is used for all main contacts. The same excellence of design and workmanship characterised all the apparatus, including automatic circuit breakers of various types and fuses, which we saw in course of manufacture in this department. In the erecting shop there was an interesting array of switchboards in various stages of progress, several being destined for central and private plants in this country, while others represented Colonial orders. Prominent among the latter was a three-phase board for South Africa, fitted with G E.C. standard switches of the carbon break type and a combined maximum and minimum demand circuit breaker. Another board which attracted our notice was peculiar, in that the connections to the various instruments and switches were all arranged on the front. The equipment of this shop includes an overhead travelling crane driven by means of three-phase motors.

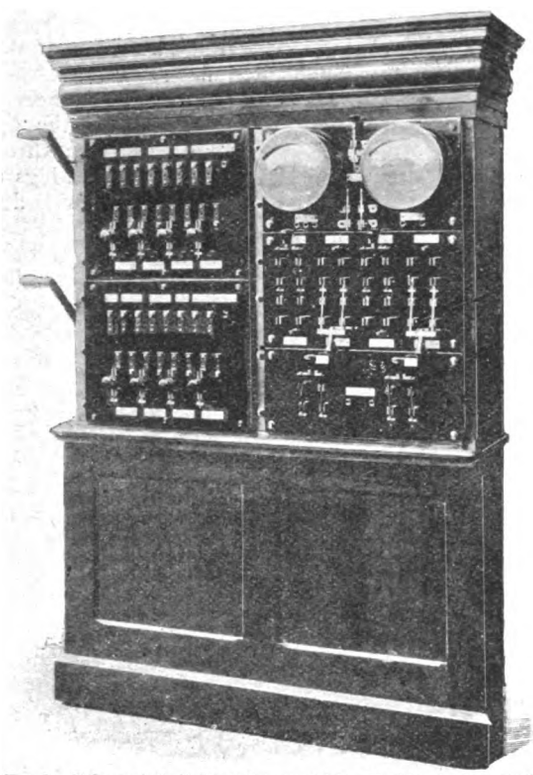

FIG. 1.—Telegraph Switchboard arranged for Working with Secondary Cells. Front View, showing Ammeters, Voltmeters, Switch Levers at the side, etc.

Continuing our way, we passed through the department devoted to brassfinishing and the manufacture of small turned metal parts and screws for telegraph and telephone work. Six parallel ranges of semi-automatic capstan and turret lathes, driven by three-phase motors of 24 h.p., 18 h.p., and 10 h.p. respectively, through line shafting, occupy the main shop of this department. The automatic tools are located in a separate bay. There is also a room set apart for hand-press work, the presses, worked by girl labour, constituting a fine collection of their class. The total daily output of parts yielded by the machine equipments serving the several departments is, of course, enormous. After careful examination these parts are added to stock, from which they are drawn as required in the fitting shops. As the task we had set ourselves of inspecting this factory progressed, we began to realise that the seemingly endless variety of work upon which it is engaged would mean, were an attempt made to deal with each in detail, a volume about the size of the G.E C. catalogue as the result. Hence we shall purposely confine ourselves to a superficial description, except in regard to the work of a certain department, to be dealt with hereafter.

Having in turn made a hasty survey of the meter department, with its complement of machines for engraving the dials of measuring instruments, and several grades of lathes, including a number of the watchmaker's variety for precision work, we passed into the arc lamp shop and testing-room, both of which were busily employed—the one in manufacturing and the other in testing Angold arcs. We then entered what was to us the most interesting department of the factory—namely, that devoted to the manufacture of telegraph and telephone apparatus. As manufacturers of the latter the General Electric Company have probably been hampered more than assisted by the monopoly which they have hitherto had in regard to the supply of a strictly English-made article. In other words, this firm have stood alone in competing for the home demand with British labour. In this circumstance it is certainly to be regretted that success has hitherto attended their enterprise only to a qualified extent, though a casual observer of the great activity which prevails in the department under notice might erroneously come to an opposite conclusion However, to prove the qualification we need but extend our observations to the home market, which, we find, is still mainly supplied with foreign-made

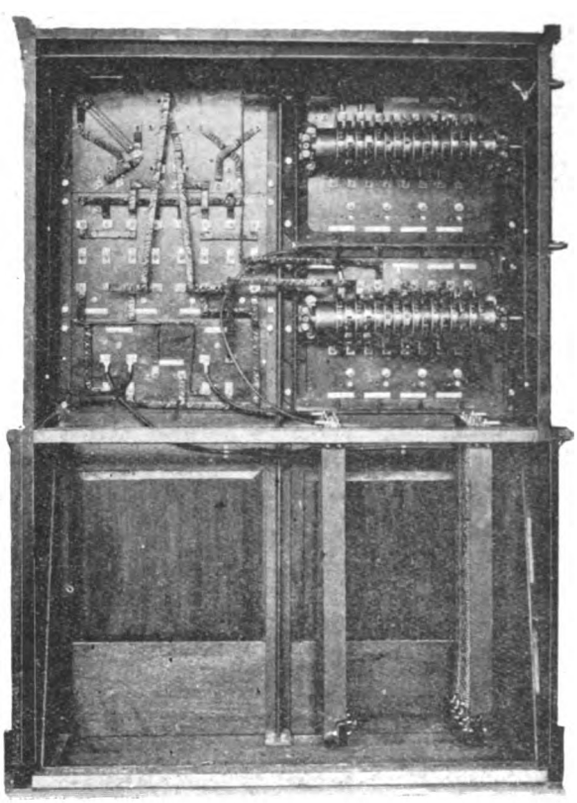

FIG. 2.—Telegraph Switchboard arranged for Working with Secondary Cells. Back View, showing Rotating Switches and Connections.

apparatus, other than switchboards, so far as the largest consumers are concerned. The explanation is no doubt due to the fact that foreign manufacturers were first in the field, and have established the merits of their wares to the satisfaction of customers. This brings us face to face with a serious difficulty—namely, that of persuading the powers that be to divide their favours between a well-tried article and one for which no more than equal excellence of design and construction is claimed. There is no stronger reason why such a course should be adopted than the sentimental one which we term patriotism, and this demands that due consideration should be given to the above claims for what they are worth. Our personal conviction in the matter is that the General Electric Company would be found quite capable of holding their own in this branch of electrical work with apparatus made throughout by British labour.

But to return to our review of the Peel Works. During our progress through the telegraph and telephone section many interesting items of manufacture other than of the firm's own standard design claimed attention. For example, the postal telegraph engineers have recently given much consideration to the problem of working telegraph lines by means of secondary cells instead of primary batteries, and appear to have entirely overcome the difficulties involved

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in maintaining the secondary cells at constant voltage. Many telegraph lines are worked continuously night and day, and it is absolutely essential that the battery power should be available continuously—without cessation, in fact, for a single instant. Were a battery to be disconnected for a second during the process of changing over, for the purpose of charging, this might mean the loss of one or two signals on several lines with serious results; and in order that a secondary cell system may prove perfectly successful when applied to telegraph lines, it is therefore essential to devise some method of making the necessary

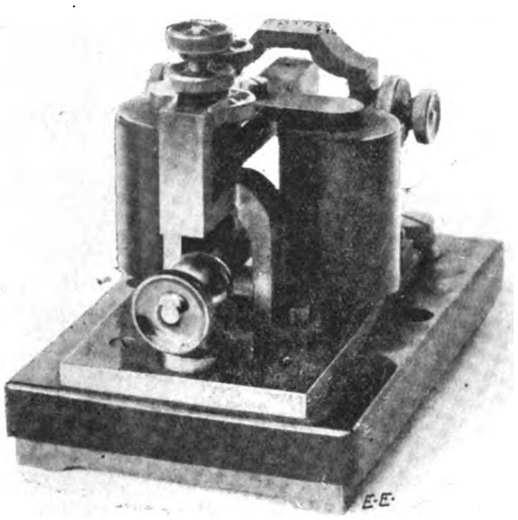

FIG. 3.—Sounder designed for Working with Secondary Cells.

changes which shall obviate the slightest suspicion of disconnection from the actual working lines. This difficult problem has been solved by the postal telegraph engineers, but, of course, the switching arrangements are somewhat complicated, and exceedingly high-class workmanship is required in order to ensure successful working. We had an opportunity of examining some specimens of no less than 30 switchboards for this class of work which have been constructed recently at Peel Works. Each of these boards (see Figs. 1 and 2) is fitted with a Stanley d'Arsonval voltmeter and ammeter with switching arrangements for measuring the voltage and strength of the incoming or outgoing current from time to time as may be desired.

coils having a resistance of 1,000 ohms as compared with 20 ohms when used with primary batteries. A distinct feature of these sounders is the shunt coil, which is placed in the base of each instrument. This coil has a resistance of about 10 times that of the working coils, and it is non-inductively wound with platinoid wire. Its function is to allow the current which is induced every time the circuit is broken to discharge itself through the shunt, thus preventing sparking at the relay contacts. The substantial construction of the complete apparatus is shown in Fig. 3, while Fig. 4 represents one day's output of sounders at Peel Works. Some 2,000 sounders for the Post Office were passing through the shops at the time of our visit, as well as 600 single-current keys. The latter piece of apparatus (Fig. 5) is the one on which the operator sends and the sounder that on which the operator receives signals. In both instruments the workmanship is of the highest class throughout, and in the case of the sounder exceptional care is taken with regard to the mixture of the metal for the castings, the

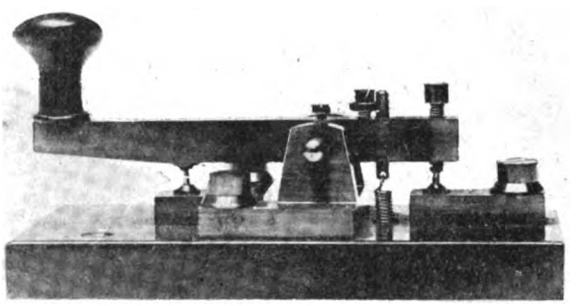

FIG. 5.—One of 500 Single-Current Keys.

object being to produce an instrument which shall give a mellow non-irritating sound, thus enabling the operator to read signals without fatigue for a considerable time.

Passing on, we saw in process of manufacture several hundreds of connection boxes, fitted with lightning arresters of a new pattern, for the Post Office London telephone system. The parts are mounted in a cast-iron box with a japanned iron cover, the whole of the working components being fitted on ebonite strips placed in such a position that there is a considerable amount of space left below the strips for the manipulation of the cables—a point which is frequently overlooked in telephone connection boxes. Ample facilities are also allowed for making

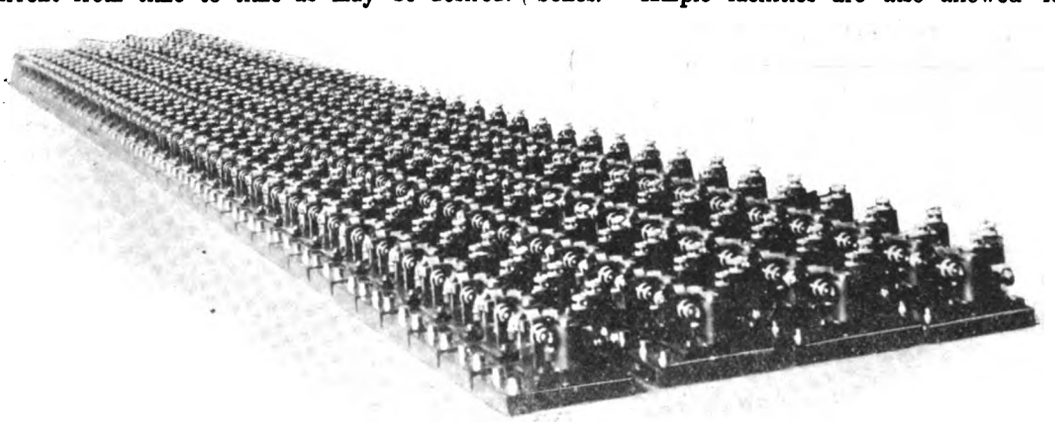

FIG. 4.—One Day's Output of Sounders from Peel Works.

Two rotating switches are also provided with each board, so arranged that by a simple movement of a lever each morning that section of the battery which has been charged on the preceding day is thrown into the position where most work is required, while the section with the lowest voltage is simultaneously thrown into the charging position. Three working voltages are provided—viz., 40, 80, and 120—for local lines, medium length lines, and the longest lines respectively. Secondary cells are now also being largely employed instead of primary batteries for working local circuit instruments—sounders, for example—and these instruments have to be provided with specially-wound coils for the purpose. We saw numbers of such sounders in process of manufacture, the changes in the connections inside the box. The lightning protector itself consists of two carbon blocks clamped between a brass earth connection plate and a strong brass spring, the two plates being separated by a thin strip of mica perforated with three holes, across which the discharge takes place to earth. Before we leave this department brief reference may be made to a telephone switchboard (Figs. 6 and 7) of special construction designed by and made for the London and North-Western Railway Company. The chief feature of this board is that the indicators and jacks are combined in one movement, the whole of which can be taken from the switchboard by the removal of four fixing screws from the front of the board, without the necessity of disconnecting or disarranging any wires or

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cables. When necessary, a faulty movement can be replaced by a new one simply by being pushed in position from the front of the board, the necessary electrical contacts being made by projecting contact pieces which pass between spring jaws suitably fixed on a backboard. All the parts

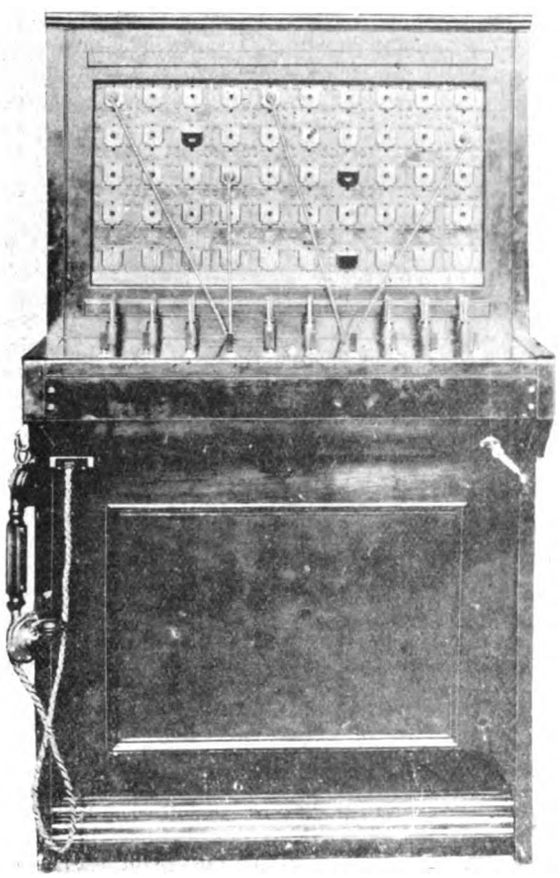

FIG. 6.—Telephone Switchboard for the London and North-Western Railway Company.—Front View.

are unusually massive with the object of standing rough usage, and the arrangement is such that the indicator shutter is automatically replaced by the act of inserting the plug into its jack to answer a call.

The last of the accompanying illustrations (Fig. 8) shows an automatic telephone set of compact form which the

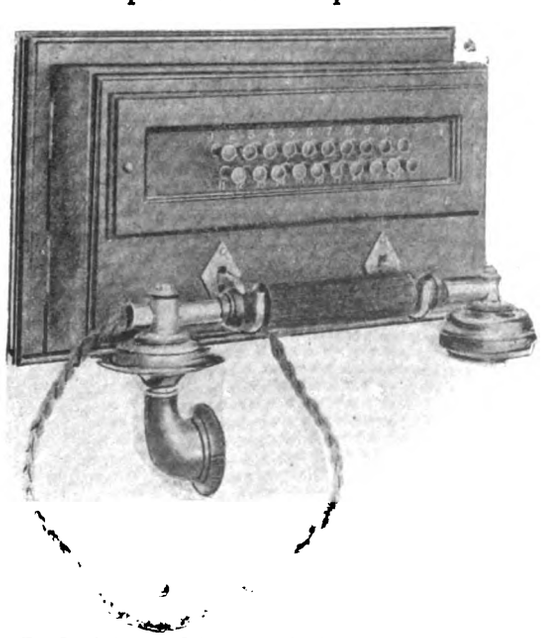

FIG. 8.—Automatic Intercommunication Telephone Set.

General Electric Company have standardised for intercommunication service in large establishments of all kinds. A number of similar sets were in hand to meet the demand which exists for them. Portable telephone sets, traction line sets, indicators for the Post Office exchange telephone switchboards, lightning arresters and fuseboards for the Post Office and National Telephone Company, telephone exchange boards for hotels, etc., fire-alarm boards, and other work of a more or less special character added to the activity of the department Nor did we find the bell and medical coil department less busy. In a room set apart, girls were employed in winding coils for

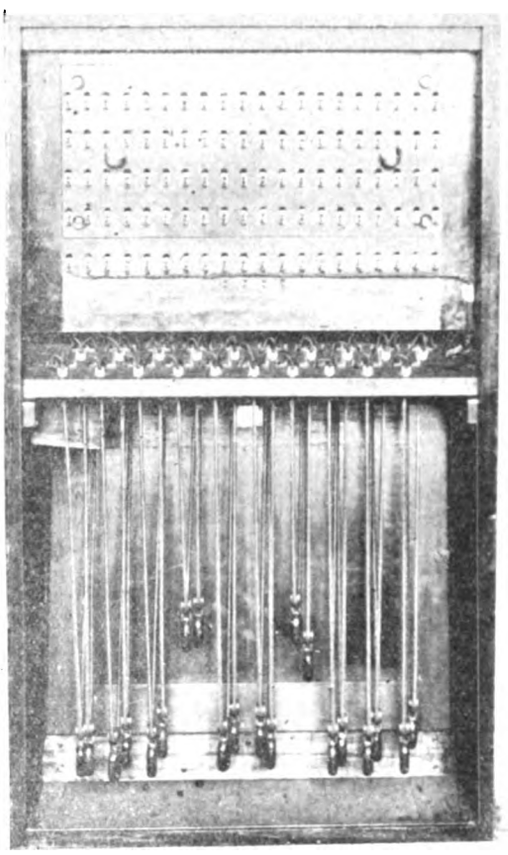

FIG. 7.—Telephone Switchboard for the London and North-Western Railway Company.—Back View.

annunciators, bells, indicators, medical apparatus, etc. The output of this room, we were told, is from 8,000 to 10,000 coils per week—figures which may well be left to tell their own tale The works average output of ordinary bells alone is about 4,000 per month. Elsewhere girls were engaged in fitting together the standard parts of such accessories as rheostats, switches of the tumbler and other household patterns, ceiling roses, cut-outs, traction type combined switches and fuses, and a variety of other articles in more or less wholesale demand. In passing, we were incidentally reminded of the perfection to which the potter has adapted his cunning to the needs of the electrical industry. It is truly wonderful with what accuracy intricate porcelain parts are now moulded and tapped.

The electric radiators, heating devices, kettles, and various cooking utensils supplied by the General Electric Company are also manufactured at Peel Works. An improvement of recent introduction fitted to every kettle or cooking utensil consists of a plug designed to fuse at a slight excess temperature, and so protect the vessel from damage in the event of it being allowed to boil dry through carelessness. A spare plug can be easily inserted. Brief mention may be made of the facilities provided for test and research work. These are of the best, all measuring instruments being carefully calibrated and circuit breakers, etc., adjusted before leaving the works.

Last, but by no means least, there is the receiving department, where all apparatus made for stock undergoes systematic examination before being passed into the general stores. For the rest the equipment of these works includes continuous-current and three-phase generating plant, having a total capacity of about 800 h.p. From 500 h.p. to 600 h.p. is the normal power and lighting load. In the dynamo-room there are some interesting machines installed for testing purposes. They include an Oerlikon generator arranged so that the speed may be varied to give a periodicity of from 40 to 105 at any voltage, and a machine with two armatures and twin commutators, which latter

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can be connected either in parallel or series, for supplying current at 100 to 600 volts pressure. A feature in connection with the boiler-house is the chimney shaft, situated about 100 yards distant. This is a huge structure designed originally to serve several works, but now doing light duty.

In conclusion, we have to thank Mr. A. Eckstein, the managing director, for the facilities afforded us in connection with the preparation of the above article, also Mr. A. Brooker, the works manager, than whom none know more about the intricacies of telephone apparatus, and Mr. Coates for assistance rendered.

## SOME PRACTICAL POINTS IN ARMATURE CONSTRUCTION, DEALING CHIEFLY WITH INSULATION.

BY H. S.

This short descriptive paper was originally written to impart information to the workmen engaged in armature construction at a works with which the author is connected. It was appreciated by those to whom copies were given, and it is thought that the hints contained therein may be of interest and service to others engaged in this class of work. Possibly, also, it may be of interest to those in charge of electrical plant who have occasionally through force of circumstances to undertake their own repairs, etc., and who, from want of opportunity, have not been in a position to acquire much electrical knowledge. To electrical engineers it is, of course, elementary in character, and is not intended for their perusal. An explanation is given below of various points which are important in the winding and construction of armatures. The points to which attention is directed are illustrated by sketches, and any intelligent workman will readily see what parts and places require the greatest care in insulating, etc.

Insulation from the core, spindle, and any other parts in metallic connection with the same, is equally important in every type of armature, whether it be Gramme ring, or wire-wound drum, bar-wound drum, or slotted core. It should be borne in mind that "no chain is stronger than its weakest link," and if an armature breaks down to "earth," it will do so where the insulation is thinnest or weakest, or where it is liable to be injured mechanically, and thereby weakened under ordinary running conditions. Thus, equally great care must be taken with the insulation of all parts.

The insulation of the core, etc., having been made as perfect as possible, the next point which demands attention is the insulation between the various wires or bars. It will be readily understood that the place where a short-circuit is most likely to occur—supposing that the insulation is equally good everywhere—is where the greatest difference of potential (or, in other words, the greatest number of volts) exists between wires or bars close to or touching one another. The position of these points of greatest difference of potential varies in different classes of armatures, depending on the method of winding, and a short description follows showing where these important places are situated in the various types of armatures.

1. *Two-Pole Gramme Ring Armatures.*—This form of armature winding is one of the safest from "short-circuit," for, as will be seen by reference to Fig. 1, the greatest difference of potential is between the conductors and commutator parts at opposite ends of a diameter all the way round. The greatest pressure between any two wires touching one another can only amount to a small portion of the total number of volts. Thus, if an armature is wound with 50 sections, roughly speaking, each section will contribute one-twenty-fifth part of the total voltage. If the armature is to give 100 volts, it means that each coil or section will have to give 100/25 = 4 volts, so that the pressure between each section and its neighbour is very little.

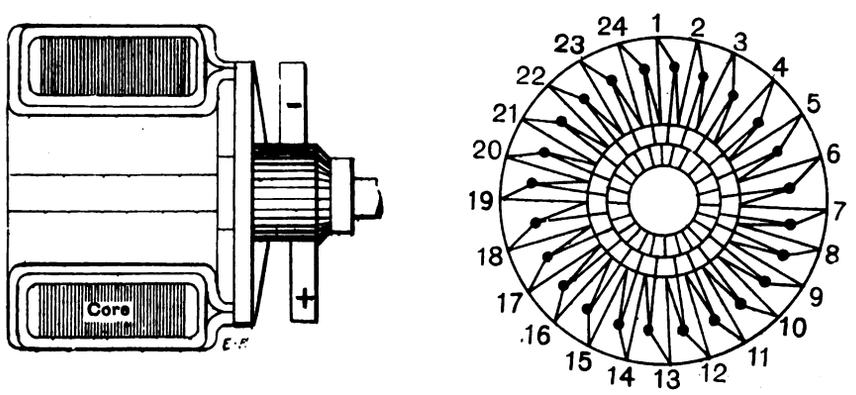


FIG. 1.—Gramme Ring Winding, showing top end of one coil and inside end of next coil joined together at the commutator arm.

2. *Two-Pole Smooth-Core Drum-Wound Armatures.*—With all drum-wound armatures the case is different. Instead of each conductor completing its circuit by returning through the inside of the core, as in the Gramme ring winding, it passes across the end of the core and along the opposite surface, each section or coil usually consisting of one long bar attached to a commutator section and one short bar on the opposite side. Now, a commutator section opposite to the one just mentioned will also have a long bar attached to it. This long bar will, therefore, be lying near to, in fact, touching, the short bar belonging to the first-mentioned section or coil. Thus it will be seen that there is the full voltage of the machine between every adjacent long and short bar all the way round the armature. It is necessary, therefore, to insulate the long bars from the short bars very thoroughly and well, especially where the long bars pass over the "crossings" or "end connections" to which the short bars are attached because these joints are bare. The strip of mica cloth generally employed forms an excellent means of insulating this place, but to be thoroughly

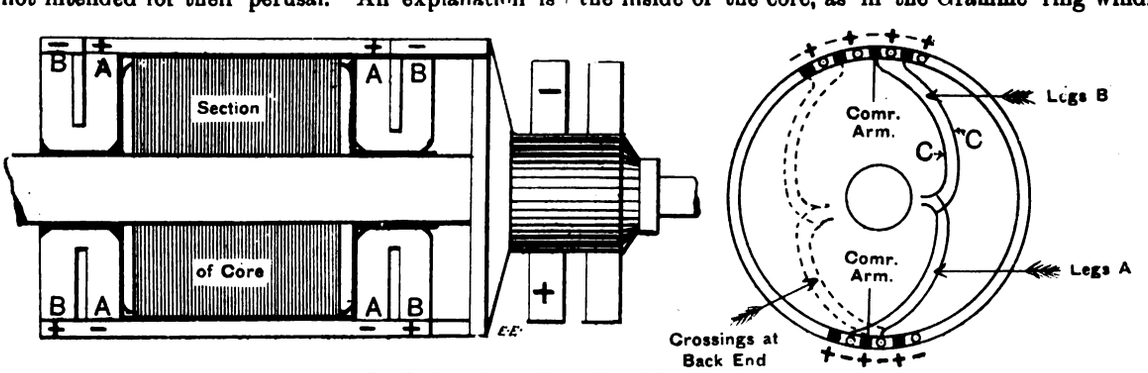


FIG. 2. Smooth-Core Drum-Wound Bar Armature.

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effective it should be at least ½in. wider than the leg of the "crossing," A, so as to project ¼in. beyond the bare metal on each side. Care should also be taken that the insulation on the long bars themselves is continued quite close up to where they join legs, B, of the "crossings." The difference of potential between each "crossing," C C, is very small, but there is the full voltage between the inside legs, A, and outside legs, B, of the "crossings" at any point near the circumference of the armature, because the tips are attached to short and long bars, and it has been shown that there is the full voltage between long and short bars. Reference to Fig. 2 will show this clearly. The long bars are represented by squares and the short bars by circles. What has been said above with reference to bar armatures applies also to wire-wound drum armatures, so far as the wires on the surface of the core are concerned, but the case is somewhat different at the ends of the core. This point, however, will receive attention when dealing with slotted-core armatures.

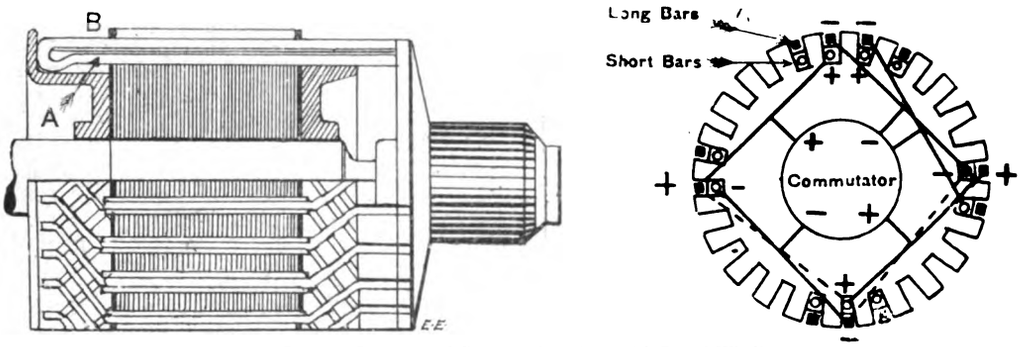


FIG. 3.—Four-Pole Slotted-Core Bar Armature with Barrel Winding.

3. *Slotted-Core Drum Armatures.*—In slotted-core armatures the full voltage usually occurs between the top and bottom bars in any slot or top group and bottom group of wires. In this method of winding the top and bottom conductors correspond to the long and short bars of a smooth-core armature, and all that has been explained previously in paragraph 2 applies to this type of armature, bearing in mind that the great need for insulation is between top and bottom bars. In four-pole and multipolar armatures it is often more convenient to adopt the so called "barrel" type of formed coils instead of using separate crossings. When such coils are used, there will be the full voltage between the top part, B, of the barrel end connection and the bottom part, A, at any point close up to the end of the core, these points corresponding to leg A and B of the ordinary crossings. It is most important, therefore, to have a sheet of good insulating material in the space between A and B, especially close up to the end of the core. Fig. 3 will explain this clearly.

4. In a wire-wound armature with slotted core, great care must be taken with the insulation between the bottom group and top group of wires. The strip of insulating material should project beyond the core at each end, so that it may be bent down to partially cover the wires of the bottom coil in the slot, where they emerge from the core. Some extra insulating material, such as varnished paper or calico, is desirable between each coil on the ends of the armature, but it need only be thin. When the first half of the coils has been wound, both ends of the armature should be thoroughly well insulated before any of the second half is wound, as there will be the full voltage at various points on the ends between the first half and the second half of the winding, in the same way that there is between the inner and outer legs of the "crossings" of bar armatures. In the case of armatures with a double winding and two commutators, the above remarks apply, of course, to each of the windings, and in addition, specially great care must be taken to thoroughly insulate the second winding from the first, both in the slots and on both ends.

5. The points mentioned with regard to wire-wound slotted-core armatures apply also to the special form of wire winding sometimes used for smooth-core armatures, where the conductors are all laid round the armature core at the start, while the ends of the armature finally form a sort of hollow cage or barrel. The full difference of potential occurs between the first and second layers in a two-layer winding due to the method of connecting up, and not between wires side by side as in a bar armature.

6. A few words on the importance of leaving sufficient surface of insulation for prevention of breakdowns. Although many materials are such good insulators that even very thin pieces will withstand a pressure many times greater than the working voltage, however good the material may be, there is always the danger that an accumulation of moisture or dirt, such as copper or carbon dust, may lead the current across a narrow surface from one place to another, say, for instance, from a long bar to a short bar, and thus a short-circuit, the effect, of course, being quite as

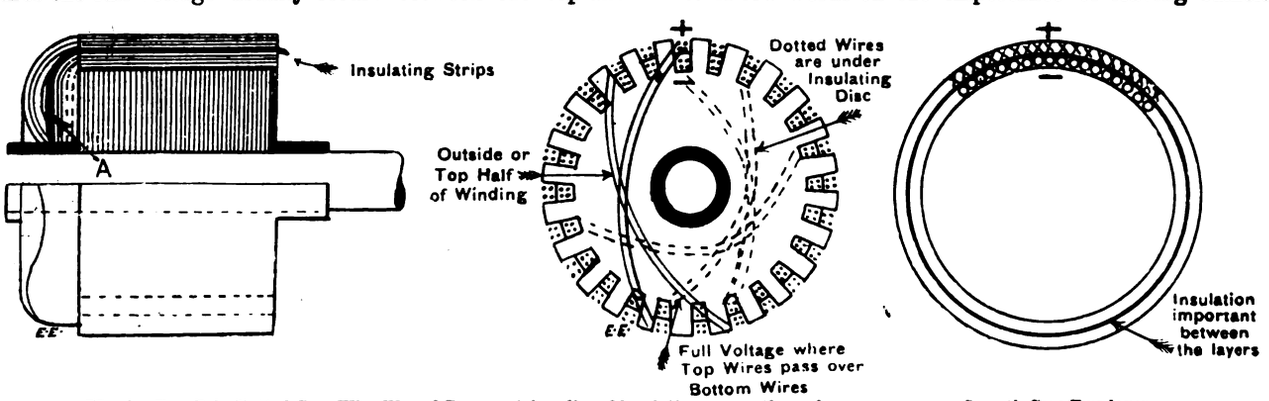
Insulating Strips
A
Outside or Top Half of Winding
Dotted Wires are under Insulating Disc
Full Voltage where Top Wires pass over Bottom Wires
Insulation important between the layers

FIG. 4.—Two-Pole Slotted-Core Wire-Wound Drum. A is a disc of insulation put on the ends as soon as one-half the total number of coils has been wound.

Smooth-Core Two-layer Drum Winding.

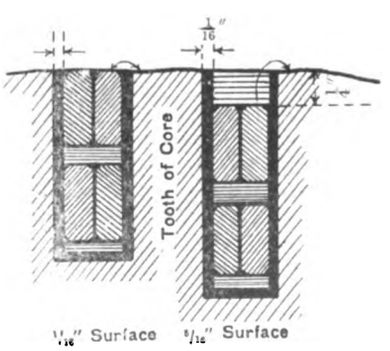


FIG. 5.

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bad as though a spark had passed clean through the insulation between them. A reference to Fig. 5 will show exactly what is meant. For an example, a bare copper bar is shown in a slot of an armature, being insulated from the core by a trough of mica, presspahn, or any suitable material. If this trough is, say, only $\frac{1}{16}$in. thick, it may take a pressure of thousands of volts to pierce through it, but if the bar is flush with the top of the trough, and a small amount of grease or dust happens to cover the edge of the trough, very likely only a few hundred volts would be sufficient to spark across this $\frac{1}{16}$in. surface. Now, suppose that instead of the copper bar being flush with the top of the trough, it is considerably below, say $\frac{1}{4}$in., there will now be a total length of surface of $\frac{5}{16}$in. to bridge across with dirt before any harm could result. And as in practice this open top of the trough would be filled in with a tightly fitting strip of insulating material, there would be very little chance of any dirt bridging across. This is the reason for making the strip of mica cloth $\frac{1}{4}$in. wider than the leg of the crossings in a drum-bar armature, as mentioned previously. This point of "surface leakage" is very important.

In conclusion, it may be once more stated that neglect of these precautions at any single point is certain to result in a *breakdown* sooner or later. It is hoped that this short paper may be the means of showing workmen the reason why, as well as how, certain things in armature construction are done.

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At the ordinary general meeting on Jan. 14 the following were the candidates balloted for:

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THE

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*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## ENGINEERING PROGRESS.

In engineering work, as in other branches of commercial life, progress in the earlier stages is made rather by individual effort than by the combined exertions of a number. It is only after any department of engineering has attained commercial success that exact determinations as to the best methods of carrying out a particular operation can be made. It frequently happens, then, that the pioneering undertaking which had by the genius of its originator shown the way to success, is burdened with capital charges which its successors in the field can easily avoid. In the early stages of any new electrical undertaking it is, therefore, well that extreme variations in the different ways of effecting the same purpose should be tried. After all, only the most fit will survive, but those which fail have not been without service, as they have warned others from the wrong path. In electrical engineering most of the branches of the science have advanced sufficiently far out of the first stages of progress to enable standardisation to be attempted with good prospects of success. The work of the Engineering Standards Committee in this direction is receiving the support of practically all concerned. This next week there is to be a joint meeting between the Electrical Sub-Committee of this Engineering Standards Committee, which is engaged upon the question of standardising generators, motors, and transformers, and those consulting engineers and manufacturers interested in power supply schemes over some differences of opinion which have been discovered as to some suggested standards. Certain of these questions to be discussed deal with the standardisation of direct and alternate current motors, on which great diversity of opinion has been shown in the replies received by this sub-committee. Another point which has been strongly criticised is that of the standard frequencies, which, it will be remembered, were to be fixed at 25 and 50 periods. The first of these frequencies was recommended for transmission work, including the supply of electrical energy to large tramway and railway systems, while the second was to be the standard frequency for electric lighting purposes. All engineers agree on the advantage of keeping the frequency low when power alone has to be dealt with, but, unfortunately, a frequency of 25 is not satisfactory for lighting. It is in consequence of this that objections have been raised to the lower standard as applied to our large power distribution schemes, from which a certain amount of lighting is always required. The whole question is one which should be thoroughly discussed, and we are pleased to see that the Engineering Standards Committee have arranged two conferences for the purpose, which are to be held on Monday and Tuesday next at the Institution of Civil Engineers. These discussions, to which all interested in the subject are invited, should clear up to a large extent the matters at issue. The importance of a prompt decision is great, but it is much more important that this decision when arrived at should be correct, and that it should be acceptable to the great majority of the profession. With the electrification of railways the methods used of collecting the current for the motor and of returning it to the power-house need to be uniform. Railway engineers quickly recognise this, as was shown by Mr. W. E. Langdon's paper on the "Position and Protection of the Third Rail on Electric Railways," read before the engineering conference of the Institution of Civil Engineers last summer. Unless the position of this third rail, and in some instances of a fourth rail, is identical on all our railways as they are converted, there will in time be as much trouble over the through running of electric trains as there was in the early days due to the different gauges of these railways. As was pointed out by Mr. Aspinall,

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who is responsible for conversion of the Liverpool to Southport line, the matter has been discussed by the railway companies. After three meetings at the Railway Clearing House a standard position was agreed upon. This was that the third rail should be 3ft. 11½in. from the central line of the track, and that it should project 3in. above the surface of the running rail. These dimensions have been adhered to on Mr. Aspinall's line, and also by the North-Eastern Railway for their branch lines to Whitley and Tynemouth. In the case, however, of the Great Northern and City line there is only 10in. between each of the conductor rails and the running rail, and the difference in level is only 2in. We trust that other railway companies will adhere to the standard dimensions arranged as above mentioned. These would apply equally to lines using an insulated return. For the present the work actually carried out shows a remarkable divergence of opinion on the question of the return circuit on railways. The divergences are so great that in the course of a year or two evidence should be forthcoming on which reliable conclusions as to the best system can be drawn.

## HOMO TO ELECTRA.

O! Thou who wast my handmaiden
And art my mistress now:
I sing this song of praise to thee,
Place laurels on thy brow.
Since first thou came'st into my life
I've learnt to love thee well,
And what thy loss would be to me
My tongue could never tell.

Before I met thee I was tied
To narrow paths and few;
But now, since thou hast been my bride,
I view the world through you.
The town that lies beside my door
Is foul, and dull, and sad;
But thou hast brought the countryside
Anigh me, sweet and glad.

Thou tendest me throughout my life,
In all I do thou art
A willing servant, faithful wife,
And goddess, too, in part.
Thine ears all distance overcome,
Thine eyes the dark make clear,
Thy feet are Speed, thine arms are Power,
Thy clutch is Death-in-fear.

B. C. H. J.

## FORTHCOMING EVENTS.

FRIDAY, JAN. 22.

**North-East Coast Institution.**—General meeting at Newcastle. Adjourned discussion on Mr. Max Wurl's paper on "Technical Education in Germany." Paper: "Notes on the Construction of Stability Cross Curves from Balanced Paper Sections," by Mr. J. H. Heck.

SATURDAY, JAN. 23.

**Institution of Electrical Engineers** (Students' Section).—At 10.15 a.m, visit to the Silvertown Telegraph Works.

**Glasgow Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Some Observations on Mechanical Training," by Mr. Wm. D. Hamilton.

MONDAY, JAN. 25.

**Society of Arts.**—At 8 p.m., Cantor lecture: "Oils and Fats—Their Uses and Applications," by Dr J. Lewkowitsch (Lecture I.).

**Camera Club.**—Ordinary meeting. Paper: "The Photography of Some Electrical Phenomena," by Mr. G. W. H. Rodman, M.D.

TUESDAY, JAN. 26.

**Engineering Standards Committee.**—At 2 p.m., at the Institution of Civil Engineers. Opening meeting of Conference on Standardisation of Motors.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper: "The Sanding-up of Tidal Harbours," by Mr. A. E. Carey.

WEDNESDAY, JAN. 27.

**Institution of Electrical Engineers** (Birmingham Section).—At 3 p.m., visit to the West Bromwich Electricity Works. At 7.30 p.m., ordinary meeting. Paper: "Energy Distribution to Sub-Stations," by Mr. C. Alfred Smith. Demonstration on "Some Uses of the Oscillograph," by Messrs. D. K. Morris and J. K. Catterson-Smith.

**Engineering Standards Committee.**—At 2 p.m., at the Institution of Civil Engineers. Conference on "Standardisation of Motors."

**Liverpool Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "Induction Motors," by Prof. E. W. Marchant, D.Sc.

**Electrical Engineers (R.E.) Volunteers.**—At 8.30 p.m., unveiling of South African War Memorial at Headquarters.

THURSDAY, JAN. 28.

**Institution of Electrical Engineers.**—At 8 p.m., ordinary meeting. Discussion on Mr. W. Hibbert's paper: "The Edison Accumulator for Automobiles," to be opened by Dr. Fleming. Adjourned discussion on Dr. Hans Behn-Eschenburg's paper: "On the Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines."

FRIDAY, JAN. 29.

**Institution of Civil Engineers** (Students' Section).—At 8 p.m., ordinary meeting. Lecture on "Metallurgy as Applied in Engineering," by Mr. A. P. Head.

SATURDAY, JAN. 30.

**Electrical Engineers (R.E.) Volunteers.**—At 8 p.m., at headquarters, Bohemian concert; uniform, tunic or mess.

## COAL CONSUMPTION IN CENTRAL STATIONS.

BY ALFRED S. GILES.

Following is an abstract of the above paper read before the Manchester Section of the Institution of Electrical Engineers on the 19th inst. The author comments on the fact that central-station engineers are constantly brought face to face with the question of supplying electric power to factories and workshops in competition with isolated steam plants. He considers the ordinary weaving and spinning mills of Lancashire, which are able to produce an indicated horse-power hour for about 2lb. of good coal, and these figures can be translated from indicated horse-power into units by taking, say, 600 watts per indicated horse-power. Taking coal at 7s. per ton in Lancashire, we arrive at what we may call our ideal figure of 0·125d. per unit for coal consumption. The equipment of these mills consists usually of Lancashire boilers supplying Corliss engines. The feature that leads to economy of coal consumption is the high load factor, which usually averages 33 per cent.; also, the losses from condensation in the steam-pipes are low, and the auxiliary plant takes but a small percentage of the total output. These mills frequently work with a poor vacuum, low steam pressure, and without any superheat; hence the author attributes the fuel economy almost entirely to the load factor.

He proceeds to deal with the coal consumption in electric power stations under various headings. The first of these is the calorific value and cleanliness of the fuel. Mr. Giles gives the figures in Table I. of a number of calorimeter tests which he made before placing the annual coal contract for the Blackburn works. He advocates that these tests should always be accompanied by a practical trial of the coal over a period of a few days, during which the amount of ash and clinker can be accurately ascertained. As a result of the trial the contract was placed for No. 7 coal, which, although neither so high in calorific value nor so clean as the other coals, is the cheapest per unit generated, and the difference in the cost is so large as to nullify the advantages of the other coals.

With respect to coal handling, it is concluded that if the central station be a small one, burning, say, 50 tons per week, mechanical stokers will show very little gain over hand firing, unless it is necessary to avoid all smoke or to burn a very small low-class fuel. In large central stations, however, mechanical stokers are most satisfactory, for not only can a cheaper coal be used than with hand firing, but the economy of labour in employing these machines in conjunction with coal elevating and conveying plant may reach sometimes 30 to 40 per cent. over hand firing. Whilst the advantages in a large station of the fuel being delivered to the furnaces with regularity, the even firing, and consequently better covering of the grate bars, with closed firedoors, must ensure a higher boiler efficiency.

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TABLE I.—BLACKBURN FUEL TESTS.

| No. of Tender. | Name of Slack. | Actual Working Test. Weight of coal. tons cwts. qrs. | Percentage of ashes. | Loads of ashes. | Units generated. | Cost per unit. | Calorimeter Test. Temp. before test. C. | Tem. after test. C. | Temp. rise. C. | B. Th. U. | Price. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | d. | | | | | |
| 1 | Arley slack | 163 6 1 | 20·8 | 34 | 40,769 | ·360 | 6·9° | 13·0° | 6·1° | 11,662 | 7/4 |
| 2 | Bickershaw rough | 260 5 3 | 11·9 | 31 | 78,001 | ·317 | 8·5 | 15·8 | 7·3 | 14,118 | 7/9 |
| 3 | Park Lane Wigan slack | 261 3 2 | 19·1 | 50 | 70,746 | ·339 | 8·6 | 14·6 | 6·0 | 11,507 | 7/6 |
| | Rose Bridge | — | — | — | — | — | 7·16 | 13·4 | 5·8 | 11,120 | 7/8 |
| 4 | Pearson & Knowles' Moss slack | — | — | — | — | — | 8·7 | 15·8 | 7·1 | 13,538 | 8/8 |
| | West Leigh rough slack | 231 19 1 | 18·5 | 43 | 63,231 | ·359 | 9·0 | 15·2 | 6·2 | 11,797 | 8/- |
| | Pearson & Knowles' washed slack | 35 7 1 | 14·3 | 5 | 9,984 | ·345 | 9·6 | 16·1 | 6·5 | 12,474 | 8/- |
| | Crompton Shawcross Ince slack | — | — | — | — | — | 9·1 | 15·4 | 6·3 | 11,990 | 8/1 |
| | Ellerbeck slack | — | — | — | — | — | 9·5 | 15·2 | 5·7 | 10,927 | 7/9 |
| | Duxbury Park | — | — | — | — | — | 7·6 | 13·2 | 5·6 | 10,733 | 7/- |
| 5 | Arley slack | — | — | — | — | — | 9·2 | 15·2 | 6·0 | 11,507 | 7/2 |
| 6 | Haydock Collieries slack | — | — | — | — | — | 9·4 | 15·2 | 5·8 | 11,313 | 8·5 |
| 7 | Meadow slack | 237 0 0 | 16·8 | 40 | 68,142 | ·297 | 9·5 | 15·8 | 6·3 | 11,990 | 7/- |
| 8 | Trencherbone hard slack | 283 0 0 | 15·2 | 44 | 75,118 | ·379 | No sample with tender. | | | | 8/3 |

As regards combustion, stress is laid on the importance of regulating the air admission and of keeping regular analyses of the flue gases in order that an excess of air may not be allowed to pass into the furnaces. Figures are given to show the loss of heat resulting from such excess of air, which can be revealed by the percentage of $CO_2$ in the flue gases. The importance of keeping the boilers clean in order to assist in the heat transmission from the coal to the water is emphasised, as is also the importance of having the boilers and the steam-pipes and their flanges effectually insulated with composition to prevent heat radiation.

The next section of the paper deals with superheated steam, and figures are quoted to show the saving both in coal and steam consumption with varying degrees of superheat. At Blackburn the author uses flue-fired McPhail and Simpson's superheaters connected with 8ft. 6in. by 33ft. Lancashire boilers steaming to a 1,200-i.h.p. Willans engine; a maximum of 100deg. of superheat is obtained at the engine at full load, the steam pressure being 170lb. at the engine. In the section dealing with steam consumption, it is pointed out that the majority of engines in use are of the high-speed self-lubricating type, and the steam consumption in this class is very little higher than with the slow-speed Corliss engine. Figures are given from recent guarantees for three 775-kw. steam dynamos. They were to be worked with a steam pressure of 170 superheated to 470deg. The high-speed engine-makers guaranteed 20·51lb of steam per kilowatt-hour at full load and 22·15lb. at half load. The best Corliss engine builders guaranteed 19·6lb. and 22·1lb. respectively.

Under the heading of vacuum some useful hints are given as to the best way of securing a good vacuum at the engine itself. As regards the best practical results that can be obtained, Mr. Giles quotes Prof. Kennedy as responsible for the following ideal figures: 10½lb. of water per pound of coal and 8½lb. of steam at the engine per pound of coal burnt. On this basis the 775-kw. high-speed engine referred to above would be able to work to 2·58lb. of coal per kilowatt-hour, which at 7s. per ton would cost 0·097d. per unit generated. This was the calculated figure, and after one of the engines, which was of the Willans type, had been fixed, trials were made to see the best result that could be obtained. The dynamo was one of the Dick-Kerr type giving continuous current, and the trial lasted four hours. The figures of the test are as follows: Mean steam pressure at boiler by gauge, 183lb.; mean absolute steam pressure, 197·8lb.; mean temperature of steam, 380deg. F.; mean temperature of feed water to economiser, 80deg. F.; mean temperature of feed water to boilers, 190deg. F.; mean load, 1,420 amperes 493 volts = 700 kw.; total coal used in pounds, 8,845; price of coal per ton, 7s.; calorific value in B.T.U., 11,990; total units generated in B.T.U., 2,640; mean draught, ¾in.; mean temperature of steam entering superheaters, 370deg. F.; mean temperature of steam leaving superheaters, 500deg. F.; mean temperature of steam at engine, 460deg. F.; mean vacuum at engine, 23in. Analysis of gases leaving boiler: carbonic dioxide, $CO_2$, 10·2 per cent. volume; carbonic oxide, CO, 0 per cent. volume; oxygen, 9 per cent. volume. Results: pounds of coal per square foot of grate area, 29·2; pounds of coal per B.T.U. generated, 3·35; cost of coal per B.T.U., ·125d.

It will be seen that the calculated figure was not obtained, the practical result being quite 25 per cent. higher. In order to get more information on the subject the author wrote to the engineers of a number of central stations of large output and obtained the figures given in Table II. These figures are new, and from being worked out at per unit generated are more important from coal consumption point of view than any based on the cost per unit sold. The actual costs, as shown by this table, prove that an enormous loss of heat takes place in central stations in converting the heat from the coal to electric energy. If we look at the items "pounds of coal per unit generated" and "cost per unit generated," we find the figures are from 100 to 500 per cent. higher than what we may call the ideal figure of 2·41lb. of coal per unit. This difference may be accounted for to some extent in the boiler-house by the banking of fires, losses by radiation, and condensation in steam-pipes, etc., and the steam used by the pumps and other auxiliaries. We cannot, however, account for more than about 25 to 35 per cent. under these headings. If we can increase our load factor, we shall certainly reduce the coal consumption per unit.

The author also gives figures to show how the coal consumption is varied with load factor in the electricity works at Southport, Salford, and Blackburn respectively. He concludes with the suggestion that central-station engineers should carefully look into the heat losses at their respective stations, in order that arrangements may be made to utilise fuel with greater economy. It is only by doing this that central stations will be able to increase the use of electrical energy for power purposes.

### DISCUSSION.

**Mr. A. S. Giles**, in reading his paper, added that it was his practice to test samples of coal before opening the annual tenders for same. His experience of steam-pipe radiation losses gave the figure of half a ton of coal per annum per square foot of exposed metal surface. He thought enough details of flue gases were not generally taken to conduce to economical working, and that stricter investigating and testing were necessary, as losses of 20 and 30 per cent. were common owing to lack of this testing. The following errors in Table II. required correcting: Southport, 7s. coal should be 8s. 6d.; 7·7lb. per unit, should be 6·5d; ·289d. per unit, should be ·295d.

**Mr. E. Cowan**, from the chair, opened the discussion with, as usual, an apt reminiscence, this time dealing with Colonel Crompton's long-ago prophecy of ·25d. cost per unit and Mr. Hammond's still cheaper ·2d., which at the time were castles in the air, but are now actually beaten by St. Helens, ·18d.; Glasgow, ·13d.; and (in his experience) Cadbury's cocoa works, ·125d—this latter plant being run by gas engines with Mond producers. He thought this improvement

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TABLE II.—COAL-CONSUMPTION FIGURES IN ELECTRICITY SUPPLY CENTRAL STATIONS FOR THE YEAR 1902-1903.

| Name of Town. | Quality and Calorific Value. | How Fired, Mechanical or Hand. | Steam or Electric Auxiliary Machinery, Number of Units used. | Condensing or Non-Condensing. | Percentage of Output Non-Condensing. | Superheat in degrees Fahrenheit. | Price per Ton. | Lbs. per Unit Generated. | Cost per Unit Generated. | Load Factor on Feeders. |
|---|---|---|---|---|---|---|---|---|---|---|
| Aberdeen | South Hetton, Wearmouth, Wilson & Clyde, &c. | hand and mechanical | both | both | 13·4 N.C. | none | 11/6 11/10<br>11/9 12/6 | — | d<br>·47 | 17·49 |
| Blackburn | Wigan slack 11,900 | mechanical | both | both | — | none | 7/3 | 10 | 38 | 17·45 |
| Blackpool | Lancs. slack & nuts | both | steam | N.C. | — | very little | 10/- aver. | 15·4 | ·826 | 14·32 |
| Bootle | Lancs. slack | mechanical | both | condensing | — | none | 7/6 | 9·02 | ·357 | 28·44 |
| Bradford | 11,700 to 13,000 B.T.U. | mechanical | both | both | 20·0 N.C. | partially | 9/9 about | 4·1 | ·214 | 20·93 |
| Bristol | Rhymnly washed peas 13,500 to 14,000<br>Hanham slack 12,500 to 13,000 | mechanical | mostly steam | condensing | — | partly 500°—560° | 11/10—7/6 | 8·6 | ·54 | 13·75 |
| Burnley | Small lump 13,290 | both | electric | condensing | — | none | 10/3 | 5·2 | 28 | 15·59 |
| Croydon | Best Welsh | hand | nearly all 372,140 | condensing | — | partly up to 500 | 24/6 | 5·03 | ·66 | 16·81 |
| Derby | Small peas 14,103 | both | both | condensing | — | 50 | 7/8 | 13·2 | ·543 | 13·36 |
| Devenport | Welsh | hand | steam | condensing | — | 35 | 14/2 | 9·6 | ·72 | 19·02 |
| Dundee | Fife small about 11,000 | both | 225,000 almost all | condensing | 8% N.C. | very little | 9/6—7/- | 7·7 | ·35 | 13·63 |
| East Ham | Hucknell steam and slack | hand | — | condensing | — | 60° above | 19/9—12/6 | 6·2 | ·6 | 12·95 |
| Edinburgh | Washed nuts, 12,500 | almost entirely mechanical | both | non-condensing | — | slightly | 6/11—7/6 | 6·35 | ·247 | 14·31 |
| Glasgow | Washed nuts 11,000 | mechanical | all purposes 745,801 | condensing | — | 500 | 7/- | 6·05 | ·227 | 14·01 |
| Halifax | Nuts and slack | mechanical | both 409,015 | condensing | — | 430 to 450 | 7/6 | 9·6 | ·39 | 16·98 |
| Huddersfield | Slack | both | both | condensing | — | none | 5/5 | 11·02 | ·296 | 10·47 |
| Hull | Yorkshire steam 14,700 | hand | steam | condensing | — | none | 12/4 | 7·05 | ·465 | 9·96 |
| Leeds | Smudge 10,000—11,000 | mechanical | steam | condensing | — | Portion to 460 | 5/- | 8·4 | ·224 | 12·31 |
| Nottingham | Partly large and partly Pea nuts 9,000—10,000 | both | steam chiefly | N.C. | — | none | 9/-—9/6 | 6·5 | ·37 | 16 31 |
| Salford | Slack | mechanical | elec. 554,381 | condensing | — | 50 to 100 | 8/4 | 4·3 | ·244 | 21·84 |
| Sheffield | Engine slack 12,000 | mechanical | — | condensing | — | none | 7/9 | 7 8 | ·32 | 11·92 |
| Southport | Slack | hand | both 95,377 | condensing | — | 60 to 100 | 7/- | 7 7 | ·289 | 15·31 |
| South Shields | Small | hand | steam | condensing | — | none | 9/6 | 6·3 | ·32 | 15·82 |
| St. Helens | Lancs. slack | hand | both | condensing | — | 460 | 6/9 | 5 | ·18 | 19·78 |
| Sunderland | Durham Bean and small 13,480 | mechanical | both | both | 40% N.C. | none | 9/10 | 10 | ·535 | 17·87 |
| West Ham | Best Welsh Derby Pea nuts | both | steam | condensing | — | slightly | 20/6 13/8 | — | ·75 | 12·82 |
| | | hand | both | — | 10% N.C. | none | 7/3 9/1 | 7·9 | ·43 | 18·33 |
| | Tredegar Best Welsh 13,500 | hand | both 180,177 | both | — | none | 22/4½ | 5·2 | ·637 | 17·38 |
| | Engine slack | mechanical | both 427,331 | both | 16% N.C. | 100 | 7/8 | 7 | ·281 | 18·87 |
| **TRAMWAY GENERATING STATIONS.** | | | | | | | | | | |
| Glasgow | Washed singles 10,000 | mechanical | electric 988,000 | condensing | — | 390—400 | 6/8 | 3·64 | ·13 | 47·7 |
| Sheffield | Treeton washed and screened nuts 13,700 | principally hand | partly | condensing | — | none | 8/8 | 4·3 | ·2 | 37·15 |
| Hull | Hickleton Main washed slack | mechanical | partly 93,861 | condensing | — | none | 12/4 | 8·0 | | |

should be the means of displacing the coal burnt in domestic fires with their miserable 7 per cent. efficiency. The heat transmission through iron boilers was sometimes thought to be inferior to that through copper, but with the latter it was impossible to keep the surfaces clean. Gold was really the best heat-conducting and non-corrodible metal, but was not immediately practicable for use. Mr. Geipel had published an estimate for waste at the rate of 300lb. per square foot of surface for lagged pipes. Mr. Cowan referred to the seeming inaccuracy of the statement that four boilers working at quarter load was a more efficient arrangement than one boiler working at full output. He commented on the fact that Manchester was not mentioned in Table II. of principal stations.

**Mr. S. L. Pearce** thought the testing of coal very important, and preferred to evaporate a given quantity of water in place of making actual running tests, owing to the varying loads met with on the latter tests. When analysing his coal he noted moisture, ash left, and unburnt coke also. He instanced the City and South London Railway taking out their mechanical stokers and replacing them by the human type, but considered that the price of coal was chiefly responsible for the success or not of such mechanism. He could recommend his own practice of dosing boilers with soda at the rate of 1lb. per boiler per day, and only found it necessary to clean them annually, when the thickness of scale amounted to about $\frac{1}{16}$in. to $\frac{1}{8}$in. His figures for radiation losses came out to 2lb. of coal per square foot per 24 hours at 125lb. pressure (and this was 16 times Mr. Giles's figure) at the city stations—Stuart-street exceeded even this—and he considered it fair practice. Dr. Kennedy had stated for such stations, with boilers end on to engines, 5lb. of coal per kilowatt installed was to be expected. Regarding superheating, a recent 3,000-h.p test at Bloom-street gave the following remarkable figures with water-tube boilers at 90deg. superheat: coal, 2·31lb. per Board of Trade unit = ·11d. He referred to the marine practice of 24lb. to 25lb. vacuum as being a useful figure. His experience of the human element went to prove that to attain uniformly good figures the bonus system must be employed.

**Mr. C. D. Taite** pointed out how the load factor of textile mills, practically 100 per cent., gave them a huge advantage over electricity works. He referred to the peculiar figures for Bootle in Table II. as an exceptional instance of high load factor comprised with high cost, and hoped to have an explanation. Mechanical stokers were generally satisfactory, but wanted careful attention. He had had to alter his to get satisfaction. He did not at first consider it necessary to use a recorder on his flue gases, as he thought his figure of 4·31lb. per unit was satisfactory enough, but since installing one he had found his $CO_2$ too low, and thereby altered his figure by 7 per cent. in one month, thus paying for the recorder. He expected to get 3·5, and even lower, with the help of the recorder. He also recorded

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every 2½ minutes. Superheaters he also thought satisfactory if properly treated, and referred to the Schmidt system as a novel application in use at St Pancras, etc. He laid stress on the fact that a good vacuum in the condenser is not a good vacuum in the engine, and pointed out that Edinburgh and Nottingham—both non-condensing stations—are well placed in costs per unit. Mr. Taite concluded by reference to the lack of coal and water statistics in general practice, some stations not recording even the number of units generated.

**Mr. Bennis, jun**, gave prolific figures of a variety of tests made upon his make of stoker; emphasised the necessity of care in use; stated that Lancashire coal required more air through the furnace than Midland coal; survived an appeal for verbosity by the chairman; and ended by a reference to the fate of the City and South London stokers, which, as coking stokers, he considered to be an unsuitable type for the special purpose.

**Dr. Fenton** thought that a low rate of charge would produce a high load factor by supplying motorcars, and looked to this as a sure means of salvation.

**Mr. S. J. Watson** had made a close study of the points that make for low costs, and considered that load factor and output were the two principal points, and that with cheap fuel cheaply-generated power was the rule. He did not know why Lancashire boilers were not generally lagged in front.

**Mr. Seaton** took exception to the superheat tables as being too good, gave 6d. a day as the cost of oiling a certain engine, and thought superheaters spoilt the users' chance of going to heaven.

**Mr. Giles**, in reply, said that the St. Helens figures were deceptive, as the destructors supplied some steam. His proposed coal tests taken alternative weeks balanced out satisfactorily as the load factors average. As regards boiler cleaning, he would not like to follow Mr. Pearce's yearly turn out, but water differed so considerably in various towns that no rule was allowable. Bootle to him was incomprehensible also, and certainly required explaining. He disclaimed responsibility for the lavish display of the Bennis framed tables in the lecture-room, and did not use their stokers in his works. He agreed with the maxim that to develop business the price of selling must be reduced, and deprecated the general chariness of municipal committees to making a bold plunge in this direction.

A hearty vote of thanks to Mr. Giles concluded the business of the meeting, and adjournment was made to a further (gastronomical) function downstairs, which was thoughtfully mentioned on the notice cards in more conspicuous type than the title of the paper itself.

## PERSONAL.

Mr. T. Robert Smith, A.M.I.E.E., chief electrical and mechanical assistant to the borough engineer of Leicester, has been appointed resident electrical engineer for the Leicester electric tramways. He is to take charge of the working and general repairs and maintenance of all completed electrical plant and equipment of the power station, car depôts, overhead work, cars, and feeder system. The salary is £250 per annum, rising to £350 per annum. There were 129 applicants for this appointment, five of whom were selected and attended before the committee. Mr. E. George Mawbey, M.I.C.E., is the engineer-in-chief and Mr. E. Manville, M.I.E.E., is the consulting engineer for the electric tramways of the borough.

The Birkenhead Tramways Committee have decided to recommend the appointment as tramways manager of Mr. Wyld, who for the past three years has occupied the position of manager of the Doncaster tramways.

The Wigan Borough Council have granted a honorarium to the borough engineer and his staff in connection with the work of laying the tramways in different parts of the borough.

The St. Marylebone Borough Council have increased the salary of Mr. Terence G. Bacon, electric inspector, from £180 to £190 per annum.

Mr. J. Gray-Scott, borough electrical engineer, Croydon, has recently been appointed engineer and general manager of the Hong Kong tramways. Mr Alexander C. Cramb, the present assistant electrical engineer has been appointed as his successor at a salary of £400 per annum, rising by annual increments of £50 to a maximum of £600.

The Chester Lighting Committee propose that the salary of the electrical engineer be increased to £550 per annum, rising by annual increments of £50 to £700 per annum, it being understood that the electrical engineer undertake all additions, extensions, and any other engineering work which the Corporation may require of him in connection with the electric lighting and tramways undertakings or otherwise.

The Bolton Corporation Tramways Committee have appointed Mr. A. A. Day, the borough electrical engineer, general manager of the electric tramways; and Mr. C. C. Howard, formerly of Liverpool, as traffic superintendent, the salary of the latter being fixed at £250. Mr. Day, who has been responsible for several inventions in the tramways department, has at present a salary of £650, which will be subjected to revision in consequence of his added duties.

**Electrical Engineers' Ball.**—Our readers will be interested to know that a dance on a large scale is being arranged to take place at the Hotel Cecil on Monday, the 15th prox. An influential committee has been formed to further the project which includes such well-known members of the profession as Mr. R. K. Gray, Sir Henry C. Mance, Sir David Salomons, Bart., Major-General Webber, C.B., Mr. J. Gavey, Mr. W. L. Madgen, Mr. Alex. Siemens, Mr. J. H. Rider, and Mr. J. S. Raworth. On the Executive Committee are Messrs. J. E. Kingsbury, W. Geipel, Martin F. Roberts, and R. Wallis-Jones. The hon. treasurer is Mr. R. Hammond, and the hon. secretaries Messrs. A. M. Sillar and H. Alabaster.

## TRADE NOTICES AND NOVELTIES.

### Electric Radiators.

The "1904 Radiator Pamphlet," issued by the British Prometheus Company, Limited, Kingston-on-Thames, deals fully with the attractive system of heating associated with the word "Prometheus." This system, we may remind our readers, is distinguished by the absence of wire coils or embedded resistances. In place of these heating strips or elements are employed, consisting of metallic films, deposited mica sheets, and enclosed in very thin metallic cases. All the elements are in parallel, so that is practically impossible for a Prometheus radiator to completely break down, and in the event of an element at any time requiring replacement this can be instantly effected. A very large emissive surface is obtained by this system, whereby a comparatively low temperature suffices to produce the desired heating effect, and the air is not robbed of its moisture through contact with glowing surfaces, such as are employed in gas fires, etc. Attention is drawn in the pamphlet under notice to a number of new designs of radiators, and to several improvements which have been embodied in the general construction. The copper radiators have a number of special features not present in any other form. The elements are placed more forward in these radiators than hitherto, with the result that the apparatus itself is cooler, and discoloration of the metal thereby avoided. Immediate access to the elements, lamps, and connections is secured by a simple arrangement at the back of each radiator, permitting the whole of the electrical portion to be easily and quickly removed for examination. In addition to the heating effected by conduction, the new type gives out a considerable amount of radiant heat, making it particularly suitable for local heating, where it is only required for a very short interval of time. Ample provision is made for regulation. All radiators provided with three terminals have two distinct electrical circuits (of different resistance), which are so proportioned that maximum three-quarter, half, or quarter heat can be approximately obtained. As regards the life of the elements, this, we are told, with fair wear and tear has practically no limit. A special form of Prometheus heater is supplied for use in tramcars and railway carriages. The open elements employed in this heater are held in position by means of spring contacts similar to those employed in all Prometheus radiators, but the elements themselves are compound, being made up of several parts joined together to form one electrical circuit. Three compound elements are used, all being in parallel, and each element being constructed to take 200 watts at any specific voltage. The advantage of this arrangement is that, in the event of a single heater breaking down, the remaining heaters on the car are not affected thereby. The separate elements and the complete heaters are altogether independent of each other. The loading of the elements is considerably lower than that of the ordinary radiator element, due allowance being made for large and fairly frequent fluctuations in line pressure. Prices and full data are given, also particulars of the cost of running Prometheus radiators, which cost shows the apparatus in a very favourable light. Undoubtedly there exist great possibilities for a radiator which combines such excellent features as the above, and we are glad of the evidence before us that the merits of the system are widely recognised.

### Neptune Bonds.

We have received from Messrs. W. F. Dennis and Co., 49, Queen Victoria-street, London, E.C., the sole agents in this country for Felten and Guilleaume, a copy of their new list of Neptune copper rail bonds for electric tramways and railways. This list contains illustrations and particulars of various designs of these bonds, and should be useful to traction engineers.

### Roller Bearings.

From the Empire Roller-Bearing Company, Limited, 1, Delahay-street, London, S.W., we have a copy of their latest catalogue of roller bearings, in the manufacture of which the firm have had an experience extending over seven years. The economies which may be effected by the use of these bearings are given, the figures, based upon actual results, being most commendatory.

### Publications, etc.

ELEKTRISCH BETRIEBENE STRASSENBAHNEN. By S. Herzog R. Oldenbourg, Munich and Berlin.—This is a fat pocket-book made for stout people, with extra large pockets, otherwise it contains an autology of everything in theory and practice of the construction, calculation, design, finish, and working of electric tramways. There are 500 pages of text, well illustrated with 377 figures and four tables.

CALENDARS.—W. T. Henley's Telegraph Works Company, Limited, Blomfield-street, E.C., makers of Henley's cables for telegraph, telephone, electric light, and traction. The Fuller-Wenström Electrical Manufacturing Company, 110, Cannon-street, London, E.C., manufacturers of continuous-current motors and dynamos, generators, transformers, etc.

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## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

655. A polyphase motor when driven at a slightly higher speed than synchronism, and paralleled with a synchronous machine, becomes a generator. Unlike a synchronous generator, it is not self-exciting; also its speed must be increased to maintain the frequency on increased load. Explain thoroughly the action of such a machine.—J. G.

656. Compare the use of gas-engine plant run by producer or Mond gas with a steam plant. Capacity about 250 kw., ordinary lighting station. Consider (*a*) capital cost; (*b*) running cost, including repairs and labour; (*c*) reliability of working, and possible nuisance from gas-engines. Coal about 21s. per ton for Welsh; good engine slack not available at a reasonable price.—ALPHA.

### ANSWERS.

*Question No.* 647. — Explain, with diagram of connections, the construction and action of the synchronous motor used with the Ferranti rectifiers. Does this motor start up as an induction motor?

*Best Answer to No.* 647 (*awarded* 10*s.*).—An explanation of the constant-current converter not being asked for, a lengthy description will not here be given, but a few words anent the same will make the explanation of the rectifier a little clearer. I append a sketch showing the connections of the converter (Fig. 1), which is a diagrammatic plan. The leads from the switchboard are connected to the fixed primary coils. The secondary coils are movable, being steadied through gearing by dashpots. A quadruple water-break switch is in the circuit between the secondary coils and the high-tension commutator. This allows of the full load being put on the rectifier without appreciable variation in station voltage. When all lamps are working the secondary coils are close together, cutting a maximum number of lines. As lamps are cut out of circuit, the resistance of the circuit decreases and the current rises The fields created by the secondary coils repel one another with a force over and above the resistance of the moving parts, and a position is taken where the voltage is reduced to that in accordance with the number of lamps, and the current is again normal. This current is rectified by the high-tension commutator, which is rotated synchronously by the motor according to the periodicity of supply.

The rotor of the motor presents no special feature, unless we except the commutator for rectifying the current supplied to the rotating field. This precaution ensures constant polarity of the poles, and renders the synchronous motor independent of continuous current for excitation. The current for the fields requires only a few volts when the motor has reached synchronism. These are obtained by taking tappings from the stationary armature, which obtains its current from the secondary motor coil fixed between the primary coils. The armature is wound with four coils of alternate polarity. This armature, though stationary, is capable of being rocked through an angle of 90deg. The reason for this will be made clear later. The voltage of supply to the armature can be regulated between 100 and 75 by the motor-regulating switch, which connects with tappings on the motor coil.

In starting the motor the fields are put in parallel with the armature through a resistance, care being taken that the starting switch is on the starting contact, to be changed over, when synchronism is attained, to the low-voltage tapping for synchronous running. The motor starts as a modified induction motor, and to facilitate starting a small hand-wheel is provided on the rotor spindle, which should be rotated by hand for a few turns. It should be noticed that until the motor reaches synchronism a "properly" rectified current does not flow round the fields of the rotor. The rotor brushes should be given a good "forward" lead, and gradually rocked back as the motor approaches synchronism. The position of the brushes may be regulated for starting from the fact that the motor will either not start or attempt to go backwards if the brushes are not in the correct position. When the motor is in synchronism, the regulating switch may be put on whichever tapping from 100 volts downwards is found to give the steadiest running. Synchronism is readily distinguished by the sound, as also by the steadiness of the ammeter needle when the motor is in phase. The switch should now be put on the stop marked "synchronism." This puts the

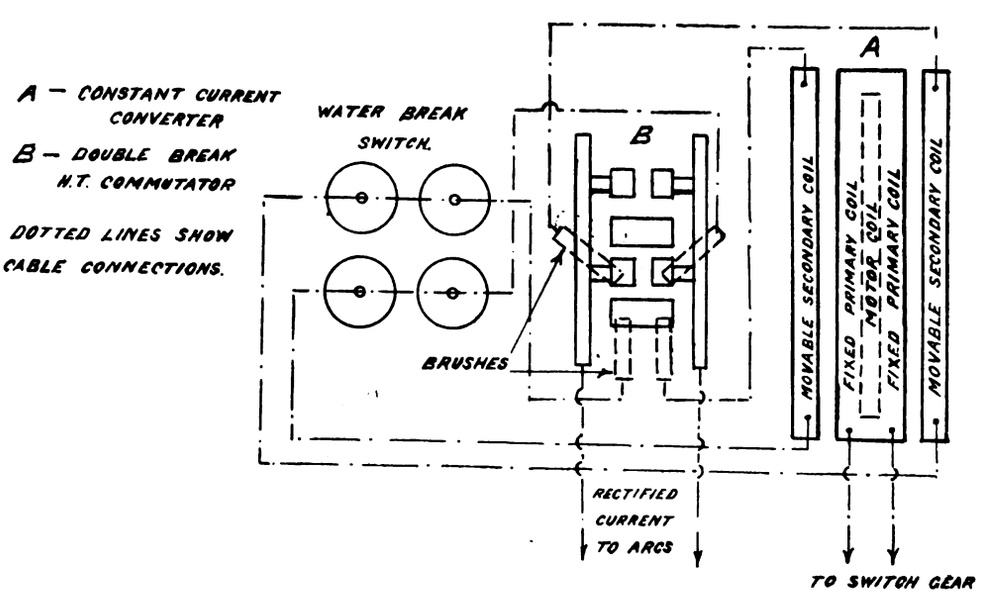


FIG. 1.

rotor on the low-voltage tappings, and it would be advisable, when first starting a rectifier in a station, to see which of three tappings is most suitable for the rotor.

In putting on the arc lamps, the secondary coils of the converter should be opened to reduce the initial load on the alternator. If the water-break switch is inserted a little way in the water, the pole indicator will show the direction of the current in the arcs. Should this show negative, the water-break switch must be withdrawn and the armature rocked through 90deg. (as before referred to). This reverses polarity, and if done slowly, the motor will not be disturbed from synchronous running. The switch may be pushed right home when the direction is correct, the less effect on station voltage being noticeable if this is

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done steadily. The subsequent running and position of the brushes are merely a question of regulation to prevent excessive sparking. As the arcs draw out the current decreases, and the coils close in, thus shortening the spark. The spark on the high-tension commutator is only a static one, and should be kept about ½in. long, as, if shorter, it is likely to flash over and put out the arc for a moment or two. The length of spark can be regulated by rocking the armature slightly. The armature should never be rocked "over" when the arcs are on; only slightly with the rotor to lengthen the spark. Care should be taken that the brushes on both the high and low tension commutators should be set "exactly" on their segments, so that there will be no undue sparking and the commutators last longer.—W. W.

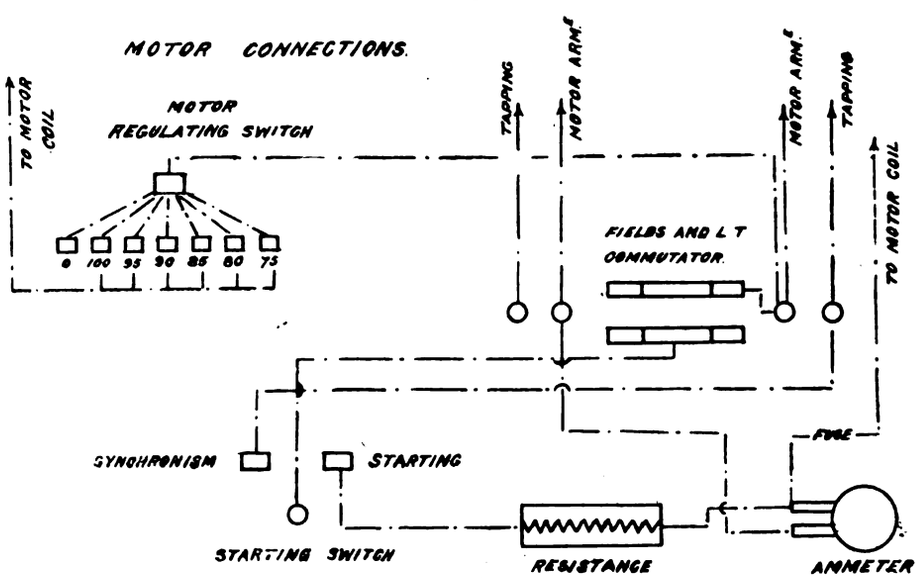


FIG. 2.

*Answer to No.* 647 (*awarded* 5*s.*).—In the earlier type of rectifiers, the motor used was an ordinary single-phase synchronous one. It was rendered self-starting by splitting the incoming current into two parts—one part passed through a non-inductive resistance coil, the other through a coil which had induction. By this means currents differing in phase were produced which energised their own particular set of fields. Under these conditions it ran as a two-phase motor. When synchronism was arrived at, the motor was switched direct across the mains. This plan I believe was due to Messrs. Brown, Boveri, and Co. The accompanying sketch (which is purely diagrammatic) shows how the modern type differs. The driving current is obtained from a secondary coil placed between the two primary coils of the constant-current transformer. The armature coils (consisting of four wound for opposite polarity) are fixed while the fields are made to revolve. In order to run the motor up to synchronism the starting switch is placed in the starting position, which brings the fields into parallel with the armature through a resistance. When synchronism is arrived at, the switch is placed in the position marked "synchronism." In this position the revolving fields are fed with rectified current, tapped from the armature coils, thus ensuring the poles being kept of constant polarity. The alternating current is rectified by the commutator, which is fixed on the motor shaft. As the field only requires but a few volts when the motor is in step, a tapping taken from a coil of the armature is ofttimes sufficient for the purpose. In the accompanying sketch but one coil of the primaries of the constant-current transformer is shown,

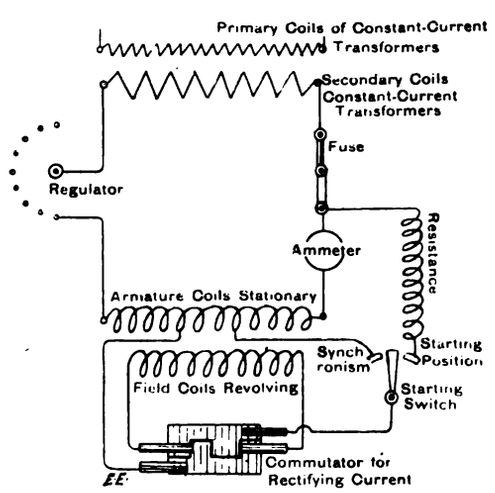


Diagram representing the action of the Synchronous Motor used in connection with Ferranti Rectifiers.

and the armature and field coils are shown as simple helices.—W. B.

*Question No.* 648.—In shutting down a 500-kw. 2,000-volt alternator from undergoing a test with a water load, the contractor in charge repeatedly reduced his load to about 40 amperes, and broke his field switch "previously" to the main switch; the exciter was mounted on the alternator shaft, and was not supplied with a non-inductive resistance for breaking the circuit. Is this a safe practice, and are any troubles likely to arise from it?

*Answer to No.* 648 (*awarded* 7*s.* 6*d.*).—The opening of a high-tension main switch is always more or less liable to set up an excessive voltage, due to resonance, if the apparatus connected to the circuit has capacity and inductance. This resonance depends merely on the relation of the capacity current of this circuit to the reactance voltage of the circuit, and though seldom present to any extent at the ordinary periodicities employed, it may easily occur at the higher periodicities which may be set up on suddenly opening a circuit by means of a switch. Breakdowns of insulation have frequently occurred, for instance, when disconnecting long cables from high-tension 'bus bars, and on this account non-inductive resistances are often employed to enable the voltage on the cable to be gradually reduced. The opening of the field circuit of the alternator would have this same effect of a slow voltage reduction, for, owing to eddy currents, the flux would take an appreciable time after the opening of the circuit to die down to zero.

When dealing with an alternator loaded on water resistances, however, the danger of a large voltage rise would be very remote because of the absence of all capacity and inductance, except such as exists in the alternator armature itself. In this case, therefore, the reduction of the voltage to zero by the opening of the field circuit cannot be considered as necessary or justified. In fact, the danger is probably greater on the part of the field circuit than of the armature circuit, for the breaking of the field without the use of any breaking resistance in parallel would undoubtedly lead to a considerable voltage rise in the field circuit. As, however, the field is probably excited at a quite low voltage, the maximum voltage reached would not be very high, and the danger to ordinary insulation not very great even on the field.—Q.

*Answer to No.* 648 (*awarded* 7*s.* 6*d.*).—The object in reducing the load to 40 amperes before opening the field switch was, no doubt, to prevent any increase of speed

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which might have occurred if all the load had been thrown off at once, and also probably there was a weaker field to break at 40 amperes than at full load, so that the induced E.M.F. set up by breaking the field was less than it otherwise would have been. With regard to why the field switch was opened before the main switch, I must say that it is not a very good practice for those who are responsible for running machines in parallel to get into; but in this case, provided a proper breaking device is used, I see no special objection. In the first place, presuming that the switch used was a temporary one, the contractor in charge might not have considered it suitable for breaking 40 amperes at 2,000 volts. Of course, this difficulty could have been overcome by bringing the load down to zero, but possibly this operation took longer than desired, so to save time the field switch was opened first. Another reason might have been that the main switch was not considered well enough insulated to handle with 2,000 volts. But in such a case as this it makes very little difference whether the field is broken before the main switch or after, and it may be that there was no special reason for shutting down in this manner. Personally, I should not have opened any switches, but, when the time arrived for the test to stop, reduced the field and shut the engine down. Under the circumstances this appears to me to be the best, for since the field is excited by an exciter driven off the same shaft as the alternator the field will die down with the speed. In fact, alternators that are excited from exciters driven off the same shaft are sometimes run without field switches, the field being connected straight across the terminals, and I see no reason why the one in question should not have been treated in this manner, especially as there was no field-breaking resistance used. I do not say that such machines should not have field switches, for they often come in very handy when a machine is burning up, for the switchboard attendant is often able to save the armature from considerable damage by pulling out the machine and breaking the field, whereas with no field switch the machine can only be made to stop generating by shutting it down, and this often takes some minutes, but there is no reason why they should be opened and closed each time the machine is shut down and started up With regard to the question, Is there any harm likely to come of breaking the field without a breaking resistance? the answer is, In cases of large fields, such as those of the average size alternator or direct-current dynamo, yes. From the well-known law of Faraday we learn that if any circuit be placed in a magnetic field, and an alteration be made in the number of lines passing through or interlinked with the circuit, an E.M.F. will be induced in the circuit which is proportional to the rate at which the lines are altered. Now, when the current is flowing round the field magnets of a dynamo or alternator we have a strong magnetic field passing through a circuit, the circuit being the field windings which are carrying the magnetising current, and it is obvious that if this current is suddenly switched off we shall have a great alteration in the number of lines passing through the circuit; and, according to the above law, we shall have an E.M.F. induced in the field windings which in most cases would amount to some thousands of volts, and most probably break down the insulation of the field coils if they are at all weak. This danger can, of course, be lessened by putting as much resistance in the field circuit as possible, and this should always be done whether a field-breaking resistance is used or not. The method of preventing any serious rise of pressure is to so arrange that before the field leaves the contact it first makes contact with the breaking resistance or, as it is sometimes called, the absorbing coil, and joins it in parallel with the field windings; so that on the field being broken the induced E.M.F. is prevented from rising to a high figure by giving it work to do in sending a current through the resistance.—E. AUSTIN.

*Answer to No.* 648 (*awarded* 5*s.*).—If at the end of the test the alternator was not required for immediate use, the safest and quickest way of shutting down would have been to stop the engine, throwing off the generator load just before the set ceased running, when, of course, the excitation would have vanished. To take hot resistances, etc., this would have to be done, owing to the residual magnetism of the field. It is most certainly inadvisable to open the alternator field even when running at no load. "Mundy" does not state whether the load was dropped by increasing the external resistance in the main circuit or by decreasing the exciter volts. In the first case the field circuit would be broken whilst carrying the full-load field current, the effect being to induce a momentary high-voltage kick, with great danger to the field insulation. The magnitude of this "kick" depends upon the number of turns in the circuit and the induction and the current at the moment of opening. The sudden cessation of the load would not in itself have much effect, but might slightly add to the sudden rise in volts. In the absence of a field-breaking switch, the safest way to make the machine "dead" would be to slowly open an ordinary knife switch in the exciter field circuit, allowing the arc to gradually flare up and break, all available resistance having been previously inserted. There is, of course, slight danger to the exciter field, but the effects of a breakdown here would be small compared to the breakdown of the alternator field. In a station, when shutting down a set, the main circuit breaker is opened, the excitation gradually dying down as the machine stops.—WENSDAY.

*Answer to No.* 648 (*awarded* 5*s.*).—The question does not give enough detail to make a definite answer possible. What is the exciter voltage? Is the alternator iron cored? What was the alternating voltage before breaking the field? Forty amperes through a water resistance may mean anything. A knowledge of the time constant of the alternator armature would be useful, although it is perhaps too much to expect.

Firstly, with regard to the field. To break an inductive circuit without a discharge resistance is to produce a tremendous voltage rise due to self-induction, if no other effect modifies this—the result being strained insulation. This should be tested for by ohmmeters or Wheatstone bridge testing set while the field coils are still warm after a long run. If the breaking switch is single-pole, the exciter (armature and field) should also be tested. Any weakness should be traced. The higher the exciting voltage the more injury would be possible.

But this result may be modified as follows: In certain positions of the armature coils the field lines of force pass through the coils, and these, by the conditions of the question, form a closed circuit with the water resistance. The momentary energy of discharge may hence be transferred to the armature coils by mutual induction, and the energy dissipated in the form of an extra spurt of current through the resistance. If the field break occurs in another position of the armature, the field will not have the benefit of the armature discharge current, and the effect on the insulation will be as stated above.

A third condition may arise due to presence of iron in the armature core. The time constant (due to the inductance of the circuit) may be so large that the armature coils carrying the discharge current may travel to an exactly opposite phase position with respect to the field before the discharge current rises to a maximum. Hence, this current, instead of checking the rise of potential in the field, may react in an exactly opposite manner and aggravate the kick.

Considering the armature, the effect on the coils is that of the superposition of a strong field on the ordinary one. If they are iron cored, the effect will be choked, and hence made more gradual—possibly eliminated. Were the coils open-circuited the increase of voltage might strain the insulation severely, but since they are closed through the water resistance the current will rise as soon as the voltage rises, and by self-induction the coils will choke this voltage rise back again. The precise effect depends on how much self induction the coils have. With air cores the momentary rush of current may be dangerous, though this is not likely. With iron cores very little danger may be anticipated, even if the alternator were running at full speed, and with an excitation equal to full terminal volts before being switched out.

The general conclusion is, that without a discharge resistance the chief danger lay in injury to the field, and hence the contractor in charge did the wisest thing in break-

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ing while the armature windings were in circuit and turning, so that they could damp the energy of discharge as much as possible.—J. A S.

# LEGAL INTELLIGENCE.

## A GENERATING PLANT DISPUTE.

In the King's Bench Division of the High Court, before Mr. Justice Jelf, the case of Lloyd's Packing Warehouse *v.* Verity's, Limited, was resumed, it having been commenced before his Lordship at Manchester. The plaintiff company are makers-up and manufacturers of packing cases, carrying on business at Castlefield, Manchester, and their case was that by letters passing between the parties from October, 1901, to January, 1902, the plaintiffs agreed to buy and the defendants to supply certain electrical generating plant for the sum of £1,187. It was a condition of the contract that the plant should be capable of dealing with the maximum load required by the plaintiffs' motors and machinery, and should produce sufficient power to satisfactorily run the whole of the plaintiffs' motors and machinery then installed or to be installed at their works. This power was to be produced at a cost not exceeding 1d. per Board of Trade unit of 1,000 watts of electrical energy per hour. The defendants supplied the plant, and plaintiffs paid the sum of £890. 15s. on account. The plaintiffs alleged that the plant was not in accordance with the conditions, and was incapable of dealing with the maximum load of the motors, and would not produce sufficient power to satisfactorily run them. They therefore rejected the plant, and asked defendants to remove it. Plaintiffs alleged they had lost the money paid for the plant, which they claimed the return of, and also asked for damages for increased cost of plant and production.

The defendants denied that they agreed to the conditions alleged, but said it was an express condition that the plant should be capable of producing 51 kw., and this condition was fulfilled. They also denied that plaintiffs made known to them that the plant was needed to produce sufficient power to satisfactorily run the motors, and counterclaimed for extra work and materials supplied.

**Mr. T. Edgar Weaver,** an electrical inspector of Manchester, on behalf of the defendants, said he inspected the plaintiffs' work on three occasions, and always found them in order, with no trace of neglect.

**Mr. C. H. Wordingham** said he was called in when the plant did not work satisfactorily. He found no trace of neglect on the part of plaintiffs' men. The sawing plant at plaintiffs' required a varying amount of energy, according to the capacity of different machines.

After some further evidence it was arranged that the conclusion of the case should be taken at Manchester.

## INEFFICIENT TELEPHONE SERVICE.

The case of the National Telephone Company *v.* Samuel came before Mr. Justice Wills and Mr. Justice Kennedy in the Divisional Court of the High Courts this week on the appeal of the company against a decision of the deputy judge of the Marylebone County Court.

**Mr. Rostron,** in support of the appeal, said the action was brought by the National Telephone Company against Mr. Henry Samuel, of Cleveland-square, who was one of its subscribers, to recover one year's rent of a telephone, etc., due in January, 1903, under a written agreement. The contract was entered into on Jan. 3, 1900, and was to extend for five years. It was provided that the company should maintain the telephone and line in good working order. For the first two years of the term all went well, and defendant paid his subscription at the beginning of 1901 and 1902, but when 1903 came round he refused to pay, and the company summoned him in the county court. The defence was that the telephone instrument and line were not maintained by the company in good working order as agreed. Defendant claimed, therefore, that he had received no consideration for the agreement, and as he said the company had failed to perform its part of it he asked that it might be rescinded. Counsel said it had not been shown that there was a total failure of the service, and the county court judge was not justified in holding that there was a defence to the company's claim for rent, and that the contract should be rescinded.

**Mr. Nield** said that unless the defendant was entitled to the remedy which the county court judge gave him, he had no remedy at all, and must go on paying for this machine, which was a total failure, for the last six weeks of 1902.

**Mr. Justice Wills** said he had come to the conclusion that the appeal must be dismissed. He did not think any jury would hesitate to find that such a service as this, which it had been admitted had to be remedied over and over again in 1902, and at length broke down in November, so that it was no use attempting to use it further, showed that the company did not intend to perform its part of the bargain and to give a reasonably efficient service. There could be no doubt that the company was bound to do that, and if what it performed was the best, all he could say was that electrical and mechanical science must have made very little progress in this country. The jury at the trial found that the company had not supplied a reasonably efficient service, and he thought they meant that the company had shown that it was not going to supply anything substantially better than that which it had supplied in 1902, and if it could not do better than that the judge was right in rescinding the contract.

**Mr. Justice Kennedy** concurred, and the appeal was dismissed, with costs, leave to further appeal being refused.

## THOMAS LIGHTING COMPANY.

In the Chancery Division, Mr. Justice Buckley sanctioned the petition of the Thomas Lighting Company, Limited, for the reduction of its capital from £15,000 to £5,000, the company, which was formed to work patents for the substitution of electricity for gas in the lighting of railway carriages, having lost the difference.

## TELEPHONE AGREEMENTS.

His Honour Judge Bishop gave judgment on Tuesday in an action brought at Haverfordwest County Court in which the National Telephone Company sued four business men of Haverfordwest for non-payment of three years' rent of telephones. The wires had been laid under an agreement by which defendants were to have the benefit of communication with all subscribers in the Pembrokeshire exchange area for their fixed subscription. The defendants contended that it was represented to them by plaintiffs' agent that subscribers would be secured in the other towns in the southern part of the county, and those towns connected up as the exchange area referred to. This, however, was not done. Plaintiffs denied liability to do anything of the sort, and contended that their obligations ceased when they had connected all the Haverfordwest subscribers by means of the local exchange and then connected that exchange to the main trunk line. His Honour now held that any representations as alleged by defendants were no part of the contract, and that the latter had been fulfilled by the plaintiffs, for whom he gave a verdict.

A stay of execution was granted pending an appeal.

## TRAMCAR MISCONDUCT.

John Scott was summoned before the stipendiary at Cardiff recently for refusing to pay his fare on a tramcar on Dec. 16, and also with presenting an old ticket to the conductor with the pretence that it had been issued to him.

Mr. Cecil Brown prosecuted for the Corporation, and Mr. Phœnix defended.

Both the offences were admitted, Mr. Phœnix saying that defendant was sorry for what he had done, but at the time he was under the influence of drink.

A fine of 10s. and costs was imposed for each offence.

There was a further charge of assaulting the conductor on the same occasion, and in this case also the offence was admitted, the conductor denying that he had in any way impeded the defendant.

There was a previous conviction against the defendant of assaulting the police, and the stipendiary imposed a further fine of £4 and costs, or one month's imprisonment with hard labour.

# COMPANIES' MEETINGS AND REPORTS.

## BRITISH ELECTRIC CAR.

The adjourned meeting of the creditors of the British Electric Car Company, Limited (in liquidation), was held at the Mosley Hotel, Manchester.

The chair was occupied by **Mr. J. J. Wild,** the liquidator and manager, who related what had happened since the previous meeting, when the committee of creditors was appointed. He said that the examination of the affairs of the Company which he had made led him to think that there would be no further losses on the works as at present staffed, but that if any change took place at all the financial position was likely to improve. He felt sure that the completion of existing contracts would not result in a loss ; he hoped, indeed, that a small profit would result. No further contracts, however, would be invited.

The meeting considered the following resolution, which the committee recommended should be passed : "That in the opinion of this meeting the receiver and manager of the estate should be requested, in the interests of the creditors, to negotiate for the sale of the business as a going concern, on such a basis as may be agreed upon between him and the committee."

Alluding to this recommendation, **Mr. Wild** said he was convinced that if the plant and other saleable assets of the Company were sold under the hammer, it would mean a loss. He was hopeful of being able to sell it as a going concern, though he had no definite offers to lay before that meeting.

A discussion ensued, and the resolution framed by the committee was carried by a considerable majority.

## BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAYS.

At an extraordinary general meeting of the shareholders in this Company, Mr. T. Blane presiding, it was decided that the nominal capital of the Company—£150,000—which is fully paid up, should be reduced to £125,000 by cancelling capital which has been lost or is unrepresented by available assets to the extent of £25,000. The nominal amount of the preference shares will be reduced from 20s. to 18s., and the ordinary from 20s. to 16s. There will now be 50,000 preference and 100,000 ordinary shares.

## DIRECT UNITED STATES CABLE.

The report of the directors for the six months ended Dec. 31, 1903, states that the half-year's revenue, after deducting out-payments, amounted to £47,815, a decrease of £4,729. Working and other expenses for the same period, including income tax, amounted to £21,816, leaving a balance of £25,998 as net profit, making, with £2,694 brought forward, a total of £28,692. Interim dividends of 3s. per share for the quarter ended Sept. 30, 1903, and of 3s. per share

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for the quarter ended Dec. 31, 1903, have been declared, and after setting aside £8,000 to reserve fund, the balance of £2,479 on revenue account has been carried forward. The reserve fund has been debited with £30,178 for cost of cable repairs, and after being credited with interest on the investments, profit on sale of securities and amounts set aside from revenue, now amounts to £462,094, taking the investments at cost price.

## EASTERN TELEGRAPH.

The report of the directors for the half-year ended Sept. 30 last states that revenue for the period amounted to £565,703, from which are deducted £168,232 for ordinary expenses and £48,004 for expenditure relating to repairs and renewals of cables, depreciation of spare cable, sundry differences in exchange and income tax payable abroad, leaving a balance of £349,466, to which is added £5,031 brought from the preceding half-year, making a total available balance of £354,498. After making provision for income tax payable in England, interest on loan from Eastern and South African Telegraph Company, Limited, interest on mortgage debenture stock, and for two quarterly dividends on the preference stock, which in all absorb £94,630, there remains a balance of £259,867, from which is allocated £7,000 to reserve fund for maintenance ships, £120,000 to the general reserve fund, and £100,000 to meet the two interim dividends of 1¼ per cent. each on the ordinary stock for the quarters ended June 30 and Sept. 30 respectively, the balance of £32,867 being carried forward. The new rules and regulations agreed to at the Telegraph Conference recently held in London will come into operation on July 1 next, from which date the following tariffs (Great Britain) will be reduced: to Portugal, Spain, and Gibraltar, from 3½d. to 3d. per word; to Tangier, from 5d. to 4½d. per word; to Malta, from 6d. to 4½d. per word; to Greece, from 6½d. to 6d. per word; to Egypt, first region, from 1s. 7d. and 1s. 10d. to 1s. 5d. per word; to Labuan, from 5s. to 3s. per word.

## MANX ELECTRIC RAILWAY.

The report of the directors for the period ended Sept. 30 last states that gross receipts amounted to £41,300, and gross expenditure to £20,434, leaving net earnings, £20,865. From this must be deducted debenture interest and interest on mortgage, £8,863, also profit earned before incorporation, placed to capital account, £4,005; the preference dividend, 5½ per cent. from date of allotment, Nov. 20, 1902, to Sept. 30, 1903, £4,731, leaving a balance to be carried forward of £3,266. The above accounts cover a period of one year and six weeks. The gross takings during the extra six weeks in August and September, 1902, were £9,605, which in the ordinary course would have been credited to a separate year. Profits, however, earned during the period antecedent to the incorporation of the Company—that is, from Aug. 18 to Nov. 12, 1902—may not in any case be treated as revenue, and have accordingly been placed to the credit of capital account. After payment, therefore, of debenture interest and preference dividend there remains a balance of £3,265, which the directors propose should be carried forward to next year's accounts. During the past year new works have been undertaken upon capital account, the total expenditure upon which will amount to £49,239, made up as follows: new plant and equipment, £44,399; new retaining wall and permanent way at Bulgham Bay, £3,332; purchase Dhoon Quarry, £1,508.

## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion sat again on Thursday and Friday last week at the Westminster Palace Hotel, Sir David Barbour in the chair.

**Sir Douglas Fox** said that local traffic, involving the transit of from half a mile upwards, would always be most efficiently dealt with by motor omnibuses and electric tramcars running generally on the surface of the streets, but in some very congested parts of the Metropolis possibly in shallow subways, if the excessive cost of these could possibly be entertained. The district most urgently in need of further facilities, and not covered by existing powers, was that lying to the north-east, and comprising Stoke Newington, Tottenham, Leyton, and Walthamstow, and thence skirting Epping Forest to Waltham Abbey. The City and North-East Suburban Electric Railway Bill, which proposed to authorise a line from the Monument to Tottenham, and, by a junction at Hackney-road, to Waltham Abbey, was deemed so urgent that it was specially exempted from the general rule against considering any new tube schemes pending the report of the Royal Commission. One very important connection was that forming an extension of the North-West London Railway from the Marble Arch to Victoria, whilst a line from Sloane-square Station of the Great Northern, Piccadilly, and Brompton Railway to Clapham Junction would also give great facilities in the south-west. He believed that the cost of shallow subways for tramways under old main thoroughfares would be found prohibitive. A shallow tramway from Bishopsgate along the Kingsland-road, even if it were feasible, would be quite prohibitive on account of cost. The only way in which the desired access to the heart of the City could be obtained for the Walthamstow and Tottenham districts was by tube. The secret of success of tubes had been the placing of them in the London clay, below the made ground and water-bearing strata which overlay the clay. There was no practical analogy between the circumstances in London and New York. He had hitherto advocated a slightly larger diameter for tube railways than that now generally adopted. The advantages were the space afforded for more powerful motors, permitting an increased acceleration, and the improved facilities for ventilation, but the financiers who controlled the authorised railways had apparently decided that it would not pay to go beyond a net diameter of 11ft. 6in. The serious accident on the Paris "Metropolitan" Railway had resulted from electrical arrangements which were being avoided in London, where every precaution was being taken on the lines under construction against fire, and to secure the lighting of tunnel and stations in case of accident. On the point of Tube Bills, he thought that many of the clauses insisted upon were of excessive stringency, and involved unnecessary cost in carrying out the works. Public traffic and private interests being reasonably safeguarded, every facility should be given to ensure dispatch. The conflicting and overlapping authority of county and borough councils required to be reconciled. Capital could not be provided for carrying out tube railways if the Acts authorising them were burdened with onerous conditions. No clause such as the London County Council would be likely to agree to, giving them a right of purchase, could be entertained without destroying the prospect of raising the capital. The same observation applied to proposed clauses making it compulsory on tube railway companies to apply to Parliament from time to time for power to make at their own expense subways not capable of being indicated when the special Acts were passed, and to clauses limiting the dividend, and making companies liable to have their authorised charges and fares reduced arbitrarily below the rates fixed by the special Act. Provisions of that kind made it impossible for the investor to calculate on his return, however moderate. On the question of procedure, the witness mentioned the objections to the tramways provisional order. Every facility was given by the Light Railway Commissioners, and, so far as their action was concerned, both economy and saving of time were certainly effected, and the local enquiry was most valuable to all parties concerned, but those advantages were largely discounted by the fact that an allegation of serious competition with existing railway companies was *ipso facto* fatal to the application, and also because the Commissioners could not suspend or modify Section 92 of the Lands Clauses Act, thus often rendering the cost of widenings prohibitive where only forecourts were required, because the whole property must be taken. Also, their proceedings had to be confirmed or revised by the Board of Trade. It was, therefore, often necessary to proceed by private Bill, as regards which procedure he thought substantial justice was done. At the same time, the requirements of Standing Orders were very onerous and the fees were high. If the practice set last year of committees asking for an absolute guarantee of capital was to be continued, a very serious obstacle would be placed in the way of increased facilities. The tribunal should be well satisfied of the *bonâ fides* of the promoters, that the capital was neither deficient nor unduly inflated, and that the 5 per cent. deposit was fully secured for the protection of the public and of property owners. The chief objection to the present parliamentary system was that there was no comprehensive programme, that often in the same session works affecting London were dealt with by different committees, and that there was no continuity of policy underlying the decisions. He was strongly in favour of the establishment of a new and permanent tribunal, say of five members—all to be paid—and, except perhaps the chairman, required to give exclusive attention to their duties as such members. The chairman should be of well-known high character and of judicial capacity, and should be assisted by a barrister of parliamentary experience, a civil engineer of railway, tramway, and parliamentary experience, a representative of the municipal authorities, and a representative of the Board of Trade. The tribunal should give preliminary consideration to existing means of communication and the probable requirements of the future, and sphere to a fixed policy. The Standing Orders should be simplified as much as possible. The tribunal should have full powers to hear witnesses, to grant compulsory powers for properties as a whole, or for portions thereof. They should hold a public enquiry, at which all persons interested should be freely heard, either personally or by counsel. They should have full powers with regard to costs, competition, the amount of capital and borrowing power, and dates of commencement and completion of the works. There was no necessity for a right to appeal to the Board of Trade or other State departments, but all orders before becoming law should be reported to Parliament and lie on the table for a fixed period. In case of opposition it would be very desirable that their fate should rest with a joint committee of both Houses. The clauses introduced lately into Tube Bills, giving the Board of Trade more complete control, and extending the protection of landowners against damage to two years after opening, should become standardised.

**Mr. Alpheus C. Morton,** chairman of the Streets Committee of the Corporation of London, was recalled. In reply to the Chairman, he made the following suggestions with regard to the proposed tribunal: (1) the members should be paid; (2) they should devote the whole of their time to the work, and local authorities should not be represented upon the tribunal; (3) they should consider the schemes presented to them, and report not less than once a year on the subject of the traffic and locomotion in London generally; (4) the tribunal should not have the power to direct improvements to be carried out; (5) they should report on local improvements required, and on locomotion generally; (6) they should not be responsible for the supervision of works; (7) they should include in their general reports the streets which, in their opinion, should be made or widened; (8) all tramway schemes should be settled by them, subject to the rights of local authorities; (9) they should have the power to confer compulsory powers in regard to the acquisition of property upon promoters of schemes; (10) they should have the power to compel existing companies to carry out new works, after hearing all parties interested, who should have the right to be represented in the manner they thought best; (11) the powers of the tribunal should be retrospective; (12) they should have, as far as possible, a settled policy of action, so as to ensure continuity of principle; (13) the road authorities should have complete control in regard to the opening of streets in their respective districts; (14) the tribunal should have the power to apportion the cost of improvements according to the advantages derived from them in districts contiguous to those in which improvements were effected;

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(15) they should settle all questions in dispute between local authorities and companies and promoters of schemes of proposed improvements, or for facilitating locomotion ; (16) the area of the jurisdiction of the tribunal should correspond with the Metropolitan Police area.

**Alderman Sir Henry Edmund Knight,** alderman of the Ward of Cripplegate since 1874, suggested two zones or ellipses of underground electric railway—one about a mile north or south of the river, and a second about a mile or a mile and a half further out—for the conveyance of goods only. All railway companies bringing goods into London should be compelled to make connections between the suggested railway and their several goods stations, all goods being taken by that means to the company's nearest depôt to their destination. Goods leaving London for the country should be similarly dealt with, and by that means all the heavy railway vans would be got rid of from the streets. Depôts at distances of about a mile apart should be established on the proposed railway, each of which would serve a district of about half a mile round it in every direction. Those depôts should be in the streets off the main thoroughfares, and the goods should be delivered from them in small motorcars to their several destinations. Large establishments might be accommodated with a siding to themselves, the goods being lifted to the surface of the ground by means of lifts. There should also be sidings at the docks and at all great centres. Those classes of goods which could not be conveyed underground, such as beer, coal, builders' plant, etc., should be carried by motor traction and delivered before 10 a.m or after 7 p.m. The witness further suggested that the use of coal in London should be interdicted and gas substituted for cooking and heating purposes. On the question of tramways, although they were of great public utility where streets were wide and not congested with other traffic, they would be impracticable in the City. They should not be permitted in any city or town unless the lines could be laid 20ft. distant from the kerb. Although a tramcar could be built to hold more persons than a motorcar, yet the latter would be more convenient in the City if constructed to carry from 24 to 30 persons each. The service would be more frequent, and would not be confined to a fixed line. No trams should be allowed over any of the City bridges. Even if they were so allowed, they would be of very little practical utility owing to the congested condition of the London streets. Blackfriars Bridge, which had the best approaches on the City side of the river, still presented a formidable obstacle to any through traffic between south and north, owing to the necessity of passing through Ludgate-circus, a difficulty which could only be obviated by a suspension bridge being erected to carry the north and south through traffic. Relief streets should also be constructed.

The **Chairman:** Do you not think that omnibus proprietors will see the advantages of motor traction ?—Yes.

Then you will not want a law making that compulsory ?—I would not do it immediately, to cause immediate alteration, but I think a law might very well be enacted that all new omnibuses should be constructed for motor traction. Whether the law is passed or not, I think it will come in time.

The Commission adjourned till Thursday next.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Woolstanton and Burslem.**—The Guardians will shortly invite tenders for supplying the workhouse with an electric light installation.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000

**Hastings.** — The Corporation invite offers for the supply of alternating current motors to consumers on a hire-purchase agreement. Proposals by Jan. 30. See advertisement.

**Marcinelle (Belgium).**—The Municipal Authorities of this town, in the province of Hainaut, require tenders for erection of an electric station and supply of current. Tenders by Feb. 26.

**Bristol.**—The Corporation invite detailed particulars of standard single-phase H.T. and three-phase E.H.T. switchgear. Further particulars from the City Electrical Engineer. See advertisement.

**Kirkcaldy.**—The Corporation invite tenders for seven motorcars for their tramways. Specifications, etc., from Mr. O. F. Francis, Electricity Works, Victoria-road. Tenders by Feb. 1. See advertisement.

**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Whitby.**—The Urban District Council invite tenders for the supply and delivery of feeding and distributing mains Specifications, etc., from the Electrical Engineer. Tenders by 10 a.m. on 25th inst. See advertisement in last issue.

**Canterbury.**—The Corporation invite tenders for supply and erection of four motor-driven centrifugal pumps for lifting sewage. Specifications, etc., from the City Electrical Engineer. Tenders by Feb. 8. See advertisement.

**Pontevedra (Spain).**—Tenders are invited for the construction of an electric tramway from Mondariz to Porrino. Particulars may be seen at this office, or obtained from the Public Works Department, Madrid. Tenders by Feb. 12.

**Edinburgh.**—The Corporation invite tenders for engine and dynamo for electricity supply station at M'Donald-road. Specifications, etc., from the Electrical Engineer, Dewar-place Station. Tenders by Feb. 22. See advertisement.

**Wiring.** — The May-Oatway Fire Appliances, Limited, invite tenders for wiring the Govan Ropeworks Company, Govan, and Maxwell and Sons, Dundee. Particulars from Managing Director, 49, Queen-street, Glasgow. Tenders by Jan. 27. See advertisement.

**Zurich (Switzerland).**—The Municipality require about 200 single-phase alternating-current meters as follows : 100 five-ampere 100-volt, 50 10-ampere 100-volt, 50 15-ampere 100-volt. Tenders to the Vorstand des Bauwesens II, Stadthaus, Zurich, by 31st inst.

**West Ham.**—Tenders are invited for supply of engine-room stores, cable, recording wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Particulars from Central Electricity Station, Abbey Mills, West Ham. Tenders by Feb. 11.

**Barcelona.**—Tenders for public arc lighting will be received at the Town Hall, Casas Consistoriales, by Feb. 9. Particulars may be obtained there or at the Local Government Office (Ministrelo de la Gobernacion), Madrid, or at this office. Sixty-four arc lamps are required.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr. J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Leyton.**—The Urban District Council invite tenders for the electrical wiring and fittings and hot-water heating apparatus required at Norlington-road Schools. Specification, etc., from Mr William Jacques, A.R.I.B.A., 2, Fen-court, Fenchurch-street, E.C. Tenders by Feb. 2. See advertisement in last issue.

**London, N.**—The Hornsey Borough Council invite tenders for section A) two dry-back or water-tube boilers ; (B) smoke-consuming apparatus ; (C) two 300-kw. steam dynamos, one 100-kw. steam dynamo, two motor-generators. Specifications, etc., may be obtained of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by 10.30 a.m. on Feb. 8. See advertisement in former issue.

**Islington.**—Tenders are invited for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors and pilot cable, with feeding, junction, and service boxes. Specifications, etc., from the Borough Electrical Engineer, 50, Eden-grove, Holloway, N. Tenders by Feb. 24. See advertisement.

**London, S.W.**—The London County Council invite tenders for the roadwork and platelaying required for the reconstruction, for the electrical traction on the conduit system, of the existing double line of cable conduit tramways from a point in Brixton-road, near Handforth-road, to the present terminus at Streatham ; and for the construction, for the same system of electrical traction, of a portion of the authorised tramways in High-street, Tooting, Merton-road, and Defoe-road. Specifications, etc., from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Feb. 2.

## RESULTS OF TENDERS.

**Hull.**—The Telephones Committee have accepted the tender of Mr. T. S. Kaye, Bond-street, at £32. 14s. 2d., for tools.

**Wolverhampton.**—The Town Council have accepted the tender of Messrs. Milnes and Co., Limited, for the supply of a salt-feeder car at £150.

**Bradford.**—Mr. C. W. Webster's, Bradford, tender has been accepted for an installation of electric lighting at the new district baths, Drummond-road.

**Scarborough.**—The tender of Mr. James Brunton, of Hull, at £4,848. 2s. 3d., has been accepted for wood-block paving in connection with the laying of tramways.

**Birkenhead.**—The offer of Messrs. Callender's Cable and Construction Company, London, to supply one mile of three-wire distributor main cable has been accepted. The price is about £700.

**Sydney.**—It is reported that the Federal Postmaster-General has accepted the tender of an English firm for copper wire in preference to an American tender, which was ¾ per cent. lower. The amount is £12,000.

**Kirkcaldy.**—The Corporation have accepted the tender of Messrs. Browett, Lindley, and Co., at £4,619, for a 430-kw. Browett-Laurence-Scott generating set. There were 31 tenders received, which included over 150 prices for various combinations of plant.

**Radcliffe (Lancs.).**—The Urban District Council have accepted the tender of J. G. Statter and Co., Newhall-street, Birmingham, for lighting and traction switchboard and accessories, at £1,345. 12s. 6d., and the Forrest City Electric Company, 3, Gore-street, Piccadilly Manchester, at £368. 1s. 6d., for rail bonds.

**Ashington Coal Co.**—An order has been placed with the British Westinghouse Company for a motor-generator set, consisting of a three-phase induction motor driving a direct-current generator. The motor will run on a 40-period circuit, at 480 to 500 volts, and 575 revolutions per minute, driving by direct connection the dynamo, which at 480 to 500 volts will have a rated output of 200 kw.

**Blackpool.**—The Corporation have ordered from the British Westinghouse Company a steam electric set, comprising a Browett-Lindley 120 size three-crank, three-cylinder, triple-expansion engine driving a 450-kw. Westinghouse dynamo. The latter machine will be horizontally divided, and will be so compounded as to give 500 volts at no load, and 530 to 550 at full load, at 330 revolutions per minute.

**Croydon.**—The following tenders have been received for extension to electricity works : builders' work, Messrs. S. Page and Son, £3,585 ; E. J. Saunders, £3,600 (accepted) ; Chas. Jackson, £3,636 ; Bulled and Co., £3,775 ; W. Potter, £3,823. 19s. 6d. ; Smith and Son, Limited, £3,929 ; Thomas and Edge, £3,982 ; J. Ferguson and Co., £3,990 ; Davis and Leaney, £4,023 ; F. W. Green, £4,153. 3s. 8d. ; W Roberts, £4,222. 1s. 7d. ; Chas Cooper, £4,225 ; G. A. Pillatt, £4,425. 1s. 3d.

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**Bo'ness (Scotland).**—The Town Council have received the following tenders for electrically lighting the new town hall and Carnegie Library:

| | | | |
|---|---|---|---|
| J. H. Sinclair, Grangepans, Bo'ness, N.B. (accepted) ... | £314 | 0 | 0 |
| Malcolm and Allan, 29, Lilybank-road, Glasgow..... ..... | 333 | 17 | 8 |
| National Electric Construction Company, Greenock ..... | 383 | 3 | 9 |
| Robertson and Hogg, 31, Nicholson-street, Edinburgh ... | 392 | 0 | 0 |
| J. Milne and Sons, 133, George-street, Edinburgh ..... | 455 | 10 | 0 |

**Blaensychan Colliery.**—Messrs. Partridge and Jones, proprietors of the Blaensychan colliery, near Pontypool, Wales, have recently given a considerable order for modern electrical plant to the British Westinghouse Electric and Manufacturing Company, Limited. This includes a Westinghouse 112-kw. direct-current generator driven by a Belliss and Morcom engine of corresponding power, exhausting into a Korting ejector condenser. A three-panel marble switchboard will serve to control generator, motors, etc. The main purpose of the generator will be to supply power to a 100-h.p. Westinghouse motor coupled to a Markham haulage gear.

**Tyneside Tramways and Tramroads, Limited.**—The British Westinghouse Company have received an order for the equipment of six electric tramcars for this company. The contract includes the trucks (Brill 21E) for four single-truck cars, and likewise for Brill No. 270 bogie trucks, 4ft. wheel base, for two cars. The double-truck cars will have four-motor equipments, with motors of the Westingbouse 80 pattern No. 412 controllers, and the single-truck cars two-motor equipments, with motors of the 80 pattern No. 210 controllers. The order also includes Westinghouse magnetic brakes for all cars, and heater equipments to be used in connection with the brakes.

# BUSINESS NOTES.

## TRACTION.

**Cardiff.**—The question of the rearrangement of the tramway fares has been deferred.

**Leith.**—The Corporation of Edinburgh are petitioning against the Leith tramways order.

**Coulsdon (Surrey)** —The Croydon Council have decided to oppose the Coulsdon Tramways Bill.

**Llanelly.**—The proposed Bill of the Corporation in connection with the tramway undertaking is to be dropped.

**Coatbridge and Airdrie.**—The tramway company expect to open the tramways for traffic in the first week of February.

**Twickenham.**—The District Council have decided to oppose the London United Tramway Company's Bill in Parliament.

**Walsall.**—The Town Council have placed an order with the Leeds Steel Company to supply 100 tons of rails for repairs, etc.

**Greenwich.**—The new electric route from the Thames bridges to Greenwich, described in our last issue, were opened on Sunday.

**Milngavie.**—The Town Council have decided to oppose the proposal of the Glasgow Corporation to extend the tramways to Milngavie.

**Rotherham.**—A special meeting of the Town Council has formally approved the promotion of the Tramways Bill in the ensuing session.

**Hindley.**—The South Lancashire Tramways Company will probably commence the construction of the Market-street tramway route in February.

**Hull.**—Colonel von Donop, R.E., has visited Hull for the purpose of inspecting the Hedon-road tramway route, which was recently opened for traffic.

**Middlesbrough.**—The Town Council have decided to dissent from the Bill which the Imperial Tramways Company are promoting in Parliament.

**Dumbarton** —On the recommendation of the Road Board the County Council have decided to themselves apply for an electric light and tramway order.

**Bingley.**—The District Council have confirmed their resolution to increase the period of the lease to the Mid-Yorks Tramways Company from 35 to 42 years.

**St. Marylebone.**—The Borough Council are recommended to adhere to their previous decision not to give consent to the proposed tramway in Tottenham Court-road.

**Dover.**—The doubling of the tramlines on the Folkestone-road over the railway bridge was completed last week, when the trams commenced to use both tracks.

**Wallasey.**—The ratepayers have passed an adverse vote in regard to the proposed Tramways Bill. The District Council have decided to take a poll on the question.

**Perth.**—Messrs. Kincaid, Waller, Manville, and Dawson, of London, have been appointed as consulting engineers to the Town Council for the tramways reconstruction scheme.

**The Highlands.**—In connection with the scheme for a hydro-electric power station in the Highlands, it is proposed to construct an electric railway from Dundee to Stanley.

**Bournemouth.**—A ratepayers' meeting has sanctioned the promotion of a Bill in Parliament to empower the Corporation to extend the municipal tramway system to Christchurch.

**Clydebank.**—The Glasgow Tramways Committee will begin the construction of the tramway from the present terminus in Clydebank to the end of the burgh at Dalmuir probably in April.

**Wolverhampton.**—The parochial electors have unanimously approved the Corporation Bill which seeks power to extend the tramways to Wednesbury and to run motor omnibuses.

**Chester.**—The electrical engineer and the tramways manager have jointly prepared a report on the question of the proposed tramways extension to Boughton, with regard to route, service, etc.

**Ilford.**—A meeting of the parochial electors has rejected the proposals of the District Council for tramway extensions as embodied in the Bill which the Council are promoting in the ensuing session.

**Smethwick.**—It was stated at the last meeting of the Town Council that the tramways company had made arrangements with the Birmingham Corporation to run the trams straight through to the city.

**Rochdale.**—It is believed that matters in connection with the proposed agreement between the Corporation and the tramways company for the transfer of the latter's undertaking are being satisfactorily arranged.

**Macclesfield.**—A committee of the Town Council has been appointed to confer with the promoters of the Cheshire tramways scheme which will shortly be brought up for parliamentary sanction or otherwise.

**Musselburgh.**—At the last meeting of the Edinburgh Town Council approval was conditionally given to the substitution of the surface-contact system for the overhead system of traction on the proposed tramways.

**Heywood.**—At a meeting of the Town Council this week it was reported that a working agreement has been made with the local tramway company pending the final transfer of the undertaking to the Corporation.

**Excessive Speed.**—For driving his car at an excessive speed (alleged to be 16 miles an hour), and colliding with a cab, a motorman in the employ of the London County Council has been fined £2 and 2s. costs.

**Exeter.**—Sir Colin Scott Moncrieff, the arbitrator in the claim brought by the Exeter Tramways Company against the Corporation for £14,900 as compensation for the compulsory purchase of its property, has made his award at £6,749.

**Grimsby.**—The tramways company have now completed two years' working by electricity. During the second year they took 423,949 units, or 63,949 units more than the minimum. During the first year they used 352,919 units, or 7,081 less than the minimum.

**Guildford.**—The Light Railways Commission, at an enquiry at Guildford, intimated that they would be prepared to submit to the Board of Trade an order for the construction of an electric light railway connecting the centre of Guildford with the populous district of Stoughton.

**Aberdare.**—At the last meeting of the District Council, a letter was received from the secretary of the Trades and Labour Council asking the Council to take steps to obtain an electric tramway for the town. After some discussion the matter was referred to the Tramway and Electric Lighting Committee.

**Barrow.**—The work of completing the reconstruction of the tramways is proceeding satisfactorily. The permanent way from Roose to the Abbey terminus is now completed, and the work of laying the branch into the tram-shed is proceeding. It is probable some of the cars will commence experimental running in a few days.

**Metropolitan Railway Co.**—The Metropolitan Railway Company have declared a dividend for the past half-year at the rate of 3 per cent. per annum, with £11,500 placed to reserve and £21,000 carried forward. The dividend on the surplus land stock is at the rate of 2¾ per cent. per annum, or the same as last year.

**Deptford.**—The General Purposes Committee of the Borough Council have reported in favour of making a contribution (not to exceed £21,000) of one-third the cost of the necessary local street widenings in connection with the proposed London County Council tramways from Lewisham High-road to Forest-hill.

**Competition.**—Last week the chairman of the Caledonian Railway, at a special meeting in Glasgow, announced that, owing to the depressed character of trade and the development of the competition of electric traction, the directors had agreed to defer, if not abandon, certain schemes which had been estimated to cost one million sterling.

**Torquay.**—The Town Council at a special meeting on Thursday last week approved the Tramways Bill and the draft agreement with the Dolter Electric Traction Company, subject to the inclusion of a clause protecting the Corporation against damage to their pipes in the streets from electrolysis. The estimated cost of the tramways is £89,000.

**Lewisham.**—The Borough Council have agreed to contribute £71,815, being one-third the cost of the necessary local street widenings in connection with the proposed London County Council's tramways from New Cross to Lee Green, from Greenwich to Catford, from Lordship-lane to Forest-hill, and from Lewisham High-road to Forest-hill.

**Newcastle.**—The Tramways Committee have agreed to make a concession to clerks and others who are aggrieved that they have not been allowed to take advantage of the workmen's cars at the cheap rates. The committee have agreed that workmen's cars at night may be used by the general public, if there be spare seats not needed by workmen, at workmen's fares.

**Leeds** —In response to further representations of the men against the "split-turn" system, the Tramways Committee have agreed that if after a fair trial the system should not work satisfactorily to refer the matter to the Conciliation Board. A poll of the ratepayers is to be taken on the question of promoting a Consolidation Bill, which includes powers for further tramway developments.

**Electro-Pneumatic Signalling.**—The directors of the North-Eastern Railway Company have decided that the Westinghouse electro-pneumatic system of power signalling should be installed in the new Paragon Station at Hull, and the contract for the installation

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has been let to Messrs. Mackenzie and Holland, of London and Worcester, British agents of the Westinghouse Company.

**Dublin and Lucan Electric Railway.**—The accounts of the Dublin and Lucan Electric Railway Company for the half-year ended Dec. 31, 1903, show a profit of £1,625. After including the balance brought forward and providing for debenture interest, the directors recommend the payment of half-year's dividend on the preference shares, placing £700 to reserve fund, and carrying forward £359.

**Blackpool.**—At the meeting of the Tramway and Electricity Committee this week, the tramway receipts from the three routes from April 1, 1903, to Jan. 14, 1904, were presented and as compared with the corresponding dates of 1902-1903 they present some very interesting figures. Altogether, the receipts on the three lines show a decrease of £225. 11s. 7d., the passengers an increase of 248,622, and the mileage a decrease of 38,768.

**St. Pancras.**—At Wednesday's meeting of the Borough Council upon consideration of the report of the Joint Committee on the electrification of tramways, an amendment was considered that in the opinion of the Council it is desirable that one system only of electrification shall be adopted throughout the borough, and that the London County Council be requested to reconstruct the whole of the lines on the underground conduit system.

**Bath.**—The first accident on the new electric tramways system occurred on Saturday, when a runaway car collided with two wagons and did considerable damage. Going down a hill the trolley slipped off the overhead wire, and the electric brake could not be used. The rails were in a greasy condition, and the driver had only the hand brake to rely on, which, however, failed to check the course of the car. There were no personal injuries.

**Beckenham.**—At the last meeting of the District Council it was reported that the clerk had been unable to obtain from the British Electric Traction Company the security which they undertook to give for the due performance of their obligations under the heads of agreement relating to tramways. The clerk was directed to inform the company that under no circumstances whatever would the Council be prepared to postpone the question of the security.

**Paisley.**—The Town Council have agreed to oppose the draft provisional order promoted by the Paisley District Tramways Company to extend the times for the completion of the tramways. The time fixed for completion by the present agreement is Aug. 17, 1904; the new order asks it to be extended for two years beyond that date. It is stated that Renfrew intends to oppose the order, and Johnstone is to be asked to fall into line as well in opposing the measure.

**Bristol.**—The Bristol Tramways Company have been negotiating with the neighbouring district councils upon their proposals for extensions into the country, and with varying results. Some councils, like Westbury and Henbury, cordially welcome the scheme; others, like Warmley, are asking terms which may possibly be unobtainable; while Keynsham lays down conditions so impossible that the company have notified its withdrawal of the proposed section from Brislington to Keynsham.

**Wandsworth.**—The Borough Council have passed a resolution asking the City and South London Railway Company to extend their line from Kennington through Brixton to Streatham Common. A reply has been received stating the directors have no intention of seeking powers to extend the railway in the direction indicated. It was added that the competition of the tramways has such a serious effect upon the traffic that the heads of the company are discouraged from embarking on further developments.

**Lambeth.**—The local Progressives are urging the Borough Council to comply with the London County Council's request to increase their offer of £20,000 to the full contribution—viz., £40,450—being one-third of the cost of street widening in connection with the electrification after purchase of the lines from Vauxhall to Norwood and Dulwich. A resolution to this effect was unanimously carried at a crowded meeting of ratepayers held on Wednesday under the auspices of the Herne Hill Progressive League.

**Liverpool.**—At the last meeting of the Tramways Committee, Mr. Bellamy stated that during 1903 passengers had been carried to the number of 113,057,234, while the receipts amounted to £524,509. As compared with the previous year, there is an increase of passengers of 3,721,649, and in receipts of £17,883. Contrasting these figures with those of 1897, the last year of the old tramway company's control, and before the electric system was adopted, the increase is 194 per cent. in passengers and 80 per cent. in receipts.

**Darwen.**—At the meeting of the Tramways Committee on Monday an application was made by the General Electric Company for permission to equip one of the cars with a "Case" guard. The application was referred to the electrical engineer, with authority to grant the required permission if considered effective. A sub committee was appointed to consider the question of the provision of further car-shed accommodation. The question of relaying Deane-road tramways was referred to the borough engineer for further report.

**City and South London Railway Co.**—The accounts of this company for the half-year ended Dec. 31, 1903, show a balance sufficient, after providing for debenture stock interest, dividend on the preference stocks, and transferring to the renewal fund £1,500, to allow of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £746. The dividend for the corresponding period last year was at the rate of 3½ per cent. per annum, carrying forward a balance of £1,268.

**Paris Metropolitan Railway.**—A Reuter Paris message, dated Jan. 18, says an accident occurred that evening on the Metropolitan Railway between the Combat and Belleville Stations. It does not appear to have been of a serious character. A breakdown occurred in one of the trains, which was immediately emptied of its passengers, as was the train directly behind it. A third train which had been allowed to proceed under the belief that the line was clear ran into the two stationary trains in front of it. Six passengers were slightly injured.

**Birmingham.**—A section of the Bigwood patent two-part rail and bonding for tramway electric traction is being laid down in Suffolk-street as a trial test by the city authorities. The feature of the rail is its renewable top portion or head, which when worn can be removed without taking up the whole of the rail and the paving setts, and a new top substituted with very little trouble and expense. Fishplates are also dispensed with, and another feature is the method of bonding, which is concealed or hidden instead of on the outside of the rail, as at present.

**Halifax.**—The Tramways Committee are reported to have replied in the negative to a request from the legal representative of a syndicate asking if they are prepared to relinquish certain of the powers which they possess with regard to the laying of tramlines from Halifax to Brighouse, the object of the syndicate being apparently to connect Halifax, Elland, Brighouse, and Huddersfield by tram. A similar request with regard to Brighouse is, it is understood, under consideration by the Brighouse Council. Application is to be made to borrow £10,000 for providing another generating set for the traction load.

**Penarth.**—The District Council have received a request to resume negotiations respecting the proposed tramway. It is understood that the syndicate are prepared to meet the requirements of the Council, which they failed to agree upon at the last meeting—viz., the lowering of the crown of Cogan-hill, the rebuilding of the bridge over the Ely River, and the laying of a double line, and not single lines, as was then suggested. On the application of the promoters the Board of Trade have decided that the proposed provisional order shall be proceeded with, notwithstanding that the consent of the local authorities concerned has not been obtained.

**Ashton-under-Lyne.**—The Urban District Council of Hurst intend, subject to the consent of the Board of Trade, to grant a lease to the Corporation of Ashton-under-Lyne of the several tramways constructed by the Council under the Hurst Urban District Tramway Order, 1900, for the term of 10 years. The yearly rent is to be the annual amount of interest and sinking fund which the District Council shall pay during the said term in respect of any money borrowed by them for the purpose of defraying the expenses incurred in obtaining the district order and carrying the same into effect, and also the costs of and incidental to the preparation and completion of the lease.

**Tottenham Court-road.**—Before the Examiners of Private Bills at the House of Commons on Tuesday, the London County Council objected to Messrs. Shoolbred and the borough of Holborn being heard against the proposed Tottenham Court-road tramways on Standing Order proofs. The examiners decided that both had a right to be heard at that stage. These two opponents to the measure then stated their case, which was to the effect that the London County Council had not the requisite consents, and therefore the Standing Orders had not been complied with. The examiners decided that there was a non-compliance with the Standing Orders in respect of the consents necessary, and the Bill would therefore go before the Standing Orders Committee on that point.

**Batley.**—In Thorncliffe-road, Staincliffe, on Saturday afternoon, a car ran off the metals at a curve, and the driver and several persons were injured. The line was only recently opened, and is worked by the British Electric Traction Company. The driver suffers from concussion of the brain and severe bruises. There were eight passengers in the car at the time of the collision, and five of them were injured. It was at first thought that the accident owed its origin to the failure of the brakes to act, but as soon as the car had been brought back to the rails, and before any part of the mechanism had been touched a test was made of the working of the Westinghouse magnetic brake with which the car was equipped. It was found to be in perfect working order, although the controller was dislocated and the front platform badly broken up.

**Additional Traffic Returns.**—Anglo-Argentine, £1,893 increase; Barcelona Ensanche y Gracia, £68 increase; Barcelona, £151 increase; Brisbane, £373 increase (month of December, £11,915, increase £371), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £33 increase (month of December, £15,057, increase £1,099); Calcutta, £372 increase; Cape Town (month of December), receipts £18,088, expenditure £8 235; Isle of Thanet Electric, £27 increase; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of December), receipts £47,600, expenses £27,400; Perth Electric, £197 increase (for the year 1903: receipts £62,097, expenses £34,871); Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**Yarmouth.**—At the last meeting of the Town Council the borough surveyor reported that in the event of the Corporation becoming owners of the Gorleston tramways it would be desirable to reconstruct and electrify them. He advised that the necessary cable for electric current should be carried across the Haven by the overhead method as the best for economy of construction, maintenance, and safety. The cost he estimated at £1,150. Considering the alternative of placing two cables under the harbour he put the cost at £2,500. The committee had resolved to recommend the Council to adopt the overhead method, and appointed a sub-committee to deal with the question of the purchase of any ground required at Gorleston for the site of the steel mast and stays on that side of the harbour. The Council now decided to take no further action in the matter until they had considered the question of the ferries.

**Accident at Cardiff.**—A tramway accident occurred on Wednesday last week in the vicinity of St. Andrew's-crescent. An electric car was proceeding from the direction of Cathays towards Windsor-place and when passing the corner of the junction road the conductor noticed

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that the standard post situate on the right-hand corner of St. Andrew's Church seemed to be wavering. Immediately afterwards the standard fell right across the roadway. The pole in falling broke the overhead wires, and traffic for about a distance of 80 yards was interrupted. Before the electrical engineer arrived the current had been cut off. Prompt measures were taken to repair the damage. It is somewhat difficult to explain how the standard snapped. The more likely theory is that the pole, being situate at a curve, was severely tested by the gale which blew all the morning and at last gave way. The damage was confined to the standard and the wires.

**West Ham.**—The new regulations issued by the District Council for drivers and conductors of the electrical trams about to be inaugurated in the district are somewhat amusing reading. Conductors are to be freshly shaved each morning, except those growing or wearing beards; they are to have their buttons and boots freshly polished each day; they are to have their uniforms buttoned closely up, display no jewellery or watch chains, and if any buttons become loose they are to immediately stitch them on tightly again. Then, in the case of offensive persons getting on the cars, the conductors are to ask them quietly to alight, and if they refuse they are to remove them "as quietly and gently as possible." Again, they are to stand on the rear platform with their backs to the cars, keep a look-out for passengers, and at the same time see that the cars in front of them do not loiter, though how this double duty is to be done does not appear. Altogether there are nearly 130 regulations for the men to mark, learn, and inwardly digest.

**Huddersfield.**—At the last meeting of the Town Council the Tramways Committee reported that for the nine months ended Dec. 31 last the receipts were £50,676. 17s. 6d., or 9·83d. per car mile, as against 10·51d. in the same period in 1902. The working expenditure was £26,781. 6s. 11d., or 5·19d. per car mile. In the corresponding time in 1902 the expenses amounted to 5·83d. per car mile. There was a surplus of £3,895. 9s. 6d. after deducting £20,000. 1s. 3d. for interest on and redemption of debt. No provision for depreciation was included. A firm of solicitors wrote stating that they were negotiating for their clients with a view of constructing a tramway between Halifax and Huddersfield, *viâ* West Vale and Elland or Brighouse, and asking whether the Corporation would have any objection to the proposed line joining the Huddersfield tramways at their terminus. The town clerk was instructed to reply that the Corporation have no objection to their joining the Huddersfield tramways, and that they welcomed the proposed tramways.

**London United Tramways (Railways) Bill.**—The London County Council have presented a memorial to the Examiners of Private Bills praying that this Bill may be reported to the House as having failed to comply with the Standing Orders. The object of the Bill is to give more direct access between the company's tramways and the District Company's railways by the construction of railways to connect the tramways with the Hammersmith Station of the District Company. The County Council allege that, although these works are described as "railways," they are not railways to the true intent and meaning of the Standing Orders, but are really tramways, and, as such, ought to be subject to the consent of the road authority. As an alternative, the Council contend that the proposed lines are partly tramways and partly tramroads, and ought to be subject to the Standing Orders applicable in such cases. The promoters, the petition proceeds, having failed to comply with these Standing Orders, or to obtain the assent of the Council as the local authority, the Bill has failed to meet the requirements of Parliament.

**Manchester.**—The Tramways Committee have come to an agreement with the Gorton Council about the construction of tramways in Gorton-lane, Wellington-street, and Reddish-lane. The committee have agreed to construct the tramways and take a lease on the same terms as those in Hyde-road. The Droylsden District Council have asked for a tramline from the Fairfield-road end of Openshaw across Droylsden to the Droylsden Station, and in the event of the amalgamation of that township with Manchester, the Tramways Committee reply that they see no difficulty in complying with the Council's wish within reasonable time. A special meeting of the City Council will be held on Wednesday next for the purpose of confirming the propriety of the promotion in the next session of a Bill to authorise the Corporation to construct tramways and street widenings within and beyond the city, to confer further powers upon the Corporation and neighbouring authorities with respect to the exercise of powers relating to tramways, works, and electricity within and beyond the city, and for other purposes.

## LIGHTING AND GENERAL.

**Taunton.**—The lamps connected during the past quarter were equivalent to 977 8-c.p. lamps.

**Milngavie.**—The Town Council are opposing the Clyde Valley Electric Company's provisional order.

**Acton.**—Mr. W. H. Trentham is preparing plans and specifications for laying mains and for the sub-station.

**Stockport.**—The Finance Committee have decided to apply for a loan of £882 for the electricity department.

**Kingswinford.**—A number of additional electric lights are to be provided in each ward where most necessary.

**Hull Telephones.**—The charges for second instruments to a subscriber will be 20s. for wall instruments and 25s. for table stands.

**Brechin.**—The District Council have granted the Angus Electric Light Company permission to lay a cable in a road at the west side of Brechin.

**Chester.**—The Town Council will oppose the Cheshire Electricity and Power Gas Bill, with the view of excluding (except with the consent of the Corporation) the city of Chester from the powers sought by the Bill.

**Boston.**—The Board of Trade will defer consideration of the question of revoking the electric lighting order for a period of one year from 8th ult.

**Ilkeston.**—The Town Council on Tuesday accepted an offer of a loan of £70,000 for the purposes of the tramways and electricity undertaking.

**Morecambe.**—The Council have accepted a premium apprentice at the electric light works at a premium of £30 for three years, subject to a month's trial.

**Chili Telephone Co.**—The directors have declared an interim dividend at the rate of 6 per cent. per annum for the six months ended Sept. 30 last.

**Carlisle.**—The electric lighting cable is to be extended from its present termination in Irishgate Brow to Caldcotes, Caldewgate, at an estimated cost of £400.

**Stoke Newington.**—The Electric Lighting Committee have elected Mr. Councillor White, LL.D., as chairman. This committee is to be constituted a standing committee.

**Battersea.**—It has been decided to increase the plant at the central electric generating station, at a cost of £11,000, in order to cope with the winter demand for electric current.

**St. Marylebone.**—At a public meeting on Tuesday a resolution was passed against the promotion of the Bill by which the Council seek power to raise the funds for the electric lighting purchase.

**Rawmarsh.**—The Urban District Council have appointed a deputation to interview the New General Traction Company and the Board of Trade with regard to the extension of the electric lighting order.

**Houghton-le-Spring.**—The Urban District Council will support the North of England Electrical Power Supply Company's application for an Act of Parliament for proposed electrical power distribution orders for the North of England.

**South London Electric Supply Co.**—The company reports having sold during the quarter ended Christmas last 2,009,230 units, realising £18,230. The figures for the corresponding quarter in 1902 were 379,167 units, realising £7,412.

**Colwyn Bay.**—The electrical engineer in his last report stated that 17,671 units of electricity were generated in the past month, and number of consumers connected up to date was 175. A number of additional street lamps are to be provided.

**Heywood.**—The consumption of electricity for the month of November, 1903, was 7,723 units. The electrical engineer's report with reference to the lighting of the electrical arc lamps in the Market-place is before the Watch and Baths Committee.

**Lowestoft.**—The electrical engineer in his last report stated that during the past month 16 new consumers were connected to the mains, representing 702 8-c.p. lamps. There were connected to the mains 458 consumers, representing 22,500 8-c.p. lamps.

**Lichfield.**—A meeting of the Ratepayers' Association last week passed a resolution in favour of the application of the Corporation for a supplemental provisional order for electric lighting at Whittington Barracks and other portions of the rural district.

**Chichester.**—The Corporation being the undertakers for the purposes of the Chichester Electric Lighting Order, 1898, propose to transfer their powers, duties, and liabilities under the order to the Chichester and District Electric Supply Company, Limited.

**Coventry.**—The Electric Light Committee on Monday decided to purchase, subject to the sanction of the Local Government Board, a new engine and alternator of the same type as those last installed, at the price of £1,750 for the alternator and £4,169 for the engine.

**Beccles.**—At the last Town Council meeting a letter from the Southern District Electricity Corporation was read, stating that they were unable to proceed with a provisional order this year, but would probably communicate with the Corporation upon the subject before next year.

**Canadian Electric Traction Co., Limited.**—This company has been registered with a capital of £120,000 in £1 shares, the object being to construct, improve, work, lease, administer, or control electric, steam, and other railways and tramways and electrical storage, power, or lighting works, etc.

**Grimsby.**—At the last meeting of the Corporation Public Lighting Committee, Mr. Vignoles, electrical engineer, reported that during the month there had been an increase of 5,364 units for traction as compared with the corresponding period last year, 730 units increase for public lighting, and 7,792 for private consumers.

**Burnham.**—The question of the provisional order of the Maidenhead Corporation Electric Lighting Committee came before the Parish Council on Wednesday. The price agreed upon is ½d. in excess of that charged at Maidenhead for each two-thirds of a mile beyond the borough boundary, and a reduction for power purposes.

**Middlesbrough.**—The borough electrical engineer (Mr. H. M. Taylor) has presented a report in which he remarked that better street-lighting meant less police supervision and increased facilities and comfort for the townspeople. He recommended the committee to accept the offer of 40 arc lamps at a cost of £20 each per annum.

**Basingstoke.**—At a meeting of burgesses last week a resolution was passed against the Parliamentary Bill promoted by the Town Council for power to provide a supply of electric power and light, a dust destructor, and better provision for the improvement, health, government, and finance of the borough, involving about £108,000.

**Aberdeen.**—The Secretary of Scotland has consented, pursuant to the provision of the Electric Lighting Acts, to the borrowing by the Town Council of a further sum of £65,000 for the execution of capital works under the Aberdeen Electric Lighting Order, 1890, raising the total sum authorised to be borrowed for that purpose to £250,000.

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**St. James's and Pall Mall Electric Light Co.**—The directors recommend a dividend for the half-year ended Dec. 31 last of 7s. 6d. per share, together with a bonus of 2s. per share on the ordinary shares, making a dividend of 12½ per cent. and bonus of 2 per cent. for 1903.

**Leamington.**—The Town Council have adopted a recommendation of the Pump-Room Committee *re* the specimen electric light and incandescent gas lamps exhibited in the Winter Hall, that the 600-c.p. Lucas gas lamps be adopted with an additional lamp (making nine in all), as recommended by Mr. Berridge, the cost of the installation being £30.

**Paisley.**—The Council have signed the agreement with the National Telephone Company regarding the question of underground wayleaves. The company has declined to accede to the request of the Council to abolish the terminal fees charged for obtaining connections with other systems on the ground that, if these fees were abolished in Paisley, it would form a precedent for their abolition in other parts of the country.

**Penrith.**—The majority of the Urban District Council have not decided to resign their seats by way of reply to the resolution of protest against the electric lighting scheme sent by the ratepayers a week ago; and the General Purposes Committee are having a full statement of the case prepared, showing how the matter stands, and, presumably, incorporating the information asked for by the opponents of the measure.

**Kensington.**—Sanction has been given to the undermentioned electric lighting companies relative to proposed extensions of their mains, etc., in the borough, as shown on plans submitted—viz.: Kensington and Knightsbridge Electric Lighting Company, Vicarage-gate and Elvaston-place; Notting Hill Electric Lighting Company, Portobello-road; Brompton and Kensington Electricity Supply Company, Evelyn-gardens and Collingham-road.

**York.**—The first of a series of four new engines that are to be erected in the new portion of the works was started running on Friday, and the supply henceforth will be materially supplemented. The engine is of 1,000 i.h.p., and will give 1,100 h.p. without alterations to the valve settings. Preparations are in progress for the erection of the other three engines, two of which will be similar in size, while the remaining one will be even larger, approximating 2,000 h.p.

**Macclesfield.**—On Monday afternoon the Electricity Committee of the Corporation visited the works, at Openshaw, of Messrs. Crossley Bros., whose gas-engines Messrs. Crompton and Co. propose to use in the scheme they have submitted for supplying the borough with electricity. The committee particularly inspected one of four large gas-engines, of 650 h.p., and costing something like £3,000 each, which are being made for America, and upon which a duty of 60 per cent. will have to be paid.

**Bridgnorth.**—The Rural District Council are objecting to the application of the Shropshire and Worcestershire Electric Power Company for an electric lighting order as far as the parishes within the Bridgnorth rural district are concerned. The Town Council have also considered the draft provisional order, and given instructions for the application to be refused. The object of the opposition is to obtain the insertion of protective clauses in the interests of the Corporation and of the ratepayers.

**Stock Exchange.**—The Stock Exchange Committee have appointed Jan. 27 a special settling day for West London and Provincial Electric Supply Company's further issue of 5,763 ordinary shares of £1 each, fully paid, Nos. 19,892 to 25,654; and 5,763 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 41,915 to 47,677. Application has been made to the committee to allow the Isle of Wight Electric Light and Power Company's £50,000 4½ per cent. debenture stock to be quoted in the official list.

**Greenock.**—The Corporation have resolved to adopt the motor-hiring system, and Mr. Robertson, engineer, is preparing a draft of proposed conditions of hire. During the month of December the units generated at the Corporation works amounted to 89,415 for private and public supply and 62,273 for traction supply—total, 151,688, against 140,780 in the corresponding period 12 months before. Port Glasgow and Gourock are considering the question of introducing electric lighting, and the engineer is about to report on the practicability of giving these towns a supply from the Corporation works.

**Ferranti-Schuler Motors.**—The Lahmeyer Electrical Company, Limited, of 109-111, New Oxford-street, inform us that they have taken over the sale in this country of the Ferranti-Schüler single-phase alternate-current motors pending a permanent settlement. The large starting torque given by this type of motor makes them of great service for lift and crane work. The firm have had very considerable experience with these motors, having manufactured and sold on the Continent a large number of the same. It will be remembered that the rotors of these motors are provided with commutators as well as with slip-rings.

**Edmonton.**—The Urban District Council at a small meeting of members have at last decided to adopt a scheme for lighting the district by electricity. Both Mr. Hammond and Mr. Hawtayne submitted schemes—one estimated to cost £44,000 and the other £33,000. The former was adopted, and Mr. Hammond has been appointed as consulting engineer. It will not be necessary to carry out the scheme in its entirety at first, but in order to protect their provisional order the Council must take action, or by the time the enquiry is held, the loan sanctioned, and the work commenced, the time allowed by the Board of Trade in which to make a beginning with the undertaking will have expired. Opposition at the enquiry is expected.

**Cardiff.**—The question of the lighting of James-street, Docks, has been referred to the electrical engineer for report. Mr. Arthur Ellis, borough electrical manager and engineer, reported on Tuesday that there were at present 969 consumers whose premises were connected to the mains, with a total equivalent of 103,760 8-c.p. lamps. The total at the corresponding period last year was 75,666, being an increase of 37 per cent. in total connections. The revenue was—for street-lighting £482. 7s. 6d., and for private supply £3,811. 12s. 3d. The estimated revenue for the corresponding month last year was £2,615, being an increase of 46 per cent. The total number of units generated for the month reached 418,281, and at the Eldon-road station the increase was some 14,277 units. Notwithstanding the fact that they were paying a little more for coal, the generation costs had been slightly reduced.

**Nernst Lamps.**—We have received from the patentees, the Electrical Company, Limited, 121 to 125, Charing Cross-road, W.C., a copy of a letter they have received from Mr. E. E. Hoadley, borough electrical engineer of Maidstone, about Nernst lamps for street-lighting as follows: "I have just received the figures for the life of the last 100 ½-ampere Nernst burners which we have used for street-lighting, and I thought that you would be pleased to know that the average life of this last 100 under street-lighting conditions works out at 598 hours." We are informed that Mr. Hoadley is using several hundreds of Nernst lamps for public lighting, and the results are so satisfactory that large extensions are being made, and that over 20 other towns in the United Kingdom have also made experiments with Nernst lamps for street-lighting, and the results have in almost every instance been highly satisfactory.

**Blackpool.**—The electrical engineer (Mr. C. Furness) in his last report stated that the returns for December showed a slight decrease in the works output of 1,570 units, as compared with the corresponding month last year, made up as follows: lighting—1902, 181,082; 1903, 179,059; decrease, 2,023. Corporation trams—1902, 88,654; 1903, 80,981; decrease, 7,673. St. Annes trams—1903, 8,126; increase, 8,126. Total units—1902, 269,736; 1903, 268,166; net decrease, 1,570. The decrease of 1,570 units, he says, is easily accounted for, as the public arc-lighting for the month shows a decrease of 9,623 units as compared with December, 1902, so that there is really an increase in private lighting of some 8,000 units. The returns for nine months ending Dec. 31 are: Lighting—1902, 1,006,468; 1903, 1,000,524; decrease, 5,944. Corporation trams—1902, 721,048; 1903, 836,645; increase, 115,597. St. Annes trams—1902, nil; 1903, 54,157; increase, 54,157. Total units—1902, 1,727,516; 1903, 1,891,326; net increase, 163,810. New consumers, nine months, 1903, 49; ditto, 1902, 41; increase, 8. Mr Furness further points out that there is shown a decrease in lighting of 5,944 units, but as the public lighting output had been decreased to the amount of 33,000 units during this period, there remained a slight increase in private lighting of some 27,000 units, and as this is only equal to 2¾ per cent., he considered the increase far from satisfactory, and attributed the stagnation in demand to the want of a more popular system of charges, which he considers ought to be revised.

**Salford.**—Salford has been trying to emulate Bristol in the fashion of fires. An outbreak occurred in the Corporation generating station, Frederick-street, at about 8 o'clock on Sunday morning last. It would appear from the meagre reports to hand that the trouble was originated by a short-circuit among the cables in the balancer-room, whence it spread to the traction switchboard immediately above. Nearly all the traction feeders were involved in the conflagration which ensued, but the reports do not say any serious damage was done to the switchboard itself in this case. As it was Sunday morning very few cars were running at the time, and there was consequently no serious disturbance of traffic. Current was borrowed from the Manchester system to run a few cars during the afternoon and evening. What little damage was done to the lighting cables was quickly repaired, and the station staff worked heroically to restore the tramway feeder connections, which job was finished, we understand, in time to re-establish the full service of cars early on Monday morning. It is interesting to note that cable of Messrs. W. T. Glover and Co.'s patent fire-resisting type were immediately ordered to replace the rubber-insulated cables which had been damaged by the fire. Particulars of this recent development in cable manufacture were given in our issue of Dec. 11 last. We mentioned the suitability of the cable in connection with switchboards, little dreaming that such striking emphasis was to be given to our remarks within sight almost of Messrs. Glover's works.

**Borough Theatre, Stratford.**—As mentioned in our issue of the 8th inst., the electrical installation at this theatre has recently been thoroughly renovated and extended. The current is generated in a spacious engine and dynamo room in the basement, which contains two 48-i.h.p. Premier gas-engines connected by belting to two 238-ampere dynamos. The whole of the wiring is run in oak casing direct from the main switchboard situated in a specially-constructed recess above the stage, the only access to which is through a 2in. oak door. The switchboard is of the contractor's latest type for theatrical lighting, and is fitted with single-pole switches and fuses on either side, and is also furnished with Lyons liquid resistances for regulating the flow of current to the lamps. Over 300 amperes are required to light the stage, for which purpose 200 32-c.p. and 200 16-c.p. incandescent lamps are distributed on five battens, on each of which 80 lamps are grouped—40 being white, and the remainder red and green in equal numbers. The floats, hanging lengths, and bunches also contain 250 32-c.p. lamps, equally distributed with regard to the colours, and 10 powerful arc limes are also used for special effects. The whole of the auditorium and front of the house is wired on the concentric system, the current for lighting the same being obtained from a separate source, so that the lighting of the stage and auditorium is entirely independent. The whole of the work has been executed in a thoroughly efficient and workmanlike style by Messrs. G. E. Taylor and Co., of Bush-lane, E.C., and Mr. W. J. White is the electrician in charge. Mr. Fred Fredericks, the general manager, is to be congratulated on this latest addition to London theatre lighting.

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**Thames Ditton.**—We understand that the Council have informed Edmundson's Electricity Corporation that they are opposed to the grant of a provisional order on the ground that it would be prejudicial to the Council, that there was no demand for electricity for public lighting, and that the tramway company already had acquired power to supply electricity in a portion of the district.

**Stratford.**—The Board of Trade have informed the Council that they will defer consideration of the question of revoking the electric lighting order for 12 months from the present date, adding that if a substantial commencement of works has not been made at the expiration of that time, the Board as at present advised will not be disposed to allow the order to remain any longer in force.

**Stepney.**—The Finance and Parliamentary Committee reported at the last meeting of the Borough Council that their attention had been drawn to the Bill about to be introduced into Parliament by the East London and Lower Thames Electric Power Company. This measure, if passed, would seriously affect the welfare of the Borough Council's electrical enterprise, and, having been requested by the Electricity Committee to strenuously oppose the measure, they had decided to lodge a petition against the Bill and to oppose it in other directions.

**New Branch Office.**—We are informed by the British Westinghouse Electric and Manufacturing Company, Limited, that they are now in a position to receive visitors at their new office at Market-place-buildings, Sheffield, which has hitherto been used only for correspondence. This office is in charge of Mr. C. A. Slater, and considering the volume of business now being done by the Westinghouse Company in the Sheffield neighbourhood, it is anticipated that the new branch office will prove a great convenience to clients.

**Private Bills in Parliament.**—The examiners of private Bills met for the first time on Monday for the purpose of enquiring into the question of compliance with the Standing Orders by promoters of Bills for next session. It was decided that the following Bills, *inter alia*, complied with the Standing Orders: Great Northern Railway, Lincolnshire and Yorkshire Electric Power, Manchester Corporation (General Powers), Baker-street and Waterloo Railway, Charing Cross, Euston, and Hampstead Railway, and the North and South Woolwich Electric Railway.

**Tamworth.**—Opposition to the Tamworth electric light scheme continues. At the Rural District Council meeting on Saturday a letter was read from the Wigginton Parish Council objecting to the inclusion of any part of that parish in the scheme for electric lighting promoted by the Tamworth Town Council, and asking the District Council to use their efforts to protect the parish. It was decided that formal notice of opposition be sent to the Board of Trade and to the Town Council, giving as one of the reasons that notice of the Town Council's intention to apply for the order had not been given to the Rural District Council.

**Cheshunt.**—At the last meeting of the Urban District Council, a letter was received from the North Metropolitan Electricity Company in reply to the Council's request that a clause should be inserted in the agreement compelling the company to lay its mains within 18 months from the completion of the agreement. The company stated that, owing to the present state of the money market and the political situation, it would not be prudent to undertake to do what the Council desired. They could not guarantee to do it under three years. It was agreed to leave the matter in the hands of the chairman and the clerk to negotiate with the company.

**Portsmouth Telephones.**—In the nine months ended Dec. 31, 1903, the number of municipal telephone instruments was more than doubled, the total being 1,500. About 100 orders are in hand, and the committee are looking forward to 2,000 subscribers in the near future. Cables for the extension are being laid and will be complete before the end of the financial year, in March next. Two sub-stations are to be established in Portsmouth—one in Twyford-avenue, North End, and the other at Festing Bridge, Eastney. Financially, the telephones have been satisfactory. Since April 1 last a profit of £450 has accumulated, after paying all expenses, including repayment of loan and interest.

**King's Lynn.**—The electrical engineer in his last report stated that during November applications were received for 772 lamps of 8 c.p. or equivalent, making a total of 17,789 from private consumers, that one 23-h.p. motor was included in the increase, and that there were three extra consumers, making a total of 443. He submitted the following statement: units generated—November, 1903, 53,031 (1902. 43,322); units sold to private consumers (light and power), 22,627 (16,802); units sold at power rates, 6,790 (2,313); cost of fuel, stores, repairs, and wages at station, £132. 16s. 10d. (£111. 14s. 2d.); cost of units generated, 0·6012d. (0·6188d.); wages of lamplighters and outside staff, £23. 13s. 10d. (£20. 9s. 9d.).

**Croydon.**—At the last Council meeting the town clerk submitted a report upon the provisions of the Beddington, Coulsdon, and Sanderstead electric lighting provisional order, and the committee recommend that he be authorised to take such steps as he may deem necessary for safeguarding the interests of the Corporation. It was decided to seek powers by the insertion of a clause in the next local Bill before Parliament to supply, in bulk or otherwise, electricity to any person, company, or local authority outside the borough boundary. The borough electrical engineer's report as to capital expenditure upon extensions to generating plant, £12,535, being a portion of the loan of £27,535 sanctioned in December last, is before the Finance Committee.

**Walsall.**—The total number of consumers supplied on Dec. 31 last was 317. During the past month the total units generated at the station were 115,940. The total output from the main generators was 111,697 units. The total units from the transformers were 87,871 (estimated). The total units registered on the meters were 81,999. The machinery was run for 683 hours. The wages paid amounted to £125. The second term of lectures on "Electrical Engineering," including lighting and power distribution, commenced last week at the Science and Art Institute, the subject dealt with being "Incandescent Lamps and Lighting." A visit to the Corporation power station, Wolverhampton-street, has been arranged for the 23rd inst., when Mr. Wyllie, the borough electrical engineer, will show the students the generating plant for lighting and tramway purposes.

**Fulham.**—Electric mains are to be extended so as to serve the wharves and other premises in the neighbourhood of Crab Tree-lane, and a 200-kw. sub-station constructed and fitted, in the first instance, with a 100 kw. capacity and necessary switchgear, at a total estimated cost of £950. The Postmaster-General has been asked to lay the proposed telegraph line in Queensmill-road underground. Messrs. Deacon and Co., on behalf of their clients, the National Electric Wiring Company, having denied all liability with regard to damages, costs, and expenses paid or incurred by the Borough Council in settling the claims of the unfortunate victims of the accident at the Fulham baths last December, the Council have appointed a sub-committee to take all necessary action to secure the payment by the company, and, in case of continued default, to enforce them to remedy all defects in the work covered by the contract of June, 1901.

**Burslem.**—A deputation from the Tunstall Urban District Council recently interviewed the chairman and vice-chairman of the Electric Lighting Committee, the town clerk, and electrical engineer upon the subject of Burslem supplying electricity to Tunstall. The Chairman informed the committee that if the negotiations with Tunstall were carried to a satisfactory conclusion, it would be desirable to reconsider the whole scheme, and particularly the site where the plant should be erected, and whether it should be driven by producer gas or by steam. Mr. Bremner (electrical engineer) has been instructed to prepare two schemes—one for supplying electric light for Burslem and Tunstall, and the other for Burslem alone—giving details of the cost of a steam-driven plant and a gas-driven plant, and also showing the difference there would be in the cost of supplying electricity in bulk at the Tunstall boundary and of laying down mains for distributing the supply in Tunstall. The Local Government Board have been asked to suspend the holding of the local enquiry until the above negotiations are concluded.

**Morley.**—The electricity works have now been established nearly six years, and the progress made may be judged from the fact that last year the cost of generating per Board of Trade unit was reduced something like one-half of what it was in 1902, while the consumption increased 40 or 50 per cent. At the suggestion of the electrical engineer (Mr. J. E. Ellis) during the past year new switchgear had been placed in the town hall sub-station, and during the summer months one-half of the electrical appliances in this station can be cut out, while at the generating works the enlargement of the economisers, the new feed pumps, and the adoption of the system of distributing current direct to the mains, had also resulted in a great reduction of cost. There have been considerable extensions of the mains during the year, all of which are likely to prove remunerative. The increase in the number of consumers, consequent upon the reduction in price to 4½d. per unit, with a discount of 5 per cent., was equal to 102 per cent., 3,425 8 c.p. lamps having been fixed during the year. The total number of lamps now fixed is 11,220. The arc lighting in the streets is about to be improved.

**Newquay.**—The Council have sealed an agreement with the Southern Counties Electricity Company consenting to their application, the maximum charge for current to be 6d. per Board of Trade unit; the Council to be charged for lighting at 4d. per unit, and for power purposes 2½d.; private consumers 6d. per unit, for power purposes 3d.; no construction works to be carried out during the months of July, August, and September except by the Council's consent; the corporation to supply the Council's lamps when not at a greater distance than 75 yards from a main without charge for connection, provided an agreement were entered into for a period of not less than three years; no charge to be made for meters for public lamps; in case of purchase, the Council to give the corporation 12 months' notice of their intention to do so; purchase to be at a price agreed, or to be settled by arbitration, or on a sliding scale, as follows: if the purchase were within seven years, the price would be the amount of capital expended plus 15 per cent., and if under 10 years the amount of capital plus 10 per cent.; after 14 years the amount of capital plus 5 per cent., with a proviso that the works should be in a proper working order.

**Maidstone.**—The Electricity Committee have been empowered to put in wiring and fittings free in small houses at a cost of £2. 15s. and £3. 15s. per house according to size, an extra ½d. per unit to be charged for electrical energy, and the supply given through slot meters. The revenue account for the quarter ended March, 1902, amounted to £614 against £1,600 for the corresponding quarter last year, the amount for the quarter ended June, 1902, was £549 compared with £832 last year; for the quarter ended September, 1902, it was £884, compared with £1,250 last year; for the quarter ended December, 1902, £1,284, compared with £1,900. These figures show an increase of 50 per cent. The total applications received up to the end of last year and consumers actually connected numbered 307, representing 25,429 8-c.p. lamps. The total costs of the quarter amounted to £850, leaving a gross profit of £1,030, a net profit, deducting £753 interest of loan, capital, less credits, and amount required for sinking fund, of £277. The demand is increasing both for lighting and power. The Highways Committee are about to consider and report on the cost to the Council of changing the present ¼-ampere Nernst lamps to ½-ampere lamps.

**Aberdeen Telephones.**—As already noted, the National Telephone Company have decided to reconstruct their system on the twin-wire system, and have asked the Corporation for sanction to lay the wires underground. The sub-committee did not see their way to agree to the request of the Telephone Company, certain members maintaining that a considerable reduction should be given by the company in the

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"flat" rate, which is the ordinary rate for private instruments. The question was gone into by the Finance, Street, and Road Committees last week, and it was decided that certain proposals, incurring a reduction in the present price, or rather an extension of service at the old rate, should be submitted to the National Telephone Company, and in the event of the latter accepting them, that the Corporation should grant permission to the company to lay their system underground, as requested. It was urged in the course of the discussion that, if some effort was not made to come to terms with the Telephone Company, the latter would proceed without delay to reconstruct their system, and a seasonable opportunity would be lost of having the advantage of an underground system. The question of having a municipal telephone was mentioned, but the idea was not seriously considered.

**London Gazette.**—A general meeting of members of the Electric Lamp Supply Company, Limited, will be held at 6, Guildhall-chambers, 31-34, Basinghall-street, E.C., on Feb. 13, at 1 p.m., to have an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of. The partnership between Charles Hopkinson, Bertram Hopkinson, and Ernest Talbot, carrying on business as consulting engineers, under the title of Hopkinsons and Talbot, 29, Princess-street, Manchester, and 26, Victoria-street, Westminster, has been dissolved. Mr. Charles Hopkinson will continue the practice at 29, Princess-street, Manchester, and Mr. Ernest Talbot will, in partnership with Mr. A. D. Stevenson, continue the practice at 26, Victoria-street, Westminster, under the style of Talbot and Stevenson. At an extraordinary general meeting of the members of the Rangoon Electric Construction Syndicate, Limited, held at 3, Princes-street, Storey's-gate, Westminster, on Dec. 21, a resolution was passed that the company be wound up voluntarily. Mr. Frank Colborne Ridley, 3, Princes-street, Storey's gate, Westminster, has been appointed liquidator. The creditors of the Auxiliary and Light Railways and Tramways Company, Limited, are required to send their names and addresses and particulars of debts or claims to Mr. Frank George Armstrong Hitchcock, 20, Victoria-street, Westminster, by March 3. A dividend will be declared in the estate of Henry John Furniss, electrician, 5A, Queen-street, Derby. Last day for receiving proofs is Jan. 30. Mr. Frederick Stone, official receiver, 47, Full-street, Derby.

**The Oxford.**—The efficient train lighting which the electrical engineer has provided at this theatre in connection with the "Wild West" ought to serve as a model to some of our suburban lines. Amazing is also the rapidity with which the whole installation is disconnected when the Pullman used in the sketch is smashed to pieces. But where the engineer surpasses himself is in the artistic arrangement and brilliant effect and in the lightning changes during a number called "Bijouterie Moderne." The blending of the soft colours, the curious but highly artistic shape of the lamps and accessories used to provide a frame for some shapely maiden combine into one of the prettiest pictures produced by electricity on the stage this season. The rest of the programme is, as usual, all stars, and on account of the usual crowded state of the house, the means of fire prevention existent deserve a word of notice and praise. On the ground floor the audience and the exits are separated by a rope only, sections of which come easily undone if only one man rushes against it. The exits in the various tiers are numerous and well designated, the passages and staircases wide, and, what is of great importance, they lead into three different streets—that is to say, Oxford-street, Tottenham Court-road, and Hanwell-street. The numerous fire appliances are easily accessible, the hose being always connected and not rolled up, but placed in a kind of oblong basket on wheels, so that as soon as the muzzle is gripped the full length trails out, and the appliance is ready for use. Besides the firemen, whose rounds are checked by a number of tell-tale clocks, many of the attendants have their certificates, and are trained to act on an emergency. The whole house is lit by electricity only, and is, of course, wired throughout for a supply from two independent mains.

**Stafford.**—An enquiry has been held into the Council's application to borrow £6,000 for electric lighting purposes. The total expenditure on capital account in connection with the electric lighting undertaking up to date is £29,887, in addition to £3,000 for relaying cables, which has to be paid back out of revenue. There were losses only during 1894-5, which amounted to £245. 18s. 4d., and the profits from 1896 to 1903 came to £5,444 9s. Deducting the loss, the net gross profit was £5,198 10s. 8d. For the year ended March 31 last the gross profit was £1,489. 10s. 11d., which was almost double any previous year, and for the period ending March 31 a still larger amount is expected. As to whether there was any possibility of so utilising the system by which an annual profit could be made for the benefit of the ratepayers, Alderman Wright said, at the last Town Council meeting, he had every reason to hope that very shortly a profit would be made, and in dealing with this question they must take the two lighting concerns of the town together. Deducting the gross profit of £5,198 from £10,814, the amount paid for interest, sinking fund and depreciation, there was left a sum of £5,616 to be provided from the rates during the last 10 years. Out of that sum loan capital had been repaid amounting to £4,600, and, therefore, the net charge on the rates for the decade ended March last was only £955. In the case of a private company the gross profit of £5,198 would have been available for depreciation and dividend, but the Corporation were obliged to repay their capital by degrees. The concern was only 10 years old, and the committee had every reason to be satisfied that it was quietly but steadily growing. There was every probability of the undertaking developing in the future, and the committee hoped that when it grew into a larger concern they would be able to reduce the cost of the motor power to such a figure as would be beneficial to the manufacturers of the town. At the present time they felt they ought not to charge the ratepayers with any deficiency that might arise through electricity being supplied for motor purposes at less than it could be produced for.

## PROVISIONAL PATENTS, 1904.

JAN. 11.

**644. Improvements in and relating to electrical rail bonds.** Kenneth Robison Stuart, Sydney Broughton-Halcomb, and Peter Macgregor, Bank-buildings, George-street, Sheffield.

**653. Dynamo casings.** Saarbrücker Elektricitäts Aktien-Gesellschaft and Johann Emmerich, 51, Hohenzollernring, Germany. (Complete specification.)

**656. Electric plug switch.** Alexander Brunton and William Macqueen Brunton, Battery House, North Queensferry, Fife.

**658. Improvements in rheostats.** Wallace Fairweather, 65, Chancery-lane, London. (The Cutler-Hammer Manufacturing Company, United States.) (Complete specification.)

**660. Improvement in electric alarms.** Marcus Plato, 37, Walbrook, London.

**661. Improvements in and connected with obtaining metals by electricity.** José Baxeres de Alzugaray, Suffolk House, Laurence Pountney-hill, London.

**674. Improvements in or relating to gas or vapour electric apparatus.** Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

**699. Improvements in electric stoves and heating and cooking apparatus.** Joseph Augustus Bauer, 70, Chancery-lane, London.

**707. Improvements in electric block signalling systems.** Louis Charles Werner, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**711. Improvements in controlling devices for electrically-driven vehicles.** The Elektrizitäts Aktien-Gesellschaft vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields. London. (Date applied for under Patents Act, 1901, June 22, 1903, being date of application in Germany.) (Complete specification.)

JAN. 12.

**758. Improved process for insulating electrical conductors.** William George Heys, 51, Deansgate-arcade, Manchester. (Walter Emil Ammon, United States.) (Complete specification.)

**786. Improvements in and means or apparatus for forming the joints in conduits for electric cables.** John Holmes Sutton and Leonard Gregson, 33, Chancery-lane, London.

**789. Improvements in electric railways.** Leon Wilbur Pullen, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**810. Improvements in or relating to electric automobiles.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

**818. Improvements in electric railway systems.** The British Thomson-Houston Company, Limited, Henry N. Sporborg F. W. Carter, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**819. Improvements in and relating to electric motor-control.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**820. Improvements in and relating to electric switches and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**821. Improvements in systems of electric motor control and in controlling apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**822. Improvements in brush-holders for electric dynamos, motors, and the like.** The Phœnix Dynamo Manufacturing Company, Limited, and Herbert Alexander Jones, 322, High Holborn, London.

**833. Improvements on and relating to telephone systems.** Hope Redmon, Rufus Lail Hall, Robert Haviland Conway, and Newton Frank Smith, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 13.

**848. Improvements in electro-mechanical mechanism for controlling, from the moving car or train, the direction of motion and position of movable "shunting points" in tram or railway lines, and also in the bare electrical conductor from which the electric current is collected for propelling the electric tramcar or train.** George Dudley Aspinall Parr, The Yorkshire College, Leeds.

**850. X-ray tube for use with alternating currents.** Arthur William Clayden, St. John's, Polsloe-road, Exeter.

**869. Improvements in relays for recording, retransmitting, and controlling currents of electricity, and in apparatus therefor.** William Ewart Gladstone Johnston, 190, Upper Warwick-street, Toxteth Park, Liverpool.

**880. Improvements in automatic electric signalling for railways and tramways.** Tom Thomas, Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Thrissell-street, Bristol.

**904. Improvements in telephone apparatus.** Alexander Abercrombie, 47, Victoria-street, Westminster, London.

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JAN. 14.

954. **Improvement in variable-speed electric motors.** Henry Metcalf Hobart, Oswaldestre House, Norfolk-street, Strand, London.

959. **Improvement on electric testing apparatuses.** Gerhard Christian Geisler, 19, Sale-street, Paddington, London.

962. **Improvements in induction coils.** Vernon Warburton Delves-Broughton and John Austin Cole, 80, Central-hill, Upper Norwood, London.

968. **Improvements in electrodes for electro-chemical processes.** Richard Threlfall, 55, Chancery-lane, London.

1006. **Spark-extinguishing apparatus for use in connection with electrical high-frequency circuits.** Arsène d'Arsonval, 53, Chancery-lane, London.

1011. **Improvements in and relating to electric winches.** Hugh Laing, 70, Chancery-lane, London.

JAN. 15.

1020. **Improvements in and in the manufacture of electric light and other suspension lamps.** Frederick Ernest Spittle, 24, Temple-row, Birmingham.

1027. **Improvements in electric light switches, electric bell pushes, and the like.** George William Beldam, 15, Water-street, Liverpool.

1036. **Improvements in accumulators or secondary batteries.** Theodore Pescatore, 6, Bank-street, Manchester.

1044. **Improved electrical contact maker for gas, oil, and all internal-combustion engines.** Arthur Alltree, 279, Wilmslow-road, Fallowfield, Manchester.

1050. **Improvements in electric signalling mechanism.** Percy Richard Julius Willis, Fife House, Kingston-on-Thames. (Albert Eli Caughey, United States.)

1064. **Improvements in the mounting and construction of overhead conductors employed in electric traction.** John Brooke, 33, Chancery-lane, London.

1078. **Improvements relating to automatic electrical switches.** Charles Herbert Offord and Thomas Herbert Marsh, 18, Southampton-buildings, Chancery-lane, London.

JAN. 16.

1126. **Improvements in high-frequency electric machines.** George Beckett Batten, 2, Underhill-road, Lordship-lane, London.

1133. **Improvements in electric light fittings.** Veritys, Limited, and Percy Garniss Ebbutt, Plume-street, Acton, Birmingham.

1143. **Improved electric arc lamps suitable for currents of low periodicity.** Hugo Hirst and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

1145. **Improvements in and connected with adapters for affixing electric incandescent lamps to oil lamps.** Bernhard Louis Meyer, 9, Tempest Hey, Liverpool.

1176. **Improvements relating to means applicable for use in connection with electric cars and other vehicles, for stopping the same, and for indicating the speed thereof.** Charles Simmons, 45, Southampton-buildings, Chancery-lane, London.

1187. **Electric accumulator plate.** Chaimsonovitz Prosper Elieson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1197. **Improvements in electrical resistances.** George Herbert Padgham, 53, Chancery-lane, London.

1203. **Improvements in electric transmission by three-phase currents for motor vehicles.** Marcel Auguste Masson, 45, Southampton-buildings, Chancery-lane, London.

1205. **Improvements relating to telephonic apparatus.** Konrad Höflinger and Karl Wolffhardt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 4, 1904.*

1903.

702. **Electric measuring instruments.** British Thomson-Houston Company, Limited, and Holden.

1068. **Method of and means for generating and distributing alternating electric current.** Carolan. (General Electric Company.)

1077. **Couplings for electric and other wires.** Boult. (Hofman.)

1776. **Electric switches.** Hunter and Hulme.

2273. **Electrical measuring instruments.** British Thomson-Houston Company, Limited, and Holden.

2512. **Electric incandescent lamps.** Laybourn.

2805. **Magnetic clutches.** Jenatzy.

3705. **Single-phase alternate-current motors.** Crompton and Co., Limited, and Goldschmidt.

3825. **Electrical switches.** Heywood and Heywood.

4390. **Chain and pulley combination appliance utilised for raising and lowering weights at the extremity or other part of a curve, and protecting electrical conductors from the moving rope.** Stevenson.

5204. **Brakes, particularly brakes for electric tramcars.** Vickers and Andrews.

5291. **Dynamo-electric machines.** Carolan. (General Electric Company.)

5572. **Electric arc lamps.** Rathbone and Smith.

5845. **Construction of electrodes for storage batteries.** Joel.

5873. **Electric arc lamps.** Hamilton-Adams.

6145. **Storage batteries.** Fennell and Perry.

7335. **Electric collector shoes or slippers for the insulated third rail of electric railways and tramways.** Chambers.

10395. **Electrical incandescent lampholders.** Evered and Co., Limited, and Evered.

11316. **Electrically-controlled semaphore signals.** Siemens Bros. and Co., Limited, and Ferreira.

12101. **Electric arc lamps.** Angold, Hill, and Sir Hiram Maxim Electrical and Engineering Company, Limited.

13547. **Exciting and regulating alternating-current motors and alternators having collectors.** Blondel. (Date applied for under International Convention, June 17, 1902.)

18934. **Electric storage batteries or accumulators.** Pratt and Vince.

21216. **Electric railways.** Eader.

21405. **Electric energy meters.** Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

21653. **Coherers for wireless signalling.** Clark and Thos. E. Clark Wireless Telegraph-Telephone Company.

23482. **Secondary batteries.** Rosset. (Date applied for under International Convention, Nov. 24, 1902.)

23854. **Method of effecting a phase-shift of 90deg. or more between the pressure and the field in the shunt circuit of alternating-current meters.** Imray. (Siemens-Schuckert Werke G.m.b.H.)

27196. **Electric switches.** Hunter.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6½ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 4¼-4⅜ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 94-97 xd |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ⅜-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 11-12 |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼ 5⅜ |
| Crompton and Co. ..... | 3 | .. | 1⅜-2¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1⅛ 1⅛ |
| —— 7 per cent. Cumulative Pref..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 xd |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 13¼-14¼ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18 19 |
| —— 4 per cent. Debentures..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 | .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 | .. | 100-103 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ¾-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9¼-10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 xd |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10-10¼ |
| —— 7 per cent. Preference ..... | 5 | .. | 9¾ 10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7⅛ |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14¼ |
| —— ,, ,, £10 Ord. .... | 5 | .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 xd |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 103-105 |
| Chelsea Electricity Supply ..... | 5 | .. | 5¼-6 |
| —— 4½ per cent. Debentures ..... | 100 | .. | 105-108 |
| City of London, Ordinary..... | 10 | .. | 10¼-10¾ |
| —— 6 per cent. Cumulative Pref..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 7½ 8½ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 6-6½ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 6-6½ |
| —— 4½ per cent. First Mort. Deb..... | 100 | .. | 103-106 xd |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7⅛-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 100-105 |

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| Name. | Amount paid. £ | Last price. £ |
|---|---|---|
| Kensington and Knightsbridge and Notting Hill | 100 – | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 – | 9¾-10¼ |
| London Electric, Ordinary | 5 .. | 1⅞-2¼ |
| —— 6 per cent. Pref. | 5 .. | 5¼-5⅝ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 97-100 |
| Metropolitan Ordinary | 10 – | 17-18 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 .. | 96-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 .. | 98-101 |
| —— Preference | 4 .. | 100-103 |
| Notting Hill Electric Lighting | 10 .. | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 407-14,310 | 5 .. | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 .. | 97-100 xd |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 – | 96-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 .. | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 – | 85-90 |
| South London, Ordinary | – – | 3¼-3⅜ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 – | 14¼-15¼ |
| —— 7 per cent. Pref. | 5 – | 8-9 |
| —— 3½ per cent. Deb. | 100 – | 98-101 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 – | 4¼-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 .. | 4¼-5¼ |
| Westminster, Ordinary | 5 – | 12¼-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 .. | 6-6½ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 – | 91-94 |
| —— 4 per cent. Pref. | 100 – | 98-101 |
| —— ,, ,, deferred | 100 – | 91-94 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 113-116 xd |
| City and South London, Consolidated Ordinary | 100 – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 126-129 |
| —— ,, ,, ,, '96 | 100 – | 123-126 |
| —— ,, ,, ,, '01 | 100 – | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | – – | 13-13¼ |
| —— Ordinary, 1-50,000 | – – | 7¼-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 102-104 |
| Waterloo and City, Ordinary | 100 – | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-250,007 | 5 – | 4⅜-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 – | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 .. | 13¼-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 .. | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 .. | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 .. | 10-10¼ xd |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 .. | 102-104 p.c. |

| Name. | Amount paid. £ | Last price £ |
|---|---|---|
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 11¼-11⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 3 3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 4⅜-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 104-107 |
| —— Prov. Cert., all paid | 100 – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅛-1¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 .. | 5-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— Debentures | 100 – | 98-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-12⅝ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 22-22¼ |
| —— 6 per cent. Cum. Pref. | all – | 14¼-15¼ |
| —— 4½ per cent. Deb Stock | 100 – | 113-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11¼-11⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 .. | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 .. | ¼-⅜ |
| New General Traction, Ordinary | 5 – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 – | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 – | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8¼-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,152 6 per cent. Preference | 1 – | 1 |
| —— £523,083 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 – | 102-104 |
| —— Deferred Stock | 100 – | 77-80 |
| —— 6 per cent. Cum. First Pref. | 10 – | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 13-14 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 96 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 100-102 |
| Oriental Telephone and Electric Company | 1 – | ¾ 1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Jan. 16 | 1,050 | 714 | + 336 | + 7,678*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | — | — | — | — | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 15 | 705 | 726 | + 81 | + 1,454 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 14 | 275 | 261 | + 10 | + 226 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 16 | 159 | 162 | − 3 | − 51 | 16½ | 16½ | Dec. 31 | 30,923 | 2,043,677 | 584,939 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 17 | 1,628 | 1,433 | + 195 | + 8,619 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 13 | 887 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 17 | 3,416 | 2,856 | + 560 | +17,961 | 41 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 17 | 741 | 644 | + 97 | + 2,587*h* | 6½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 15 | 4,548 | 4,019 | + 529 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 16 | 777 | 650 | + 127 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 17 | 234 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 16 | 1,861 | 1,395 | + 466 | +21,346 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | — | — | — | — | — | — | — | ,, 31 | — | 2,216,583 | 320,123*h* | — | — | — | — |
| Central London Railway | ,, 16 | 7,057 | 7,246 | − 189 | − 194*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 17 | 3,159 | 3,463 | − 304 | − 746*h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 14 | 396 | 342 | + 54 | + 13 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 15 | 193 | 196 | − 3 | − 253 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 16 | 170 | 155 | + 15 | − 30 | 3 | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 17 | 95 | 79 | + 16 | + 11*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 16 | 3,676 | 3,321 | + 355 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 16 | 715 | 605 | + 101 | | | | | | | | | | | |
| Dundee City Tramways | ,, 13 | 780 | 709 | + 71 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 6 | 585 | 425 | + 160 | + 7,876 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 16 | 12,656 | 10,657 | +1,999 | +47,683*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 13 | 2,173 | 2,101 | + 72 | + 5,899 | 30½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 15 | 1,135 | 896 | + 239 | — | 34 | 34 | March 31 | 56,631*h* | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 7·5·32 |
| Hull Corporation, E. S. | ,, 16 | 1,957 | 1,655 | + 302 | + 5,592 | 19 | 19 | ,, 31 | 87,707*h* | 21,065,899 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 14 | 114 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 13 | 174 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 16 | 4,877 | 4,432 | + 445 | +14,075 | 77 | 77 | March 25*g* | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 9 | 9,622 | 9,327 | + 295 | + 284 | 101 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 17 | 1,569 | 1,441 | + 128 | + 291*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | — | — | — | — | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 16 | 135 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 16 | 94 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 16 | 3,441 | 2,735 | + 645 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | — | — | — | — | — | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 18 | 115 | 100 | + 15 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 14 | 377 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 18 | 3,443 | 2,628 | + 815 | +45,490 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 17 | 4,148 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,709 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 14 | 855 | 798 | + 57 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 19 | 1,013 | 906 | + 107 | + 2,457 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 16 | 594 | 483 | + 111 | + 3,533 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Indian Electricity Act, 1903.**—This Act, which received the approval of the Local Government last year, came into force on the 1st inst. It is understood to be framed on the lines of our own legislation on the subject, and applies to the whole of British India.

**Mechanical Road Carriages.**—The recent series of lectures on this subject delivered before the Society of Arts by Mr. W. Worby Beaumont have now been printed in pamphlet form, and can be obtained on application to the secretary of the society. A charge of 1s. is made for a copy.

**Industrial Decentralisation** — At the South-Western Polytechnic, Manresa-road, Chelsea, on Monday night, a popular debate will take place on the pressing question of industrial decentralisation. All interested in the theme are cordially invited to be present. Mr. Herbert T. Scoble, P.A.S.I., will open the debate at eight o'clock.

**Municipal and County Club.**—Sir Francis J. S. Hopwood, K.C.B, C.M.G., permanent secretary to the Board of Trade, will be the guest of the evening at a house dinner and smoking concert of the Municipal and County Club, Whitehall, to be held on Monday, Feb. 8, at 7.30 p.m. Mr. Laurance Gomme, F.S.A., clerk to the London County Council, will preside.

**Honours**—It is announced from Berlin that Lord Rayleigh has been appointed a Knight of the Order pour le Mérite for Science and Art. A message from Milan states that Mr. Marconi is to share with Prof. Grassi the yearly prize of £1,200, offered by the Royal Academy of Turin for the advancement of the physical sciences, for his work in connection with the development of wireless telegraphy.

**The Late Sir Frederick Bramwell's Will.**—The late Sir Frederick Joseph Bramwell left property of the total value of £100,798, including net personality of £91,955. Besides his large practice as a consulting engineer, Sir Frederick had interests in one or two electric lighting companies, and was chairman of the Kensington and Knightsbridge Electric Lighting Company, Limited. Sir John Wolfe Barry is one of the executors under the will.

**The Paris Metropolitan.**—With reference to our note last week, we are informed that the Westinghouse electro-pneumatic system of control is not the only one that is to be used on the Paris Metropolitan Railway in the near future. The French Thomson-Houston Company have just received a new order from the railway for 100 complete equipments of their system of train control similar to that in use on the Central London Railway, the Great Northern and City Railway, the North-Eastern Railway, and the Metropolitan and District Railways, which contract was given after a most thorough investigation of all systems on the market. It is a compliment to British electrical engineering that the Paris Underground should adopt a system that is in use, or about to be adopted, on some of the foremost electric railway systems in this country.

**Twenty-Fifth Anniversary of the Incandescent Lamp.**—The American Institute of Electrical Engineers has accepted the trusteeship of a fund which is being raised by the Edison Medal Association to celebrate the twenty fifth anniversary of the introduction and commercial development of the incandescent lamp. The permanent maintenance fund will be about £1,000, and it is proposed to award the medal annually to the graduating student in electrical engineering who shall present the best thesis on some original subject. The competition will be restricted to students attending regular courses in electrical engineering at universities and colleges of the United States and Canada. The National Sculpture Society will select the design for the medal, which it is suggested should be of aluminium in view of the growing importance of that metal in electrical engineering.

**Electric Telpherage in Bridge Building.**—The erection of the railway bridge across the River Zambesi at the Victoria Falls, South Africa, will be an engineering feat of gigantic proportions. According to the designs the structure will be the highest in the world, towering 420ft. above the water level in the vast gorge below, and it will have a length of 650ft. The construction of the bridge will be commenced simultaneously from both sides of the river, and it has thus been necessary to adopt some system for transporting the materials to the points at which the work is proceeding. This will be accomplished by electric telpherage, such as is largely used in America, and to a limited extent on this side of the Atlantic. The electrical cableway is now being made at the works of the Cleveland Bridge and Engineering Company, who hold the contract for building the proposed bridge.

**Electric Bakery.**—The practicability of the use of electricity in breadmaking is emphasised by its adoption by a leading London bakery. Except in the moulding of special shapes the dough is untouched by the hand, electrical power being used in the various processes of manufacture. The flour on arrival is run by electric lift to the loft on the third floor, capable of holding 1,000 sacks. Thence it is shot into hoppers leading to the dough-kneading machines on the first and second floors, being thoroughly sifted in its passage. The flour having fallen into the dough-kneader, water, yeast, and salt are added, the iron arms revolve, and in a short time the kneader rears up on end, and deposits the dough in a trough ready placed for its reception. After being left for some hours to ferment the dough is placed in a machine which weighs it off to the required weight, and the same time moulds it into shape.

**Royal Meteorological Society.** — The annual general meeting of this society was held on the 20th inst. at the Institution of Civil Engineers, Captain D. Wilson-Barker, F.R.S.E., president, in the chair. The report of the council described the work carried out by the society during the past year, and showed that there was an increase in the number of Fellows. One remarkable feature was that out of the 13 deaths reported, four of the Fellows had reached the great age of 92 or more years. The Symons gold medal for 1904 was awarded to Hofrath Dr. Julius Hann, of Vienna, in consideration of his eminent services to the science of meteorology. The president, in his address, regretted the want of liberality shown by the Government in affording financial aid for the development of this important science, and, in conclusion, urged the necessity of interesting the youth of the country in the matter by making it a special subject of school and college curriculum.

**I.M.E.A**—The London borough councils, who are now being invited to the ninth annual convention of the Incorporated Municipal Electrical Association at Derby next June and July, are apparently somewhat indisposed to continue their membership of the association owing to fear of surcharge of the guinea subscription by the auditor. The subscription became due on the 18th of this month. The auditors surcharged the amount last year, but while the Local Government Board subsequently sanctioned it, the borough councils were informed that the Board could not undertake to withdraw any future similar expenditure

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from the district auditors' jurisdiction. Under these circumstances the councils are chary of continuing their subscriptions, although it is admitted that membership of the association is of considerable value to the electricity committees. The disabilities from which the London borough councils suffer in regard to membership of various municipal associations and societies are causing considerable irritation.

**Photography of Electrical Phenomena.**—At the Camera Club on Monday evening Dr. George W. Rodman, M.D., entertained a large audience with a paper on the above subject, which was illustrated by experiment. Some fine photographs of electric sparks and photographs of coins taken by electric spark were shown, the former comprising those of a single positive discharge from a point, a negative discharge from a point, a cumulative discharge from a point, and discharges from a sphere—the sphere in this case being the knob of a bedstead. Some very pretty effects were produced, especially with the sphere discharges, the frond-like impressions from the latter being most artistic in the case of the discharge from the negative pole. It was noticeable with all the photographs that the sparks from the negative and positive poles had clearly-defined characteristics of their own. The method which Dr. Rodman followed in taking the photographs was to place the plate between the two poles, the negative and the positive, using a coil giving a 10in. or 11in. spark. The photographs of the single point discharges were taken in the $\frac{1}{10000}$th of a second.

**Rontgen Society.**—A very interesting agenda has been arranged for the next meeting of this society, which takes place on Thursday, the 4th prox. It is what is known as "discussion evening," and the members will be invited to give their views on the subject of the production of photographic reversal through the action of various radiations. In order to promote ideas and give some tangible form to the discussion, Mr. Phillips has given the following headings as a basis, and any experimental data or actual photographic results which members may be able to bring forward will be gladly welcomed: (1) The phenomena of photographic reversal or solarisation produced by white and coloured lights. (2) Reversal may be obtained with radium emanation. Which rays are most active in this respect, the $\alpha$, $\beta$, or $\gamma$? (3) No reversal with X-rays. Why? (4) General theory of photographic action as applied to No. 3. (5) Cathode rays unable to produce reversal. (6) Chemical action of X-rays. Do they "reduce" or "oxidise"? (7) Has the "strain" theory of photographic action any useful bearing upon No. 3? (8) Need of showing some marked connection between photographic and photo-electric phenomena. It seems to us that this method of starting a discussion on any particular subject without first introducing it in a long paper has much to commend itself, and it is somewhat surprising that it has not been adopted by more scientific societies up to now.

**City and Guilds Institute.**—The presentation of prizes and certificates by the Lady Mayoress to the successful students of the City and Guilds of London Institute took place at the Mansion House on Monday, the Lord Mayor presiding. After the distribution of the awards, Sir Wm. H. White, president of the Institution of Civil Engineers, gave an address, in course of which he paid a tribute to the splendid work which the institute was carrying on, and expressed the view that as a nation we had reached a very critical condition of affairs in connection with higher education. He did not advocate "servile copying of foreign methods," but we must not be ashamed to learn in any school where there were useful facts to learn or experience to be gained. If technical education were to hold its own, we must have a good system of secondary education and frank recognition of higher technical training by employers. They all hoped to see in London before long established an institution, complete and all-embracing, which would show what British technical education ought to be with the generosity of private donors, with the assistance of the authorities of the University of London, and the traditional help of all the great associations of engineers and manufacturers. We ought to have, and must have, a rearrangement of the technical institutions of London, and the creation of one great scheme which should utilise all that was good in what we have, remove all overlapping and cause of friction, and which should show to the world that England was still the leader in industry and in resource.

**Encouragement of Urban Traffic.**—The official circular of the Tramways and Light Railways Association prints a timely paper by Mr. R. W. Western, in which is discussed the question of promoting and encouraging urban traffic on electric tramways. It is to be noted that the author approaches the subject from the point of view of the passenger, his object being to find out what it is the passenger most desires. Thus he decides that for the encouragement of urban traffic it is wiser to study the passenger's time rather than his comfort, which may be done, first, by increasing speed between stations; secondly, by increasing the regularity of service; and lastly, though not necessarily least, by reducing the number of stopping places. For our part we are inclined to regard the question of stopping places of greater importance than perhaps either of the other two, as to a man pressed for time there is nothing so irritating as the continual stopping of the car, which is often quite unnecessary. From an ingenious mathematical calculation, the author fixes the happy mean of stoppages at 4 15 per mile, and expresses the conviction that there is nothing to be gained by having more frequent stoppages, particularly during the peak periods, morning and evening, when everyone is in a hurry. If, in addition to this, we take into consideration the fact that the stoppage of a loaded tramcar in full career is a costly operation both in energy lost and in wear and tear, it is evident that the present practice is to place the stopping places in the towns too close. We hope that in time this state of things will be altered. If the rule were to have stopping places at every quarter of a mile only, it would not only appreciably shorten the journey, but conduce to a more even, regular, and rapid service.

**A Single-Phase Motor.**—In the *Elektrotechnische Zeitschrift* for December Mr. Corsepius describes a single-phase motor without commutator which starts under load, and of which he is the inventor. He refers to the well-known property of the single-phase induction motor that it will not start by itself, but when once started continues to revolve and will give out power. It makes no difference whether it is started in one or the other direction. The reason of this phenomenon is that the rotation of the motor causes a distinct change in the magnetic conditions; the apparent reluctance of any two portions of the stator winding is not the same, the difference being greatest when the two portions are displaced by one-half pole distance. The author, therefore, divides the stator winding into two equal portions, which are displaced from each other by 90deg., in the same way as is usually done in single-phase motors. His motor, however, has two rotors—a main rotor and an auxiliary rotor. The main rotor is rigidly mounted on the shaft and its winding is connected with step rings, while the auxiliary rotor is loosely placed on the shaft, and is provided with a short-circuited winding. When the motor is started, the auxiliary

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rotor rotates without load, and the main rotor starts then with torque. The auxiliary rotor is provided to produce the change in the magnetic conditions above referred to. To start the auxiliary rotor, it is, of course, necessary to apply one of the usual starting devices—for instance, a small resistance. The author gives some data of a small experimental motor of this type, in which the stator part that surrounds the main rotor and the stator part that surrounds the auxiliary rotor are provided with their own individual windings. In the tests of the experimental motor the following results were obtained: the motor, when in operation, while giving 2·4, 4·62, 6·83, 7·95, and 9·05 horse-power, took 48 5, 57 0, 68·4, 72·6, and 78·4 amperes respectively; when starting under the same loads it took 48·0, 65·6, 86·2, 97·0, and 97·0 amperes.

**Birmingham Local Section.**—On Wednesday afternoon an interested party of members of the above section of the Institution of Electrical Engineers paid a visit to the Corporation electricity works at West Bromwich. Through the courtesy of the borough electrical engineer, Mr. John H. Wray, the visitors were permitted to make a close inspection of the plant at present installed at this station, which supplies current both for lighting and traction purposes. In the main building there are two steam turbo-generators of 250 kw. capacity each, two of 200 kw. each, and two of 100 kw. each. Those of the higher capacities run at 5,000 revolutions per minute, while the 100-kw. sets have a speed of 3,500 revolutions per minute. Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne, are the builders of these engines, which have been running since May, 1901. There are two switchboards — one for lighting, the other for traction; also one high-speed reversible booster and one negative booster. A Tudor battery of 360 ampere-hour capacity completes the equipment in the main building. The boiler-house contains four Babcock and Wilcox boilers fitted with chain-grate stokers, two marine boilers fitted with Bennis stokers, five Weir feed pumps, and Wheeler and Parsons condensers. Current is distributed on the three-wire system at 230 volts pressure at the consumers' terminals. The maximum demand system of payment is in vogue—*i e*, 4½d. per unit for the first 91 hours of maximum demand, and 1½d. afterwards. For church and chapel lighting a flat rate of 3½d. per unit is charged, while power is supplied at the low figure of 1d. per unit. The station is now in its third year of operation. The visitors spent some time in inspecting the interesting installation, and returned to Birmingham in time to attend the ordinary meeting of the section that night. The paper presented was entitled "Energy Distribution to Sub-Stations," by Mr. C. Alfred Smith, and this was followed by an instructive demonstration of "Some Uses of the Oscillograph," by Messrs. D. K. Morris and J. K. Catterson-Smith.

**The Tramway Veto.**—Year by year as the growth of tramway enterprise increases, the question of the right of veto held by local authorities assumes greater and more significant importance. There is no denying that in many cases this veto is wrongly used by local authorities to obtain concessions from private promoters as the price of their consent to a scheme. Of course, the parliamentary committees have a discretionary power in the matter where they consider the conditions imposed by the councils are too onerous, but more often than not these latter have not hesitated to force companies to agree to carry out public improvements for which the councils alone are and ought to be responsible. The most flagrant instance of the kind it has yet been our fortune or misfortune to come across is in the case of the Brentford District Council and the London United Tramways Company. But that we believe that the management of this tramway undertaking is quite competent to take care of itself, we confess we should be somewhat fearful of the result of the Council's aggressiveness. "As the price of their consent" to the Bill which the company are promoting in the ensuing session for powers to extend their system in West London, including a line over the new Kew Bridge, the Council have named a number of conditions, most of which can only be described as ridiculous. For example, the company are asked to build at their own cost, and to light and maintain, a passenger subway from one side of Kew Bridge approach to the other. But this is moderate compared with the demand that they shall widen Brentford High-street to 80ft. at their own cost. Towards this public improvement the Council propose to make no contribution whatever, although at no distant date the widening would have to be carried out, tramways or no tramways. More astonishing still is the cool request that, in return for the Council's "concessions," as they are pleased to call them, the company shall undertake to make an annual contribution to the authority of £1,000 at the least. No one will doubt, of course, that Brentford will not get its "price," and, after all, perhaps the District Council have rendered a great service to the whole community in showing to what unworthy purposes the right of veto at present enjoyed by local authorities can be put by none too scrupulous councils. Here, indeed, is evidence for the Royal Commission which is now studying the question of London traffic, and all that has been said of the evils of the veto before this Commission palls in light of the testimony which the Brentford District Council have unwittingly adduced.

**Limit of Liability of Tramway Undertakers.**—Many of our readers will probably have noticed a growing desire on the part of municipal councils and private persons who own or lease electric tramway systems to limit their liability in the event of accidents happening on their property, and to this end they have issued notices, which are printed on the back of every ticket, setting forth that they will not be liable for compensation for personal injury to a greater extent than £25. And they seek to justify their action on the ground that the tickets are issued at a lower rate than they are entitled to charge by statute. The new departure, it seems, was first set by two or three Yorkshire towns, notably Huddersfield and Bradford, and has now been adopted by the Sheffield Corporation and also by the Birmingham and Midland Tramways Company. These authorities have, no doubt, had the best advice in adopting this course of action, but the question which one is induced to ask is whether they can legally protect themselves in this manner? The primary factor of a bargain is that there are two parties to it, and it is extremely doubtful whether the mere publication of a disclaimer on the part of the company or corporation limiting their liability in the case of accident to a certain figure would debar the injured passenger from obtaining redress in a court of law. Mere acceptance of a ticket on which the notice appears would not be *prima facie* evidence of a contract existing between the undertakers and the passenger, except perhaps his attention were specifically called to the condition, which, of course, could not be done in every case. Moreover, it is clear that if there were a contract it would begin from the moment the passenger entered the car, and unless the conductor informed him that the authority owning the system would only carry him on condition that he consented to the limitation, there is little doubt but that the common law liability would prevail. The point, so far as we know,

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has never yet been tested in the law courts, but it would be interesting to know whether tramway authorities are legally entitled to protect themselves in this manner.

**English v. Continental Methods.** — We have received a very instructive pamphlet from Mr. J. Macaulay, general manager of the Alexandra Docks and Railway Company in South Wales, wherein he marks down his impressions and conclusions formed during a recent tour of inspection in Belgium, Holland, and Germany. One matter to which Mr. Macaulay pays considerable attention is the dock provision at the principal ports—such, for instance, as Hamburg, and compares the docks there with those at Liverpool. He finds, however, that there is nothing in Liverpool, nor probably in the whole world, to equal the latest-built dock at Hamburg, with its 35ft. of water, five quays, and the magnificent ranges of modern, movable, admirably designed, and easy-working electric cranes. The dock is about 2,000ft. long and 800ft. wide, and each side is equipped with a continuous range of cranes, which are all operated by electric power. With the use of these, the quickest dispatch can be given to any sized vessel and any class of cargo, and the goods either loaded direct into trucks or barges or put into the long, lofty, and well-lighted transit sheds running alongside the quays and cranes. The author is evidently greatly impressed with the orderly and far-seeing methods of the German. For instance, he remarks that generally, and in wide practice, the effects of highly and technically trained capacity in Germany may be seen in the enlightened way in which large dock schemes are prepared as wholes to meet known or anticipated needs, the means adopted for constructing the dock walls upon naturally soft and poor foundations, the full use made of electric power, and so on. The same beneficial results would, he thinks, follow technical education upon the higher scale in this country. Speaking of the workshops of Germany, Mr. Macaulay notes that the principle of "piecework" is very largely applied there, and expresses the view that this should exist wherever possible at home in all trades. By its means the efforts of the best men are exerted to the utmost, thereby gaining the greatest benefit for themselves, their employers, and their country. In one of the engineering shops visited a single man attended with ease to nine automatic machines, and his earnings ran to nearly £2. 10s. a week. The principal qualifications of the average German are stated by the author to be his quickness to perceive changing conditions of commerce, prompt appreciation of the practical value of scientific discoveries, and the meeting of both with promptitude, aided in material measure by the effective power gained from systematic and thorough commercial and technical education.

**Different Types of Calorimeter.**—Messrs. J. S. S. Brame and Wallace A. Cowan have favoured us with a reprint of their paper presented before the Society of Chemical Industry recently, in which different types of calorimeter are compared. The question of the calorific power of fuels in relation to boiler economy and other engineering problems has given rise during the last 20 years to the introduction of a large number of calorimeters, for each of which some special advantage has been claimed. Of these various forms there are but few in general use, and the differences between the results obtained with these instruments seriously militate against any great confidence being placed in such determinations. It is, therefore, of importance to ascertain exactly how the results obtained with a particular type of calorimeter will compare with those determined with another form, which may be very different in principle. The authors comment on the small amount of published information on the subject available, and even where tests have been recorded, the number of determinations and the extreme results are seldom given, so that the figures are of little value, for the limit of error with some commonly used calorimeters is considerable. A long account is given of the experimental work which Messrs. Brame and Cowan carried out with various types of calorimeter, as a result of which they arrive at a number of interesting conclusions. Thus, the Lewis-Thompson calorimeter is the only one in general use relying on a solid oxidising material, and with this instrument the experimental error is very large. For bituminous coals it might give a rough comparison, but in every case the amount of unburnt coal should be determined, and such determinations are laborious, and far exceed the trouble of arriving at a correct result with a bomb calorimeter. The experimental error with a Wm. Thomson calorimeter is also high, and whilst the Fischer calorimeter gives concordant results for the same coal, these results are far from the truth. There seems no reason to suppose that other calorimeters of either of these types should give much better results, for in every case of burning coal with oxygen under atmospheric pressure there is the trouble of incomplete combustion. The conclusion arrived at by all who have had experience with some form of bomb calorimeter as to its marked superiority, is amply confirmed by the authors' results. The only objection to its use is the question of expense. It is easy to manipulate when once the details have been mastered, and determinations can be made with fair rapidity; it is not, however, an instrument suited to the rough-and-ready methods of an engineering shop. Calorimetric results are of little value unless they are fairly accurate, and the requisite degree of accuracy can only be arrived at when perfect combustion can be assured, as in the bomb.

**St. Marylebone Electric Lighting.** — After the adverse verdict of the electors' meeting, as reported in our last issue, the Borough Council of St. Marylebone have no alternative but to take a poll of the ratepayers on the electric light purchase question. As the verdict was obtained on an attendance computed at only 2,500, as against a total electorate of 21,000, it is quite within the bounds of hope that on the poll the Council may yet get the necessary authority to proceed with their Bill in the next parliamentary session. In the meantime the confirmation of the Bill by the Council is to remain in abeyance, and pending the result of the poll an attempt is to be made to defer payment to the company of the sum of £60,000 as ordered by the Court of Chancery a few weeks ago. This money, it will be remembered, was to be paid over to the company on Jan. 31 as the condition on which the Council should be allowed to postpone payment of the whole amount of the award until Feb. 29. The company, it is hopefully expected, will not actively enforce payment of the smaller amount until after the poll, which is fixed for Feb. 8. Negotiations, however, are still proceeding between the special committee of the Council and the Metropolitan Electric Supply Company with a view to a compromise, and another side issue has arisen in the shape of offers which the Council have received from, first, the General Electric Company, of London, and, secondly, the British Westinghouse Company, of Manchester. The terms of these offers will be found in another part of this issue. The General Electric Company are ready to undertake the management of the St. Marylebone electric lighting undertaking, and to guarantee the payment of the interest and sinking fund on the capital expenditure and on the amount of the award, subject to their receiving the order for the new plant and materials required according to the scheme drawn up by

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Mr. Arthur Wright. The Westinghouse Company estimate the cost of the new generating station at £449,260, and they are prepared to supply the necessary plant and machinery for this sum. These two offers were considered by the Council at an adjourned meeting on Monday evening, when there was a motion on the agenda empowering the committee to enter into a provisional agreement on the lines of the letter of the General Electric Company either with that company or any other firm of sufficient stability. Such a provisional agreement the committee were authorised to prepare, so that it will be seen the Council are not yet at the end of their resources. We take it, however, that unless the Council are able to raise the full amount of the award and so satisfy the claim of the Metropolitan Company, they would not be entitled to enter into any such agreement with another company. Thus the whole issue remains dependent upon the passage through Parliament of a Bill which would empower the Council to obtain the necessary loan.

**Dunedin Electric Tramways.**—The system of electric tramways which has been laid down by the Corporation of Dunedin, New Zealand, was opened for public use on the 16th of last month. It is just over 15 months ago that the foundation stone of the car-shed was laid, and some five months later the first sod was turned in connection with the construction of the permanent way. Thus the work has been carried out with the utmost dispatch under the direction of Mr. Goodman, who acted for Messrs. Noyes Bros., the contractors. The permanent way has been constructed in accordance with the usual practice adopted on electric tramway systems in Australasia. The 93lb. rails are laid on sleepers of Australian hardwood on a thick bed of cement, while the track is made up of tarred metal, finished with screenings and rolled smooth, which is said to give a very even surface. Belgian rails, manufactured by the Société Angleur, have been used, and it is noteworthy that these are also in service at Auckland, Wellington, and Christchurch. The points, crossings, and special work were supplied by the Lorain Company, of Philadephia. In the overhead construction, which is used throughout the system, the poles are seamless steel tubes, and the trolley wire is $\frac{3}{8}$in. in diameter. In the main streets central pole construction has been adopted, but in certain others the poles are set at the side. They are 125ft. apart, and every alternate pole will have an arc lamp in place of the finial. By the way, it is claimed that when the electric lighting of the streets is completed Dunedin will be the best, or one of the best lighted cities in Australasia. The rolling-stock consists of 35 cars of three different designs—*i.e.*, "box" cars, combination cars, and open cars. They are lighted by 16-c.p. incandescent lamps, and are equipped in the best style. The cars were supplied by J. G. Brill and Co., of Philadelphia, and are mounted on Brill 21-E trucks. Each car is equipped with two 35-h.p. motors, these and the controllers being supplied by the British Westinghouse Company. They are all to be equipped with the Westinghouse magnetic brake. The power-house which supplies this system with current has been built on the site of the old stables, the old part being utilised for housing the steam-raising plant, while the engine-house has been erected close by. At present there are installed two units of 300 h.p. each, consisting each of a Belliss-Morcom engine coupled direct to a Westinghouse generator. They each have a speed of 380 revolutions per minute. The boiler-house contains four boilers of the Babcock-Wilcox type, each having a heating surface of 619 square feet. The steam-piping is brought in from the boiler-room overhead, and the whole of the exhaust is taken away in underground conduits covered in with iron chequer plates. In the car-shed, which has an area of 165 feet square, accommodation is provided for 52 cars, and in connection with this building there is the machine shop equipped with all the latest labour-saving tools. At present only the northern section of the tramways is open for public traffic, but in a short time it is hoped to have the whole system in full operation.

**Electrical Transmission in California.**—In no other country in the world has the development and transmission of electric power made such giant strides as in California. At present at least a dozen different projects of the kind are in progress, involving an expenditure of two millions sterling, and a great deal of this work is being done within the radius of electric communication with San Francisco. In a most interesting article which he contributes to our New York contemporary, *Power*, Mr. Hamilton Wright reminds us that already San Francisco is supplied with power by the longest system of electric transmission in the world, and the waters of the American River, 200 miles away, are working the machinery, heating and illuminating the buildings, and impelling the street cars of the Pacific Coast metropolis. This system is that of the Bay Counties Power Company, which is transmitting electrical energy from Stockton to Oakland and San Francisco, a distance of 219 miles, by all odds the longest system yet attempted. Not only this, but it has extended its lines as far up the coast as Burlingame, 211 miles from Colgate, where the power is generated. There is a double-pole line from Colgate to Oakland and over Carquinez Straits, by which 18,000 h.p. is carried a distance of 142 miles. The next longest system is that of the Standard Electric Company, which, using borrowed power, carries it over 200 miles—a feat that would have been deemed impossible five years ago. The Standard plant takes its energy from Blue Lakes, the water running 40 miles down the Mokelumne River before it is caught by the flumes and carried 20 miles farther. The pipe line head is 1,680ft., and at present there is 20,000 h.p. in the generators. Only during the last few months wires from three sets of generators, transmitting 13,000 h.p. at 60,000 volts, have been laid 122 miles to Oakland and 146 miles to San Francisco, with San Jose in the line. In the Northern California system are the Butte County Electric Power Company, supplying Chico and the gold dredgers of that region and travelling with 23,000 volts 30 miles, and the Kesuick Electric Power Company, which supplies power from Shasta to Redding and the Mountain Copper Company. Electricity in mining is proving of immense value, especially for gold and silver mines in the desert regions, where water is precious and fuel is costlier than almost anywhere else in the States. With electricity, shafts, tunnels, leads, and stopes may be illuminated, drills may be run, elevator hoists lifted, fans will keep out impure air, and pumps will keep the mine dry, while dynamite blasting may be conducted with less than half the present dangers. At present there are no less than 20 electric power plants on the Pacific Coast, and it is noticeable that this development has taken place practically within a decade. The first successful electrical transmission line was built between Lauffen and Frankfort, Germany, a distance of 108 miles, in 1891, and within a year the first hydro-electric power plant on which long-distance transmission was employed was begun at Pomona, in California. The few particulars we have given above will serve to show the striking development which has taken place in California since then in the utilisation of water power for generating electric power and in electric transmission to long distances.

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## THE BRISTOL FIRE.

Through the courtesy of Mr. H. Faraday Proctor, the city electrical engineer of Bristol, we have this week been allowed to inspect the Temple Back station in which the fire occurred on Dec. 23, 1903. Our readers will remember that the information as to the extent of this fire, and the time taken to resume supply, appeared in our issue of Jan. 1. Since then, in the two succeeding numbers of the *Electrical Engineer* we published articles by Mr. H. W. Clothier which dealt with the probable cause of the fire, its effects, and the means which might be adopted to prevent similar fires in the future. These two articles were illustrated by drawings supplied by the author, and we regret to say that these by no means represent the arrangements at the switchboard at the Temple Back station previous to the fire. The inaccuracies are such as to lead to wrong conclusions being drawn, and hence we shall endeavour shortly to give an account of the actual conditions which the accompanying illustration will help to explain. We propose to deal with the matter much in the same order as Mr. Clothier, so that anyone reading the two articles side by side can make for himself the necessary corrections in Mr. Clothier's descriptions.

The Temple Back station, which was opened in 1893, has since been considerably extended, and it now contains five alternators—not 10, as Mr. Clothier stated. The outputs of these alternators are as follows: four of them are of 400 kw. capacity, and the remaining one of 210 kw. The Avonbank station, which was opened in February, 1902, contains four alternators, and is connected to the Temple Back station by six trunk mains. Just before the accident five of these mains were in use, and the load of 3,000 kw. was being supplied from the four machines at Avonbank in parallel with two of the 400-kw. steam alternators at Temple Back. The alternators at Avonbank have each a normal output of 750 kw., but can work up to 1,000 kw. without trouble. The alternate-current supply at the time of the interruption was being given by the alternators above mentioned connected in parallel to all the feeders. The feeders were, however, grouped into two sets on two omnibus bars, which could have been isolated from each other by means of the interconnecting switch in the left-hand panels of the switchboard (Fig. 1). The alternators at Temple Back and the trunk feeders were also connected in two groups on to these two omnibus bars. Unfortunately, the disconnecting switch could not be operated, owing to the arc and burning oil issuing from the generator panels rendering the switch inaccessible.

The interruption occurred soon after five o'clock on Wednesday, Dec. 23, and the street-lighting was partially resumed by 2 30 the following morning. The street-lighting and the power circuits are supplied from direct-current machinery at the Temple Back and Avonbank generating stations. Before proceeding to discuss the fire the construction of the switchboard may be referred to.

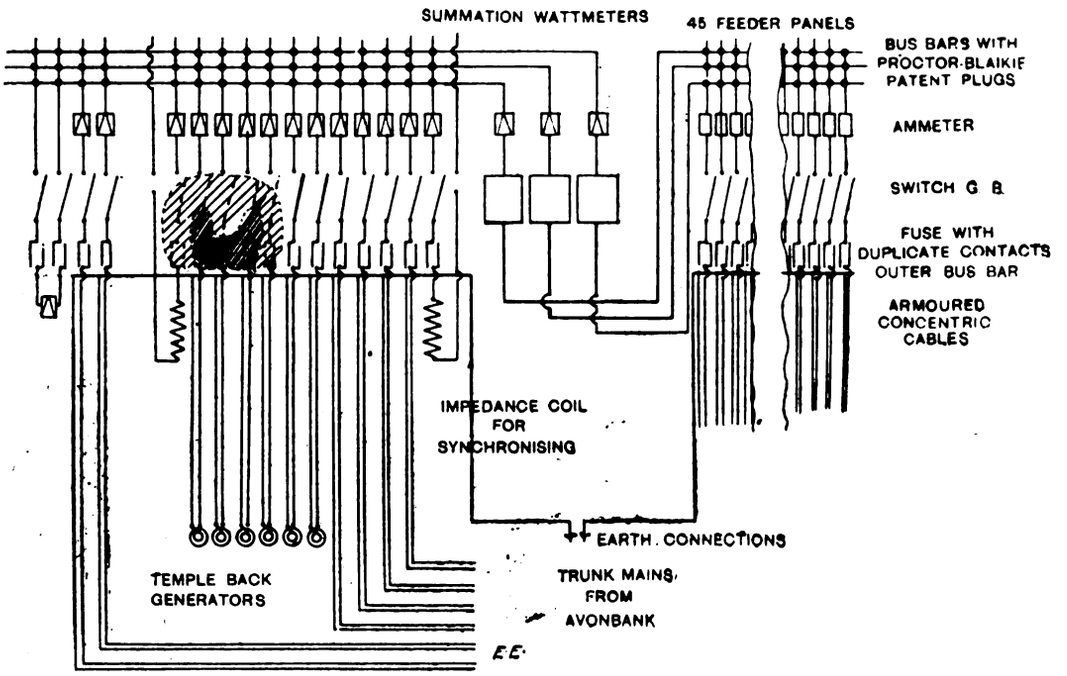


FIG. 1.—Diagram of Connections at the Temple Back Station, Bristol. The arc fused all metal within the darker patch shown, and destroyed all slate, porcelain, etc., within the more lightly shaded patch.

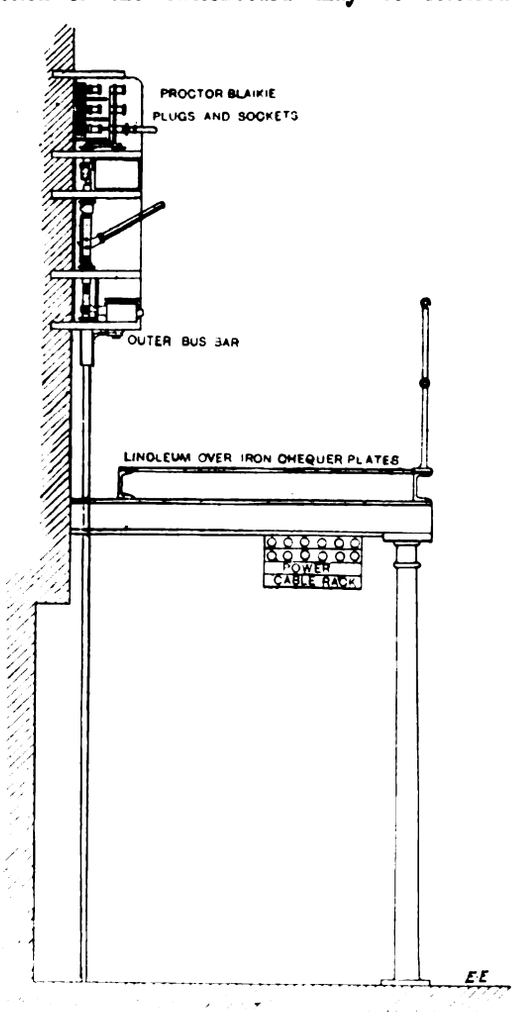


FIG. 2.—Section of the Temple Back Switchboard, showing the Construction of the Gallery opposite the panels the fire started in. The outer bus bar was fixed to the under side of the lower slate as shown.

In Figs. 1 and 2 we give the correct arrangements of this, which shows essential variations from the drawings supplied

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to us by Mr. Clothier. The first portion of the large board was supplied by Messrs. Ferranti Limited in the year 1899, and it has since been extended. The fuses, which may or may not have started the fire, are, however, of the same type as those supplied by the same firm to the Avonbank station opened less than two years ago. The earthed outer 'bus bar used to connect the outer conductors of the mains going to the board was not placed below the switchboard gallery, as shown in the drawing reproduced in our issue of Jan. 15. Instead of this, it was placed directly under the switchboard, as shown in Fig. 2, and was there connected on to the cable receivers, which are of the standard type supplied by the above firm. In erection they were improved by the introduction of a mica tube round the inner conductor before filling up the receiver with compound. The earthed 'bus bar under that portion of the switchboard where the fire occurred is still in position, and is of copper 3½in. wide and ½in. thick. The cables up to been laid. This linoleum, although burnt into holes in places, was not destroyed, as can be seen from the photograph (Fig. 3). The older portion of the gallery opposite the feeder panels was of wood, and this, as can be seen in the photograph, was totally destroyed.

At the time of the accident the machines at Temple Back were under-loaded, each supplying about 300 kw. There was no fault found in these machines or in the leads as far as they remained after the fire. The fuse-pots, which had been felt by the engineer-in-charge a few minutes before the outbreak of the fire, were not overheating, and hence there was no likelihood of a fuse acting prematurely on this account.

Again, there is no evidence forthcoming that the fire started in a fuse, but there is no doubt that the arc which did so much damage to the switchboard played in between the earthed outer 'bus bar and the 2,000-volt fuse and switchgear above. The 2,000-volt omnibus bars are not

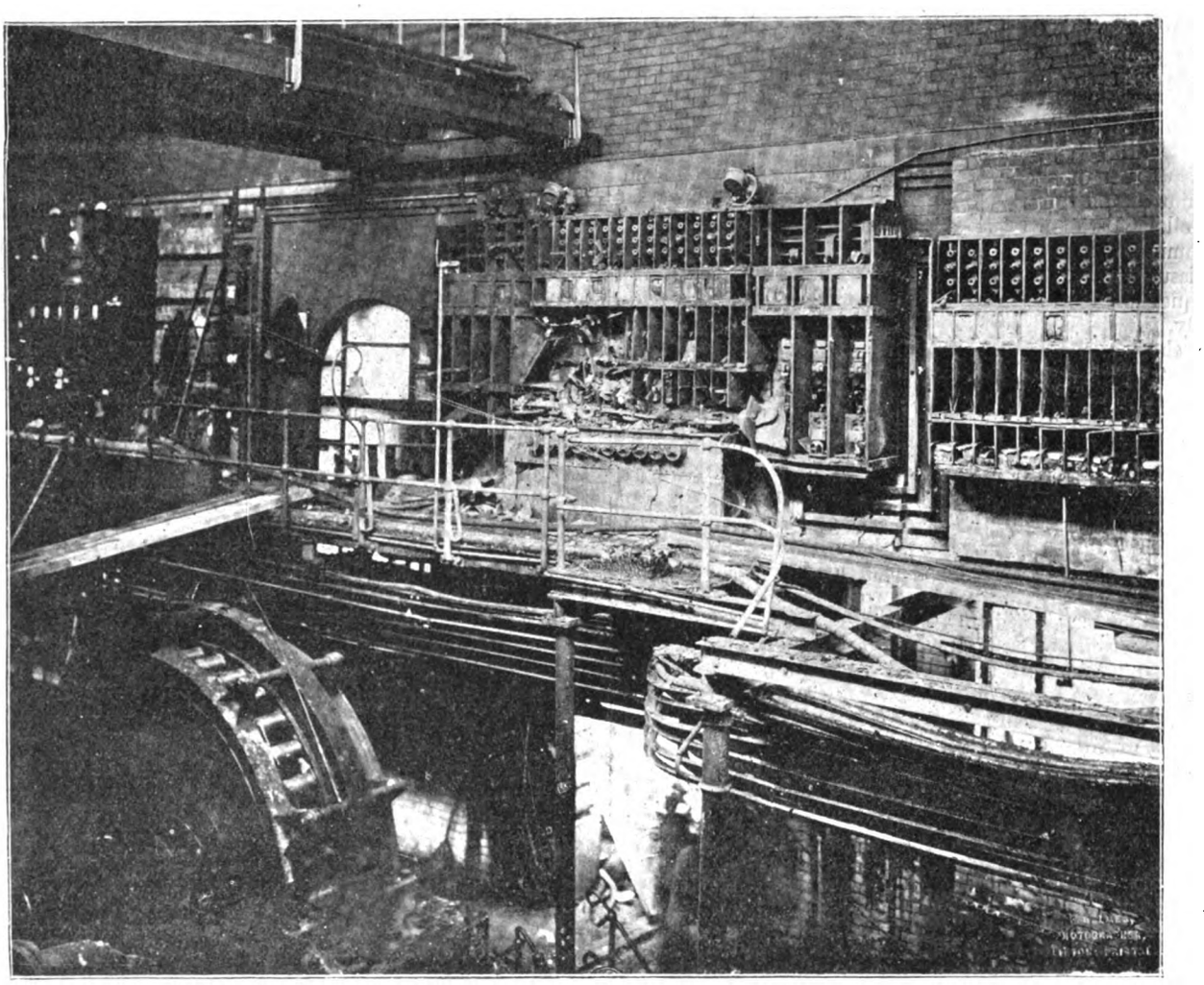

FIG. 3.—Another View of the Ferranti Switchboard after the Fire. This shows the iron chequer plates forming the gallery floor opposite the source of the fire. The wooden floor to the right was completely destroyed. The clips for supporting the armoured leads to the board can be seen against the wall in the right-hand bottom corner.

the switchboard were of the concentric lead-covered and armoured type. The actual arrangement of the panels at this part of the board was shown in Fig. 1. The panels used to control the alternators in the Temple Back station are equipped with switchgear of ample capacity to deal with the currents from the different machines, and there has been no increase in the size of the alternators connected to any panel. Mr. E. Garside, writing to one of our contemporaries, stated that two of the trunk feeder panels were designed originally as machine panels This is so, but the switchgear was replaced before the trunk mains were connected up to them. This writer's statement, that "the switchboard was ultimately put to a use which was not anticipated by the designers," is hence not correct.

The construction of the switchboard gallery was not uniform. Thus, immediately opposite the panels in which the fire originated, the gallery floor consisted of iron chequer plates supported by iron girders, over which linoleum had damaged in the slightest, as the arcing did not spread up into the ammeter compartments. All the connections of the cables under the five panels destroyed on to the earth bar were burned off, and a large semicircular piece was fused out of this earth bar at the point of the connection from a machine which was idle at the time. The evidence of the remains of this part of the board indicates that it was an electrical furnace for some time.

As soon as the fire started on the switchboard, the engineer in charge of the station attempted to get into telephonic communication with Avonbank. The private lines between the two works were in order, but the interference from induction due to the arcing at the switchboard entirely prevented conversation. An attempt to get through on the Telephone Company's lines was also futile. The records taken on the Avonbank switchboard show that at the time the trouble commenced there was no appreciable fall in voltage, and that the current did not suddenly

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increase. It would thus seem that the arc at first had a high resistance. After a little time the current rose and the voltage fell, causing three of the trunk main fuses at Avonbank to blow. The other two trunk mains were double fused by the engineer, and maintained the supply of electricity until about eight minutes had elapsed since the commencement of the fault. Mr. Clothier, in his article of Jan. 8, under the heading of "Cause and Effect," speaks of a serious conflagration being started simultaneously with the formation of the arc, due possibly to an electrical failure on the cables. This fire he attributes to the dropping of molten metal or the heat from the arc igniting the linoleum on the iron platform and also the insulation over the inner conductors of the cables. As we mentioned above, these cables were armoured right up to the switchboard, and the linoleum was only burnt into holes in places. It seems to us that the fire was spread by the oil contained in the fuses rather than by the small amount of other combustible material near this part of the switchboard. Thus the fuses on the board, if all in place, would contain nearly 150 quarts of resin oil, which would pour down over the cables and on to the switchboard gallery. The result was that all the cables were burnt, and that the flames spread up to the roof. The roof of the station was an iron structure, and not a wooden one, as was stated, but there was a certain amount of matchboarding under the slates. The louvres, as well as all the roof principals, were of iron.

Coming now to that portion of Mr. Clothier's article in our issue of Jan. 15 headed "The Faults," we are met with the question as to what was the primary fault. Unfortunately, the fire has destroyed all direct evidence of this. The shortest distance between the earth bar and the 2,000-volt metal is at the rear contact of the lower fuse. The distance between this contact and the back slate is ¾in., while 2in. of slate and a porcelain insulator separate the inner and outer conductors. There is evidence in the walls of leakage into the brickwork, as there is a hole into which a flexible steel foot-rule can be pushed. The sides of the hole are glazed over by the arc, but, as far as is known, there is no ironwork in the wall at this point. The iron stanchions of the building, which are buried in the brickwork, are 3ft. or 4ft. away to the left. It is possible that a static discharge from this fuse contact on to the back slate may have started an arc, which then fractured the slate support, and allowed the arc direct access to the outer 'bus bar. The results of the fire have clearly shown that slate flies to pieces under the influence of fire. Thus while the glass faces of the ammeters and even the thin wood locking-off panels at the one end of the board were not destroyed, all the slate subjected to the flame has been split up to such an extent as to render it useless either as a support or as an insulator. Amongst the secondary faults we have, unfortunately, to consider the part played by the oil contained in the fuse-pots. Before the arcing had reached its worst conditions, the charge engineer was able to get along the switch gallery, and he found it difficult to distinguish between the arcing and the flames from the oil. This is one point which has to be considered as a disadvantage when the many advantages of oil fuses are being summed up. A good deal has been said as to the need for light after such accidents have disorganised a central station. The facts at Bristol are as follows: immediately after the fire had been extinguished, the electric light was laid on from the accumulators in the station, for which the requisite conductors were quickly put in order. This is much preferable to any installation of acetylene lamps or flare lamps, which would tend to increase a fire, and would also be thrown out of order by the same.

The triplicate omnibus bars at the top of the switchboard, which were introduced by Mr. Proctor with a view to sectionalising the load, were not of service in this instance, because of the fact that the sectionalising switch was close to the arc, and hence inaccessible. On a previous occasion, however, the arrangement was effectual, and an arc started on the board was isolated by this means.

It remains to refer to the means adopted by Mr. Proctor and his staff to resume the supply. For this purpose the street was opened up in order to get at the cables. This was necessary because those portions of the cables inside the station had been completely destroyed by fire. Connections were made on to the feeders and trunk mains in the street, and these were led on to some old copper omnibus bars which had belonged to the first switchboard erected in the station. Practically the whole of the material required was in the stores, and every feeder was connected up solid on to the trunk mains from Avonbank by 4 p.m. on the Wednesday. Unfortunately, it was then found that one of these trunk mains, which was about the last to maintain the supply, had fused back beyond the point to which the joints had been made. The inner and outer cores of this cable had burnt back like the two carbons of a Jablochkoff candle. This fault had to be localised, and it involved making new arrangements for sub-stations, as the supply had to be resumed in the dark instead of in the daytime, when only a few lights were on. But for this the supply could have been resumed four hours earlier.

The old switchboard, supplied originally by the Newton Engineering Company, has now been used for feeder distribution, and the whole of the temporary work is enclosed under a galvanised iron structure lined with uralite. The cables from the mains in the street to the temporary 'bus bars have been filled in solid with dry sand, and every precaution has been taken to prevent another fire starting until such times as a new and permanent switchboard can be obtained. The reconstruction work was carried out entirely by the Corporation's staff, many of whom worked continuously for 36 hours, under the personal supervision of Mr. Proctor and his assistants, Mr. H. H. Couzens and Mr. H. J. Bolam. These gentlemen have been living and sleeping at the works since the fire. The work done by them in minimising the inconvenience caused is exceedingly creditable. All central-station engineers will sympathise with the Bristol Corporation electricity department in that it has had to bear the destructive effects of a 2,000-volt arc with, say, 8,000 h.p. behind it. The chief conclusion to be drawn is that Mr. Proctor was right in his provision for sectionalising, which as the works grow larger will be necessary to an even greater extent. We have to thank him and his staff for kindly showing us his station, and for answering questions from which the above article has been prepared.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

### INTRODUCTION.

Scientific men are often accused of being too optimistic—of dreaming dreams which are never likely to be realised. Some listeners, no doubt, characterised as of this nature Prof. Ayrton's memorable statement made in 1897 (when speaking of telephony): "There is no doubt the day will come—maybe when you and I are forgotten—when copper wires, guttapercha coverings, and iron sheathings will be relegated to the museum of antiquities." . . . In that day "when a man wants to telegraph to a friend he knows not where, he will call in an electromagnetic voice which shall be heard loud by him who has the electromagnetic ear, but will be silent to everyone else. He will call 'Where are you?' and the reply will come, 'I am at the bottom of a coal mine,' 'I am crossing the Andes,' 'I am in the middle of the Pacific,' or perhaps no reply will come, and he may conclude his friend is dead." Making due allowance for mere rhetoric, few dreams of scientists have reached such a stage of fulfilment in so short a time. Five years only have elapsed, and we read in the daily papers Marconi's message to the King which has been flashed across 2,500 miles of Atlantic ocean without the aid of an intervening wire or metallic conductor. Prof. Ayrton's dream is likely to become to a considerable extent a reality even whilst he himself is young and vigorous enough not only to rejoice at but also to participate in, the triumphs of the science he loves. To whom is the wonderful advance of the last few years due? Well, to many workers. To Faraday, Maxwell, Henry, Hertz, Branly, Lodge, Preece, and, most of all, to Marconi, the man who reduced theories and experiments to practical realities.

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*Early Attempts.*—Passing over the "anticatelephor" of Edwards (1829), in which air or water in pipes was probably the medium employed, we find Mr. Edward Davy in 1838 preparing to send waves "by the conjoint agency of sound and electricity," to be received in the focus of an electromagnetic receiver at a distance. Prof. Morse in 1842 gave a practical demonstration of an ordinary submarine insulated wire telegraph to connect Governor's Island with Castle Garden in New York, a distance of one mile. The accidental breakage of his wires by a passing vessel caused him to so arrange his wires along the banks as to use the water itself as a conductor—at least that was his own explanation. Sir W. Preece in recent times has carried out this method much more perfectly.

James Bowman Lindsay, of Dundee, about 1843 elaborated somewhat the same idea. Lindsay, who was born in 1799, was, without doubt, a remarkable man. He was appointed lecturer in mathematics at the Watt Institution, Dundee, in 1829. He saw far in advance of his time, but was prevented by want of means and a strange hyper-modesty from carrying his ideas out to perfection. A sort of walking encyclopædia, he spent a great part of his life trying to compile a dictionary in 50 languages with the object of finding out the time and place of man's origin. He lectured in electrotechnics, including electric lighting, and proposed in 1843 a submarine telegraph across the Atlantic. In March, 1853, he delivered a lecture in the Thistle Hall, Dundee, in which he proved by experiments that with suitable arrangements of apparatus and wires laid along the banks of a river, the water itself could be made to transmit the electrical impulses. Many experimenters have tried the same method, using [the earth or water as a conductor. It cannot be said that all these are on the wrong track, but certainly most of their experiments show very little knowledge of the capabilities of high-frequency etheric transmission.

*Practical Period.*—We come now to the time of the telephone. The invention of the telephone gave a new receiver of extraordinary sensitiveness for very feeble interrupted or alternating currents, and experimenters were not slow to make use of it. Prof. Trowbridge, of the United States, carried out elaborate researches on the propagation of electric currents through the earth or water. He found, like many others since, that if the terminals of a telephone receiver be connected to a separate metallic circuit, two points of which are earthed at two places not at the same potential as regards the metallic circuit, sounds will be heard in the telephone due to the current passing through it. By inserting an interrupter and a key in the circuit of the battery, the uniform noise or hum heard in the telephone can be cut into long and short periods to give signals in accordance with the Morse alphabet. Thus messages may be sent over considerable distances without intervening wires. Prof. Trowbridge even put forward the view, originally promulgated by Lindsay, that it might be possible to signal in this way from the United States to Europe.

Intercommunication between ships at sea was proposed, and in 1882 Graham Bell tried the experiment with boats on the Potomac River, and succeeded in sending messages over a distance of 1½ miles.

Prof. Dolbear, of Boston, made some useful suggestions in 1883. He used an induction coil having in its primary circuit a microphone transmitter with wire dipping into the earth, and he even in some cases used an elevated wire, or "aerial," not unlike that now employed.

Mr. T. A. Edison, in 1885, invented, or rather perfected, in conjunction with Messrs. Gilliland Phelps and Willoughby Smith, a method of signalling to and from moving trains. This method is based on the principle that a magnetic field, if varied, has the power to affect a second electrostatic system and create, in air-gaps, displacement currents sufficient to affect a telephone receiver.

Prof. Trowbridge, again, in 1891 proposed the use of the magnetic induction system, using two separate and insulated circuits. He found that if a primary circuit consisting of a large coil of wire with a battery and interrupter be employed, and a secondary circuit consisting of a coil and telephone receiver, the interruptions of the current in the primary circuit give rise to induced currents in the secondary circuit which make themselves heard in the telephone. Sir W. Preece has carried out many experiments with a combination of this and the conduction method, and, in conjunction with Mr. Marconi, in 1897 had considerable success, a distance of over eight miles being traversed without intervening conductors.

Dr. (now Sir) Oliver Lodge has, probably more than any other Englishman, worked successfully at this subject. He has shown the way, has written much, and formulated nearly all the known laws governing the transmission of signals without conductors. He has recently (in conjunction with Dr. Muirhead) elaborated a system which may rival those now in use.

Later success has been due mainly to Mr. Marconi, who, with true youthful elasticity combined with genius, "has never known when he was beaten," but, when seemingly defeated, has taken up the fight with renewed ardour, always to conclude with success. For instance, the lengthening of his vertical wire and the discovery of a so-called "law of distance" when failure seemed certain, and later the insertion of a step-up transformer in the transmitting circuit, the use of a split transformer in the receiving circuit, and the invention of the magnetic receiver, can only be regarded as strokes of genius. The support of a powerful company has, no doubt, been of immense value to Mr. Marconi, but he has had many detractors, and even some who appear to be opponents.

Unscientific opposition has been a rather unseemly feature of early wireless work, both in this and other countries. It is said that there are stations where considerable time and money have been expended in trying to interfere with, or decipher, another's messages, with the object, presumably, of showing that the competing system is of little commercial value through its messages not being secret. Whether these experiments are undertaken in the interests of science or from a desire to conserve certain monopolies, one can only say that Englishmen love fair play, and we are sure desire that a work of world-wide importance shall not be unduly hampered on account of any interests, however powerful. When Mr. Marconi, Mr. Bull, and others have time to thoroughly work out this problem of secresy, it is quite possible they may be able—if they have not already done so—to negotiate it as successfully as the 2,500 miles of Atlantic Ocean have been traversed. On the other hand, a new system should be thoroughly tested before being adopted officially, and the inertia which is our national characteristic may be, in this respect, no more an altogether bad thing than is the physical inertia which, though often troublesome, is, on the whole, such a boon to the engineer.

Of the future of the system who can predict? Five years have done so much, that the next five may witness revelations of hidden etheric force and its transmission such as none of us even dreams of, especially if it be possible to project the waves in a given direction. The system as it at present stands has its defects. These have been very well summarised by Mr. Bright. He says the objections or hindrances to success are mainly: (1) *the earth's curvature* (this did not stop Marconi inside 2,800 miles); (2) *the coherer is extremely sensitive*, liable to derangement, and to be influenced by "stray" vibrations (the coherer may be to a large extent replaced in the future by the electromagnetic receiver, or a better class of coherer may be employed, like the new one of Dr. Lodge); (3) *slow speed*, comparing badly with the 100 words per minute of duplex cable (but 35 words per minute will do—remember an Atlantic cable has cost over half a million sterling, and cables get out of order); (4) and, worst of all, *messages are not secret*—as compared with cables he thinks its inferiority is as marked as would be the delivery of our letters on the pavement—to be picked up by anyone—instead of in our letter boxes. But even if these be true, its advantages are many, and for many purposes are of far greater weight. It is the only system by which we can keep in touch with a moving body, such as a ship; in fact, it will soon be the case that no ship of importance will put to sea without a wireless outfit. The saving of shipping alone, and of perishable goods consigned thereby, will probably quite justify the existence of the Marconi and similar com-

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panies. Then if an enemy gets possession of our cable or cables, we are at his mercy as far as communication is concerned; but there is no monopoly of the ether, and, even if a secret code be necessary, no enemy can stop wireless messages, or prevent us from communicating with *suitably equipped* friends.* Also our locality is of little consequence—we have not to find our way through hundreds of miles of tangled forest, or over leagues of arid plain, in order to receive or send a message. The post office of wireless telegraphy is always open, and, if we have suitable apparatus, always at hand.

### Fundamental Facts and Notions.

In order to study in an intelligent manner the various systems of so-called "wireless" telegraphy to be referred to in these articles, the knowledge of a few preliminary facts and hypotheses may be necessary, and these must be borne in mind.

*Electricity.*—Some people have thought it a pity that ever the name "electricity" was invented. It answers well enough for the penny-a-liner in a daily paper who wishes to describe some occult occurrence of which there is no very material or visible cause. He describes the event, and says it is due to "electricity"—a sort of common explanation when no other is ready. What is electricity? There are various kinds of electrical phenomena and evidences of electrical disturbances, but whether it is necessary to think of electricity as a concrete and material thing is questioned. In this respect the text-books—especially cheap elementary text-books, in which the reader is taught to think of an electric current as a fluid like water moving through a pipe—are to blame. The books tell us of frictional electricity, positive electricity, negative electricity, voltaic electricity, electricity in motion, and so on. Is there really something called electricity which exhibits itself under aspects deserving all these different titles, or are there all these different kinds of electricity? No very good proof has been adduced for the necessity of the existence of any such thing or things—if an entity be assigned. Electrical phenomena can be explained on the assumption of peculiar molecular states or peculiar conditions of the ultimate particles of bodies and of the ether surrounding them. But the term is convenient, and, if not absolutely necessary, at least aids us in the formulation of our laws and in the concretion of our ideas. The objections to the term urged with particular force a few years ago have lost some of their force during the last few months, and the term is now freely employed by the highest authorities. But whilst we use the term we must not forget that it does not represent some material thing like water or air.

Just as electric energy is probably transmitted through the dielectric (or insulator) surrounding a wire, so probably the state of the ether and the ultimate particles of a body gives rise to the phenomena which we call electrification, etc. The word "electricity" is derived from ἤλεκτρον the Greek word for amber, because this material, like many others, possesses the property of attracting or repelling light bodies when rubbed with certain rough substances. May it not be that the friction causes a state of strain in the ether which, in the case of the particles of the amber, is not readily propagated, since it is what we call a bad conductor? The electronic idea, referred to later, is no doubt a reasonable explanation of how this strain is induced and propagated. So-called positive and negative electricity may be opposite phases of strain, or opposite whirls if the vortex theory be adopted. A condenser has the property of entrapping or holding its molecules with such a distribution of strain that each little particle has + strain on one face and − on the other. Other electrostatic phenomena have also been accounted for in this way in conjunction with the newer electronic development. In regard to a *current* of electricity, the electrical disturbance is propagated, we are told, mainly through the dielectric surrounding a wire or conductor, somewhat as light vibrations are propagated from the sun to us, and we say, loosely, that electricity travels along the wire. The disturbance travels, energy is propagated, and we call this a *current of electricity*. But the gross idea, so readlly imbibed from text-books, that some sort of material substance moves along or through the wire as water flows through a pipe, is, of course, quite untenable. Why, then, it may be asked, must the sectional area of the wire be sufficient to carry the given current if the dielectric has the work to do? Because the area must be sufficient to carry off the energy in the form of heat, so as to save the dielectric from rupture, and the heat-carrying property depends on the cross-sectional area of the conductor (Lodge's "Modern Views of Electricity").

Then again, in *magnetism* it may be that every particle is surrounded by an electric current or whirl in the ether, and as there is probably *no* or *very little* resistance to the continuance of these whirls they continue, and the bar is *permanently* magnetised. We must initially make the whirls face one way, or cause polarisation, by some outside means. The whirls were there before—how started we cannot tell. It may be that the earth's existence as an immense reservoir of electricity is as explainable as the starting of the whirls referred to.

Electricity has been likened to a fluid—we have had one-fluid and two-fluid theories of electricity. But, apart from these now out-of-date conceptions, electricity behaves like an imponderable (massless) incompressible fluid. The ether is incompressible—is electricity then the ether or the ether electricity? We do not say so, but electrical phenomena are probably due, mainly, at least, to peculiar states or motions of the ether. Light is propagated by vibrations of the ether. In the propagation of electrical displacements the vibrations are in directions at right angles to the direction of propagation, and in every way are similar to the vibrations by which light is propagated. Electric displacement produces a (magnetic) force at right angles to itself, and it also produces by induction (an electric) force which is propagated at right angles to both the electric displacement and the other magnetic force. Further, the rates of propagation are practically the same. However we may regret the erroneous material notions of electricity, there is no doubt, however, that it behaves, in many respects, *like* a material substance. It is *not* energy, yet it can be transformed and moves in a closed circuit. Electricity in motion and under pressure can do work; but this is true of water, and no one will say that water is energy. Electricity is plentiful, but usually inert; for every quantity of positive electricity we can detect, there must be somewhere an equal quantity of negative electricity. This is proved by the fact that inside a closed room of conducting material, well insulated, electrical experiments of various kinds may be performed, long sparks may be drawn from Ruhmkorff coils, etc., but yet the outside of the room exhibits, to even the most delicate test, no trace of electrification. Or if the outside of the room were electrified so that sparks 8in. long were taken from its surface, no effect would be detected inside the room. It seems, therefore, that we cannot create or destroy electricity, though we can *move* or *strain* it. We may say, then, that we live in a great sea of this all-pervading, perfect fluid, yet we do not know of its existence, normally, or unless something is done to it. But there are in other respects striking differences between the behaviour of any ocean we have knowledge of and the actual ether-electricity we experiment with—especially in regard to the propagation of wave-motion. The motions connected with light propagation are at right angles to the direction of propagation, are, in fact, transverse disturbances, and a perfect fluid cannot transmit such vibrations—unless we can conceive it to be almost as rigid as a solid. How can a fluid have such properties? Rapid motion is one way, and Lord Kelvin's vortex motion would give the necessary rigidity. *Strain* is another way, and Larmor's hypothesis may be the true one. But before going further, having mentioned the ether so frequently, it may not be out of place to devote a short space to its consideration.

*(To be continued.)*

* This statement is to be read in the light of such discoveries and successes as those to be described in a later article.

**Accumulators.**—The War Office have placed the order for the storage battery of 115 cells required for the electric lighting of the Royal Victoria Hospital, Netley, with the Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E.

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## THE EXCITATION OF ALTERNATORS.

BY F. H. DAVIES.

The excitation of alternators may be effected in three ways—viz., by aid of a small direct-current dynamo coupled to each separate alternator shaft either rigidly or by belting; by independently-driven dynamos, sometimes combined with battery plant and used for exciting all the fields in parallel; or by variations of either of the above methods—effected by the aid of sundry connections that will be shown later—which cause the alternator to become to a certain extent self-exciting, and able to automatically compensate for variations in load in a manner similar to the compound-wound direct-current dynamo, or, in addition to this, to also compensate for variations in power factor.

The first method is, perhaps, the oldest, and has a few points that commend it, notably those of low first cost and compactness, and for these reasons it is still very greatly employed where capital and space are considerations. As regards efficiency in working, however, there are one or two defects in this system that show up both when the alternator thus excited is running singly and when in parallel with others. In the former case the voltage regulation is apt to be very bad, owing to the speed of the engine affecting both the alternator and its exciter in a like manner. If through any cause, such as a sudden increase of load, the speed drops, the alternator volts naturally drop also, both owing to the reduction in speed and the increased load; with separate excitation the matter would end here, but under this system such is not the case; the reduced speed also lowers the E.M.F. of the exciter, which now, of course, passes less current through the alternator field, and the consequence is a very bad drop in volts for a comparatively small decrease in speed. The converse of this is naturally true, as a small increase in engine speed produces a disproportionate rise of pressure in the alternator. The voltage regulation in an alternating-current station is always more or less of a trouble; but with this system it at times amounts to a positive nuisance if the steam pressure or load is at all variable.

This method of excitation also scarcely lends itself to satisfactory regulation when working in parallel; it means that the field rheostat of each machine must be moved separately, thus running the risk of setting up an idle and wasteful current between the alternators owing to a difference in pressure at their terminals, or, that all the regulating switches must be geared together by some more or less clumsy arrangement, the scope of which is necessarily limited to a few machines by the strength of the man that has to operate it. Modern practice confines this method to small installations, anything large being carried out upon the lines of the second one mentioned—viz., that of independently-driven exciting plant. In this system two or more separate direct-current sets supply current at the right voltage to a pair of exciter 'bus bars, from which cables are led to the field switch, regulating resistance, and field coils of each alternator. The great advantage is good voltage regulation, seeing that the exciter volts are constant and small speed or load variations do not tell much upon the alternator volts. Regulation in parallel is also greatly facilitated, as it is only necessary to move one small rheostat—viz., that in the exciter field circuit—to affect equally all the machines running. It has been urged against this system that it is equivalent to putting all one's eggs into one basket, and that the entire safety of the station depends upon one exciter that may easily go wrong. This is quite true—such events have happened more than once, but the risk is one of those that we have to take owing to the advantages that go hand in hand with it. As a matter of fact, this difficulty is easily overcome by the installation of an exciter battery working in parallel with the steam sets; indeed, such an arrangement is absolutely the safest that can be devised. It appears upon the face of it that much cannot be said for its economy owing to the loss in the battery, but this is, at any rate to a great extent, made up for by the fact that the exciters are only run for a short period at full load and maximum efficiency, as opposed to a 24-hour run most of the time at practically no load, and, therefore, at great loss.

It is also a consideration that the exciters can be shut down at the heavy load, when steam is sometimes scarce, and the charging done either during the day or night watches.

A point to be noted when working with accumulators as exciters, and one that constitutes practically the only inconvenience, is that the usual two-volt step is rather too rough for nice regulation; it consequently has to be taken up to a certain extent on the alternator field resistances. As pointed out above, in the hands of a careless or incompetent switchboard attendant, this may lead to the setting up of wasteful local currents; and to obviate this, it has in cases been found necessary to provide an additional and separate resistance for each machine, capable when all in of absorbing two volts, and mechanically coupled in such-wise that one turn of a large handle will either cut it in or out in all the alternator fields at once. This should not be confounded with the other coupling arrangement mentioned above, which applied to the mechanical connection of the ordinary field-regulating resistances.

The third system of excitation, as stated, is capable of sub-division under two heads—the arrangement that renders the alternator automatically compensating for variations in load but takes no account of alterations in power factor, and the more modern method that does both.

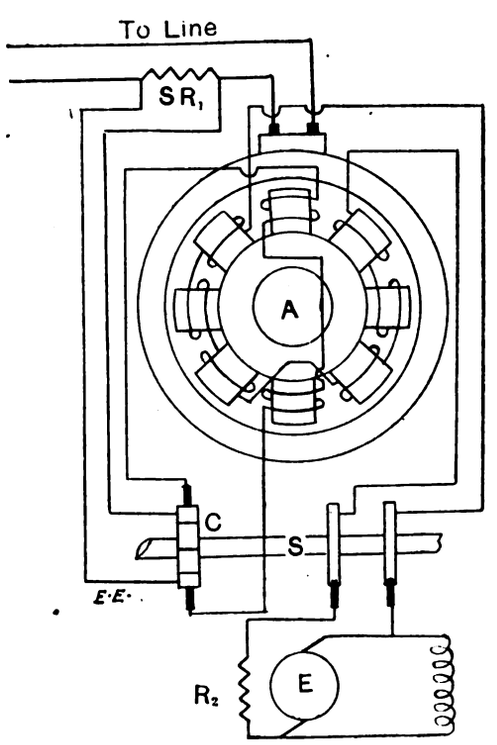


FIG. 1.

The former, originally devised by Prof. Elihu Thomson, is shown diagrammatically in Fig. 1. A is a single-phase, eight-pole alternator, and six of the poles are excited in the ordinary way by a small direct-current machine, E. The shaft, S, is fitted with the two slip-rings necessary for conveying the exciting current to the revolving magnets, and a commutator of as many segments as there are poles in the field.

In the main circuit of the alternator, shown at the top of the figure, is a low resistance, S $R_1$, from the two ends of which wires are taken to the commutator segments, placing the commutator as a whole in shunt to the resistance; the brushes in contact with the commutator are connected to the windings of any two diametrically opposite poles, as shown. By this arrangement the alternator is compounded—that is to say, its voltage will remain more or less constant with a rising or falling load. The action is as follows: the greater the current generated by the machine, the greater the drop in volts over $R_1$, therefore the larger the proportion of current that flows to the rectifying commutator, and thence round the windings of the two poles, adapted for that purpose. This, of course, results in a proportionate increase of field and the generation of a higher E.M.F. in the armature windings. Any regulation necessary beyond

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this is performed in the usual way, either by resistance, $R_2$, in series with the exciter, or by another in its shunt circuit.

As long as the E.M.F. and current are in phase, and the power factor, therefore, unity, this method serves very well, but these conditions are very infrequently met with owing to lagging currents produced by the asynchronous motors and lightly-loaded transformers that are found in most circuits. As is well known, lagging currents tend to demagnetise the alternator field; therefore, the greater the lag the larger the amount of exciting current necessary to compensate for it, and this in addition to the drop in armature volts due to increased load.

A very good method has been devised to get round this trouble, and machines are now built by several large makers that will automatically compensate over all ranges of inductive or non-inductive loads without any hand regulation whatever. The manner of doing this on a three-phase circuit is shown in Fig. 2. A is a diagram of the armature of a three-phase alternator, upon the shaft of which, S, is mounted the exciter armature and commutator, E. This exciter has the same number of field poles as the alternator, so the electrical effects produced in the armature are in strict synchronism with those in the alternator armature. It excites itself, as shown, in shunt direct from the brushes through a regulating resistance. The main current produced passes to the two slip-rings on the right, and so to the revolving alternator field, F.

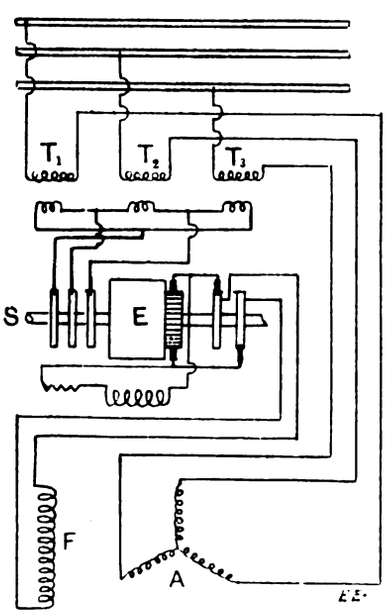


FIG. 2.

So far, this is but one of the ordinary methods, and the novelty of the apparatus, and its compensating action, depend upon the three small transformers, $T_1$, $T_2$, $T_3$, and their connection through slip-rings to the exciter armature.

As will be seen, the primaries of the transformers are respectively connected in series with the three main leads from the alternator armature to the 'bus bars; the secondaries are connected as shown, and joined up to the exciter armature at electrically equidistant points by the intervention of the three slip-rings and brushes. Upon the face of it this arrangement may appear rather complicated, but its action is really very simple.

The connections to the exciter armature are so made as to cause the auxiliary current supplied from the transformers to set up magnetic poles in the armature of opposite sign to those of the fields, and, therefore, to strengthen them.

It will be easily seen that on a non-inductive load when the current is in phase with the E.M.F. an increase of output will naturally result in an increase of alternating current fed into the exciter armature, and, therefore, a strengthening of its field, raising of its volts, and an increase of the current it supplies to the alternator field. On a non-inductive load the magnetic effect of the superimposed current in the armature leads by about a quarter of a period the effect due to the exciter field, but at the same time helps it sufficiently to give the above results on the alternator volts. Now, presuming the load suddenly becomes inductive, the result in the alternator armature is a lag of the current behind the E.M.F., and consequent demagnetisation of the field and reduced volts. The superimposed current in the exciter armature now lags behind its former value, and its magnetising effect thus approaches nearer to that of the exciter field, consequently helping it more and more as it gets nearer into phase with it, and thereby increasing the exciter volts, and likewise those of the alternator. On a load containing capacity the manner of action is identically similar, but converse in its results. The armature current will now lead the volts, and the portion that is fed into the exciter armature, as its effect is now leading the field excitation by considerably more than a quarter of a period, will start to oppose it, so lowering the exciter volts, and consequently those of the alternator, which have risen owing to the magnetising effect of the leading current in the armature on the fields. This method has in all cases that have justified its use given great satisfaction, and there appears to be a large field for it in connection with circuits of which a varying power factor is a feature.

Beyond the above systems of excitation, there is yet another that was in some small use several years ago. It aimed at making an alternator as independent of separate excitation as is a direct-current machine, and this result was attained by winding a series of extra coils on the armature core, bringing the ends to a commutator fixed upon the shaft. This practice has long been discontinued, as its bad points were found to more than equal any benefits that were derived from the absence of separate exciting plant.

With regard to the Elihu Thomson system of compounding, it should be noted that unless a transformer is used instead of the series resistance, the latter should always be placed in the earthed side of the circuit, as otherwise there would be the necessity of extra good insulation on the compounding poles and commutator, and the risk from shock would be serious. Not very many years ago it was customary not to earth one side of the system, under which conditions this machine must have given trouble with the insulation, or at any rate made any dealings with the commutator very dangerous when running.

A few words about the exciting-current switchboard arrangements may not be amiss. Going back again to ancient history, we find many points that were sadly neglected. For instance, the fashion of inserting an ammeter in each alternator field circuit is quite of recent date; and a very wise proceeding, as it is of the greatest assistance in working the machines in parallel without the risk of setting up wasteful currents between them. Also resistances have been greatly improved; instead of the old arrangement of a few coarse notches, sometimes hidden, with no attachment to indicate on what portion of the resistance the switch stood, we have rheostats that, while giving a wide range, allow of the most delicate regulation, and if concealed show unmistakably, by means of a mechanically-geared index, the exact proportion of the resistance that is in circuit. There can be no question that the installation of such plant, even though it be comparatively expensive, is justified by the greater ease of working and freedom from breakdown risks that go hand in hand with its use.

An earth on the exciter circuit, owing to its usual low voltage, is not a matter of frequent occurrence. It should, however, be guarded against by the use of some simple lamp indicating device, especially in a large station where the cable runs are long and sometimes taken through bad places. Supposing the pressure to be 50 volts, all that is necessary are two lamps of that voltage placed in series across the wires, and a connection taken from between them to earth. Under ordinary conditions the lamps will glow dull red, but if either side goes to earth, one will light up full and the other go out, the lamp that is out indicating which side of the system the earth is on. If the earth is not dead, there may only be a small difference between the light given out by both lamps—that is to say, they may both be practically only red hot. This, however, can be provided for by the very simple addition of a two-way switch,

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the arm connected to earth through a low-reading ammeter, and the contacts joined up to the + and – leads respectively. Should the lamps indicate a slight earth, the ammeter, when the switch arm is on the opposite side to that upon which the fault has taken place, will give a reading, from which, by Ohm's law, can be roughly determined the resistance of the fault. It is advisable that a fuse should be in circuit to prevent danger in the event of the switch being used when one of the lamps shows practically a dead earth.

Field switches, it is hardly necessary to state, should be of such a design as to preclude any danger of breaking down the insulation of the magnet winding when cutting the current off it. The rise of potential when the circuit is suddenly broken is enormous, especially in alternators with heavy magnets, and it is necessary that the switch should be so arranged as to insert some form of resistance in circuit before opening, and then to short-circuit the field winding in such a manner as to allow the current in it to die down gently.

In conclusion, the writer would beg to put forward a plea for the better usage of the exciter circuit as a whole; too frequently it is thought nothing of, and provided with a minimum quantity of inefficient apparatus that sooner or later goes wrong, often with disastrous effect. The correct way has been pointed out by Messrs. Ferranti and others in their manufactures, and the thanks of the electrical world are due to these firms, who have made the path of the exciting current as smooth as could be desired.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

657. In maximum traction trucks the pony wheels are sometimes fitted leading and in other cases trailing. Discuss the causes of their variation in position. Compare the advantages and disadvantages of both cases. According to modern practice, which is the better position?—E. S. C.

658. Describe what you consider the best type of packing for the piston rods of high-speed engines using superheated steam. How long should such packing last under ordinary conditions?—P. R. P.

### ANSWERS.

*Question No.* 650.—In the tandem or concatenation control of two similar induction motors on a traction system, the secondary of one motor is fed into the primary of the other. Explain clearly why the resulting speed will be equal to half the synchronous speed of the motors in parallel.

*Answer to No.* 650 (*awarded* 10*s.*).—In the tandem method of working induction motors, the rotors of two similar motors are rigidly connected to the same spindle. The stator of No. 1 motor is connected to the supply mains, and its rotor is usually connected to the rotor of No. 2 motor, the stator winding of No. 2 being short-circuited either directly or through resistances (see Fig. 1). In this case the rotor acts as the primary and the stator as the secondary of motor No 2, though, of course, it is quite possible to connect the winding of the rotor of No. 1 to the stator winding of No. 2, and to short-circuit the rotor of No. 2. In that case, however, the motors would no longer have identically the same windings, since the stator of No. 2 must be wound for the same voltage as the rotor of No. 1. In the following the more usual arrangement shown in Fig. 1 will be assumed. The connections are such that the current induced in rotor No. 1, when the combination is rotating in a given direction, produces a field in rotor No. 2 rotating in the opposite direction.

Now, if in any induction motor the speed of rotation of the rotor exceeds the speed of rotation of the revolving field (whether set up in the rotor or the stator), the machine acts as a generator, whilst so long as the opposite condition holds the machine acts as a motor.

Suppose, then, that, when connected in tandem, the speed of the combination were by some means brought up to within, say, 5 per cent. of the synchronous speed, a current would be produced in rotor No. 1 having a frequency of 5 per cent. of the full supply frequency. The frequency in rotor No. 2 would also be 5 per cent., so that, calling the full synchronous speed 100, the speed of rotation of the rotor relative to the speed of the rotating field in motor No. 2 is as 95 : 5, the difference being 90—*i.e.*, machine No. 2 would act as a powerful generator, producing a large current in the short-circuited stator of No. 2, and requiring a large torque from motor No. 1. This torque will produce a drop in speed which will give more slip in motor No. 1, and, consequently, a higher rotor voltage in both No. 1 and No. 2, so that though, with another 5 per cent. drop in the speed of the combination, the difference in the speed of rotor rotation and rotating field speed will fall to $(90 - 10) = 80$, yet the current induced in the stator of No. 2 will actually increase, for the rotor voltage being doubled the flux set up in motor No. 2 will also be doubled, and the inducing effect on stator No. 2, instead of being proportional to $90 \times 5 = 450$, as it was with the 5 per cent. slip, will now be proportional to $80 \times 10 = 800$. This increased current in stator No. 2 will demand more torque from motor No. 1,

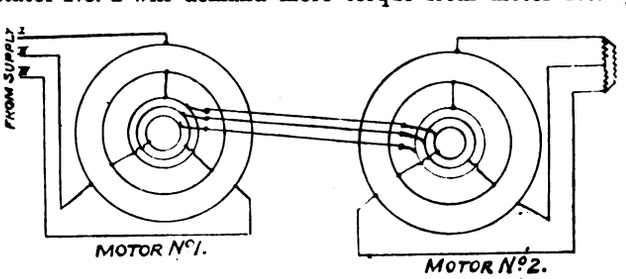


FIG. 1.

and a further speed drop will consequently result. This will continue until a slip of 25 per cent. occurs in motor No. 1, when the power generated in stator No. 2 will be a maximum. After that the speed would still continue to fall, as the torque of motor No. 1 at 25 per cent. slip would be quite insufficient to supply the requirements of stator No. 2, even neglecting any outside demand for power. The current in stator No. 2 would gradually fall off as the slip increased from 25 per cent. to 50 per cent., as shown in the following table, which is, of course, only approximate and neglects the effect of resistance and leakage:

| Slip in motor No. 1. | N. Net speed of magnetic field in No. 2 relative to stator conductors in No. 2. | F. Flux in motor No. 2 proportional to | Inducing effect on stator No. 2 = F × N. |
|---|---|---|---|
| 0 | 100 – 0 = 100 | 0 | 0 |
| 5 % | 95 – 5 = 90 | 5 | 450 |
| 10 % | 90 – 10 = 80 | 10 | 800 |
| 20 % | 80 – 20 = 60 | 20 | 1,200 |
| 25 % | 75 – 25 = 50 | 25 | 1,250 |
| 30 % | 70 – 30 = 40 | 30 | 1,200 |
| 40 % | 60 – 40 = 20 | 40 | 800 |
| 50 % | 50 – 50 = 0 | 50 | 0 |

At the latter point (50 per cent. slip) there will be no current induced in the short-circuited stator of No. 2, for the rotating field set up by the rotor windings in No. 2 will rotate backwards just as fast as the rotor itself rotates forward, thus producing no relative motion between the stator winding and the magnetic field in No 2. At the same time motor No. 1 at half speed will be capable of exerting a small torque, even rather less, however, than an ordinary induction motor at half speed, owing to the fact that in the latter the rotor would be short-circuited through a non-inductive resistance, whilst in the case under considera-

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tion it is short-circuited through the highly inductive winding of rotor No. 1. If now an external load is put on to the tandem combination when running at half speed the speed will drop slightly below half speed, and then motor No. 2 will come into action exactly like any ordinary induction motor, producing its full torque with an excess of 5 or 6 per cent, of the speed of the rotating field of No. 2 over the speed of rotation of the rotors as usual.

It will be seen that when running at the lower speed practically all the torque obtainable from the combination is that due to motor No. 2, the torque due to motor No. 1 being almost negligible. It is on this account that the maximum torque obtainable from a pair of similar motors in tandem is only about half as great as that obtainable from either of the motors alone when running at approximately full speed.—Q.

*Answer to No.* 650 (*awarded* 10*s.*).—The "tandem" or "concatenation" system for the control of two polyphase induction motors in traction work appears to have been first brought out by Mr. Steinmetz in America, and Mr. Görges in Europe, in about 1897; but its practical application to the working of electric railways is of very recent date, and is due to Messrs. Ganz and Co, of Budapest, who speak of it as putting the motor into "cascade."

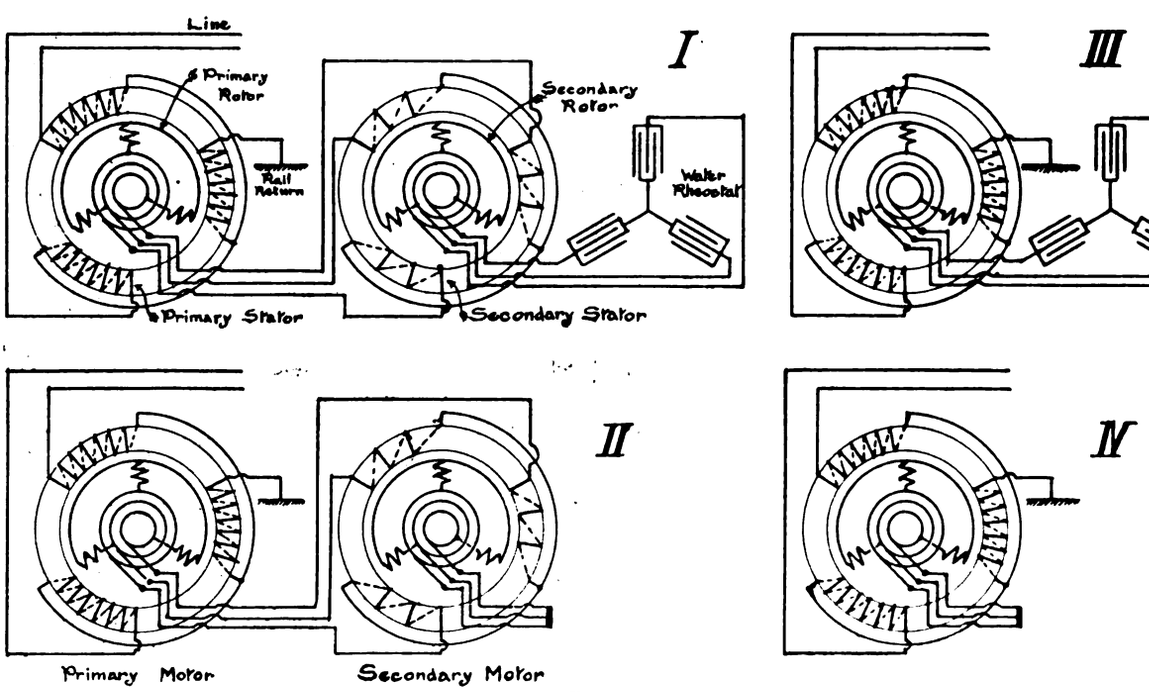


FIG. 1.

This method, besides regulating the speed, ensures a large starting torque and reduces the losses at starting to a minimum, being comparable in this respect to the series-parallel control used with continuous-current tramway motors. The general arrangement is shown by the diagrams in Fig. 1, in which the two motors—which need not be the same in power or construction—are connected as follows:

(1) Stator of primary motor on line. Rotor of primary motor on stator of secondary motor. Rotor of secondary motor on water rheostat. (2) Stator of primary motor on line. Rotor of primary motor on stator of secondary motor. Rotor of secondary motor short-circuited. (3) Stator of primary motor on line. Rotor of primary motor on water rheostat. Secondary motor cut out. (4) Stator of primary motor on line. Rotor of primary motor short-circuited. The rotor of each motor must, of course, be provided with slip-rings and brushes. The rotor winding of the primary motor must be of fairly high resistance in order to limit the current inflow and increase the E.M.F. at stator of the secondary motor, and if both motors are to be cable of running in parallel across the line, the ratio of the stator to the rotor windings must be unity.

The maximum theoretical speed when the motors are concatenated cannot exceed one-half of that of one of the motors directly connected across the line. This will be quite clear if the system be examined closely. At half speed the slip of the rotor of the primary motor will be 50 per cent., and the frequency of the stator field in the secondary motor (which is clearly equal to the slip in the primary motor) will be one-half that in the primary stator. The speed of the rotor is proportional to the frequency, other quantities remaining the same. The action of the primary on the secondary motor will be to tend to induce it to rotate at synchronous speed and frequency, and since the rotors of each of the motors must run at the same speed, the second is in synchronism with its field when the slip of the first (or primary motor) is 50 per cent.—*i.e.*, at half speed. Therefore, up to half speed the two motors could be in concatenation. This would not be possible above half speed, as then the difference between the frequency of the stator field and the cycles induced in the rotor of the primary motor would be less than half frequency, and if the motors were concatenated the secondary would act as a generator, and the rotor current in the primary motor would become reversed, causing it also to become a generator and return power to the line.

The action of the two motors when concatenated can also be explained as follows: Let the angular speed be represented by $\Omega$ for the stator field in the primary motor; $\omega$ for the rotor of the primary motor; $\Omega_1$ for the stator field in the secondary motor; and $\omega_1$ for that of the rotor of the secondary motor. The slip in the primary motor will be $(\Omega - \omega)$, and will also be the frequency (or angular speed) of the field of the secondary, since the rotor of the primary is fed into the stator of the secondary. The slip in the secondary will be $(\Omega_1 - \omega_1)$ and $\omega_1 = \omega$, since the rotors run at the same speed (due to each being coupled to one of the car axles). Hence slip in secondary $= (\Omega_1 - \omega_1) = (\Omega_1 - \omega) = \{(\Omega - \omega) - \omega\}$ $= (\Omega - 2\,\omega)$. Now, the secondary machine will act as a *motor* so long as the slip is *positive*, and will become a *generator* when the slip is *negative*. Hence we have to find the condition for $(\Omega - 2\,\omega)$ to be positive, which condition is satisfied until $\omega = \frac{\Omega}{2}$, which corresponds to half speed. From this expression it will be seen that beyond half speed the slip becomes negative, and the machine thus becomes a generator. That the synchronised speed of the secondary motor is reached when the train is going at half speed, depending on the fact that the two rotors are made to run at equal speeds, is a matter of simplicity, and if the secondary were geared to run at double the speed of the primary, power could be returned to the line until the speed of the train were brought down to one-third instead of one-half of the theoretical maximum speed.

The following brief particulars of the equipment of the

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motorcar trains supplied by Messrs. Ganz and Co. to the Lecco-Sondrio three-phase railway in Italy may be of interest.* Each motorcar is mounted on two four-wheeled bogies, each of which has one primary and one secondary motor mounted direct on the axles. The following are the principal weights and dimensions of the motorcars for express passenger traffic, the train being made up of one motorcar and three or more trailers:

*Particulars of Motorcars.*

| | |
|---|---|
| Complete weight of motorcar | 53·6 tons. |
| Weight of one motor truck with wheels and axles, but without motors | 7·5 tons. |
| Weight of car body | 16·5 tons. |
| Total weight of one motor complete | 3·8 tons. |
| Weight of one complete trolley | 357lb. |
| Weight of one water rheostat, complete with liquid | 997lb. |
| Distance between king pins of trucks | 37·8ft. |
| Wheel base of truck | 8·2ft. |
| Length of car over dashboards | 59·9ft. |
| Length of car over buffers | 62·9ft. |
| Width of car over all | 8·9ft. |
| Diameter of wheels (46in.) | 3·84in. |
| Gauge | 4ft. 8½in. |
| Height from top of rail to top of car | 11·4ft. |
| Diameter of car axles | 9·32in. |
| Play between car axle and sleeve on which rotor of motor is fixed | 2in. |
| Maximum seating capacity of car (passengers) | 40 |

In addition to the two primary and two secondary motors, each motorcar carries an air-compressor driven by a 6-h.p. induction motor, two water rheostats, four trolleys, and the controlling gear. The motors are controlled on the concatenation system, and the controller has normally only three positions—viz., "off," "half speed" and "full speed." The rheostat is in the rotor circuit of the second motor when the controller is at "half speed," and the normal position of the liquid is below the level of the plates. By means of an air-cock compressed air is admitted into the rheostat, causing the liquid to rise and thus decrease the resistance in the secondary rotor. When the resistance has been reduced to a certain limit, the rheostat is automatically short-circuited, and at the same time the level of the liquid is allowed to fall to its normal position. At half speed the secondary motor is cut out and the rheostat inserted in the rotor circuit of the primary motor. The same operations are followed, as in the previous case, whereby the primary motors are brought up to full speed. The ratio of transformation in the primary motors is 10 to 1, so that the rheostat is only subjected to 300 volts (the line voltage being 3,000).

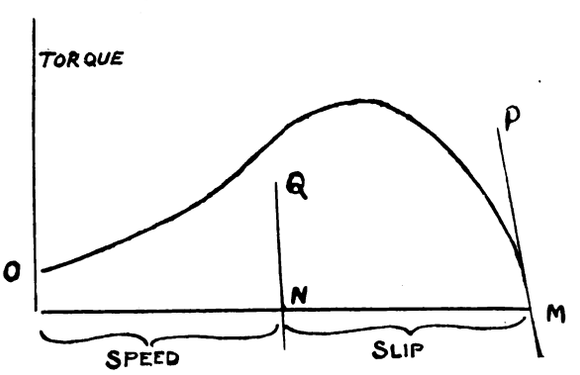
With regard to the motors, there is practically no difference in weight, design, and cost between the primary and secondary motors. The primary motors have six poles, and are rated to develop 150 b.h.p. each at 300 revolutions per minute, 3,000 volts, and 15 cycles per second. The ratio of transformation in the primary motor is 10 to 1, and in the secondary moter 1 to 1. The stator of the primary motor is always connected to the line (unless the trolleys be lowered), and the magnetising current amounts to six or seven amperes at 3,000 volts. The following data refer to the motors:

*Particulars of Motors.*

| | |
|---|---|
| Current per primary motor at 150 b.h.p. | 26 amperes |
| Current per primary motor at starting | 40 amperes |
| Starting current per motorcar (total weight of train 84 to 90 tons) | 70 to 90 amperes |
| Efficiency of primary motor at full load | 90 per cent. |
| Power factor of primary motor at full load | 90 per cent. |
| Power factor of primary motor at half load | 80 per cent. |
| Power factor of primary and secondary motors at maximum torque when concatenated | 70 per cent. |
| Weight of rotor | 2,420lb. |
| Weight of stator | 5,940lb. |
| Air-gap (distance between rotor and stator) | $\frac{5}{64}$in. (2 mm. |
| Diameter of rotor | 31·5in. |
| Horizontal pull with 46in. wheel at 300 revolutions per minute, 3,000 volts, 15 ⁓, per primary motor | 2,200lb. |
| Horizontal pull with one primary and one secondary motor concatenated, 150 revolutions per minute | 3,960lb. |

Hand-wound coils passing through tunnels are used both on stator and rotor. There are three slip-rings on each rotor, ¾in. apart and 1·18in. in width, 10 carbon brushes being used per ring for collecting the current. The rotor sleeve is connected to the car axle by a flexible coupling of the drag-link type, the latter being balanced by counterweights. It is claimed that by the use of this coupling the rotor, whilst running in fixed bearings, can drive the wheel, at the same time leaving the latter and the axle free to accommodate itself to the inequalities of the track.—A. D.

*Answer to No.* 650 (*awarded* 5*s.*).—First let us consider very briefly the principle underlying the action of the polyphase induction motor. By the action of the currents in the stator winding a rotary field is produced, the speed of rotation of this field for any particular stator being directly proportional to the frequency of supply. In the rotor windings an E.M.F. is produced of strength proportional to the relative speed of the field and rotor, if the strength of the rotating field remains constant. If the rotor windings are short-circuited, or connected to some external resistance, a current is produced in them which is proportional, and in phase with the E.M.F. induced, if the self-induction is negligible. Now, the torque on the rotor is proportional to the product of the current in the rotor windings and the strength of the rotating field. Hence, if we can assume the field strength constant, and the rotor self-induction of no account, the torque is directly proportional to the slip, and the curve connecting torque and speed would be some such straight line as P M in the accompanying diagram. These assumptions are practically correct for small rotor currents—*i.e.*, small slips—as then the disturbing effect of the rotor currents on the field strength is unimportant, and the magnetic leakage is small for the same reason, and hence the rotor self-induction is small. As the speed is reduced and the slip increased both




these assumptions cease to hold, the torque curve falls away from the line P M, and the actual curve connecting speed and torque will be of some such shape as O M in the figure, P M being tangential to O M at M. If the rotor revolve faster than the field the induced currents are such as to oppose this relative motion—that is, the torque is negative, or mechanical power is required to drive the rotor.

Now, with induction motors in tandem the frequency of the supply to the second motor depends upon the frequency of the generated E.M.F. in the first rotor, and this is obviously directly proportioual to the slip in the first motor, but the two motors are compelled mechanically to run at the same speed; hence, if the speed is greater than the slip, the second motor is running above synchronism and acting as a dynamo. Hence it is shown that the second motor will not tend to run above half the synchronous speed of the motors in parallel. Consider the case of the second motor running in synchronism with its supply. It is exerting no torque, consequently no current can pass—in fact, it has a back E.M.F. equal to the E.M.F. of supply. Now, in the diagram, so far, we have not considered the case of a rotor supplying current to a circuit in which there might be a back E.M F. When there is a back E.M.F. there can be no torque until the E.M.F. induced in the rotor is sufficient to overcome the external back E M.F. and produce a current, and a little thought will show that the torque speed curve for the first motor cuts the axis of speed at a point corresponding to half the speed for which the point M corresponds, for above this speed the second motor is running above synchronism, and the current in the first rotor, which must all pass through the stator of the second machine, cannot therefore possibly be in the right direction to produce a positive torque. In fact, the

* For a detailed account of the electrical equipment of this railway see the *Electrical Engineer*, April 10 and 17, 1903, vol. xxxi., Nos. 15 and 16, pp. 510 and 546.

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current producing torque in the first rotor is now proportional to the excess of the slip over speed, since the induced E.M.F. varies as the slip and the back E.M.F. as the speed of the second motor; hence the same reasoning which led us to obtain the line P M in the first case, shows that the new torque speed curve will be some such line as Q N. This is, of course, making the same assumption as before, and hence the line Q N is only correct quite close to N, just as P M is the asymptote to the curve O M. Hence we see that as less and less torque is required, the speed of the combination approaches more nearly to half the asynchronous speed of the motors in parallel. Of course, all losses in the second motor and the rotor of the first simply have the effect of preventing the torque ever sinking quite to zero while running as motors, and hence the speed never quite reaches the limit except when power is supplied externally, in which case the speed may be still further increased, and both machines act as dynamos. This property of the tandem combination is sometimes made use of to hold trains in check down inclines, the motors running as dynamos slightly above half speed and returning power to the system.—SUPERHEAT.

*Answer to No.* 650 (*awarded* 5*s.*).—To simplify matters, let us first consider the case of one induction motor only connected to the mains in the usual way, and see why it attains synchronous speed. When current is switched on to the primary, currents are generated in the secondary and a torque is thereby produced, and the motor starts. Further, it starts up with the ultimate intention, as it were, of revolving with the stator flux, because until this speed is reached currents are induced in the secondary, and, therefore, a torque exists which tends to accelerate the motor. Now, let us proceed to the case of the concatenation of two motors, which, by the way, will be most satisfactorily arranged by connecting the first rotor in series with the rotor of the second, because then the second motor will be working at its proper densities, and will, therefore, give the best results, especially at starting. Note, however, that if this is done, the connections between the different phases of the two motors should be so that the fluxes in them rotate in opposite directions with respect to one another. At the instant when current is switched on to this concatenated arrangement the frequency of current in the first rotor, and, therefore, frequency of supply to second motor, is the same as frequency from mains. Therefore, the second motor will also start up, with the intention of finally attaining synchronous speed. But as the motors get up speed the frequency of current in the first rotor is decreasing, and as this current is supplied to work the second motor, the ultimate speed of the second motor is decreasing. When the system has attained such a speed that the frequency corresponding to the rate of rotation—*i.e.*, $\frac{\text{Number of poles} \times \text{revolutions per second}}{2}$ — equals the frequency of the supply of the current from the first motor to the second, then no current is induced in the secondary part of the second motor, and therefore no power current (in contradistinction to magnetising currents necessary to develop fluxes to generate back E.M.F.'s) flows through the system. No torque is therefore produced at this speed, which is consequently the final speed attained by the combination. Let $n_0$ = frequency of supply; then synchronous speed (revolutions per second) $= \frac{2\ n_0}{p}$, where $p$ = number of poles. Let the final speed of the concatenated system be U revolutions per second; then frequency corresponding to this rate of rotation $= \frac{p\ U}{2}$. Therefore, frequency of supply to second motor at this speed $= n_0 - \frac{p\ U}{2}$, and this is the same as frequency corresponding to rotation of motor.

$$\therefore n_0 - \frac{p\ U}{2} = \frac{p\ U}{2}$$

$$\therefore U = \frac{n_0}{p} \text{—}i.e.\text{, half synchronous speed.}$$

When a load is put on the arrangement, it will slow up sufficient to let such a current flow as will produce half the necessary torque in each motor.—H. W. T.

## NOTE ON HARMONICS IN THREE-PHASE WORKING.*

BY WILLIAM TATLOW, ASSOCIATE MEMBER.

It is well known that any periodic curve can be represented as the algebraic sum of a system of sine curves consisting of a fundamental and a set of harmonics if the amplitudes and phases of the harmonics are suitably chosen—this is known as Fourier's theorem.

It is easy to show that the curves representing the pressure generated by an alternator cannot contain any even harmonics—that is to say, harmonics having twice or any even number of times the main frequency—for it is obvious that the positive and negative waves given by an ordinary alternator in which all the field poles are wound and have the same form must be identical in shape, since the positive half-wave is produced by the removal of, say, the north pole from being opposite the armature coil and the bringing up of the south pole into the same position, and the negative half by exactly the same process, except that the north pole replaces the south. Now, if one combines even harmonics with the fundamental, it is easy to see by inspection of the diagram that these cause the two half-waves to differ, since, if the even harmonic adds to the beginning of the first, or positive, half of the main wave, making it steeper, it will subtract from the first half of the negative wave, making it flatter, and thus the waves will be rendered unsymmetrical.

The wave of an alternator can therefore be represented by the following series of terms:

$$V = A \sin p\,t + B \sin (3\,p\,t + \theta_1) + C \sin (5\,p\,t + \theta_2) + \text{etc.},$$

where the even harmonics are omitted, V being the pressure given by the alternator at any time, $t$; A representing the maximum value of the fundamental E.M.F., and B, C, etc., the maxima of the harmonic pressures having three times, five times, etc., the fundamental frequency, and $p$ being $2\pi$ times the frequency. The introduction of $\theta_1$ and $\theta_2$ permits of the harmonic pressures not necessarily being zero at the time when the fundamental passes through its zero value.

Now, if we assume that the form and magnitude of the three pressure waves of a three-phase generator are identical, we can write them down as follows:

Phase 1—

$$V_1 = A \sin p\,t + B \sin (3\,p\,t + \theta_1) + C \sin (5\,p\,t + \theta_2) + \text{etc.}$$

Phase 2—

$$V_2 = A \sin \left(p\,t + \frac{2\pi}{3}\right) + B \sin (3\,p\,t + 2\pi + \theta_1) + C \sin \left(5\,p\,t + \frac{10\pi}{3} + \theta_2\right) + \text{etc.}$$

Phase 3—

$$V_3 = A \sin \left(p\,t + \frac{4\pi}{3}\right) + B \sin (3\,p\,t + 4\pi + \theta_1) + C \sin \left(5\,p\,t + \frac{20\pi}{3} + \theta_2\right) + \text{etc.}$$

Or simplifying,

$$V_1 = A \sin p\,t + B \sin (3\,p\,t + \theta_1) + C \sin (5\,p\,t + \theta_2) + \text{etc.}$$

$$V_2 = A \sin \left(p\,t + \frac{2\pi}{3}\right) + B \sin (3\,p\,t + \theta_1 + C \sin \left(5\,p\,t + \frac{4\pi}{3} + \theta_2\right) + \text{etc.}$$

$$V_3 = A \sin \left(p\,t + \frac{4\pi}{3}\right) + B \sin (3\,p\,t + \theta_1) + C \sin \left(5\,p\,t + \frac{2\pi}{3} + \theta_2\right) + \text{etc.}$$

It is obvious from the above equations that the harmonic pressures of three times (or multiples of three times) the main frequency are the same in magnitude and direction in all the three phases at any moment, whereas the fundamental and remaining harmonics differ by 120deg. in phase in each of the three phases. It follows at once that in a mesh-connected winding harmonic pressures of three times or three $n$ times the fundamental frequency will, if present, add together and drive idle currents round the mesh, while the fundamental and remaining harmonics form, on the other hand, balanced sets, the sum of the three pressures due to any of them taken round the mesh being zero at any moment.

In the case of a star-connected winding, these harmonics of the third order will tend to drive current into or out of the star point equally in all the three windings at any moment, and therefore they will be balanced, and as far as pressures between any pair of the three wires coming from the machine are concerned, harmonics of the third order are eliminated by the star connection, and should not appear in the pressure wave. They would, however, appear in the pressure wave

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, Jan. 28.

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taken between any of the three leads and the neutral point if they happen to be set up in the windings, and the waves of pressure between lead and lead and between any lead and the neutral point would differ in form.

Now, if the star point of the three-phase generator is earthed, as is commonly the case, and the three leads bringing current from the machine are in the form of a three-core lead-sheathed cable, these harmonics of the third order will give rise to a capacity current flowing to earth from the neutral point and charging the sheath of the cable; for it will be noticed on adding the three equations given above that the mean potential of the three cores is not zero, but a fluctuating quantity, given by

$$\frac{V_1+V_2+V_3}{3}=B \sin (3pt+\theta_1)+E \sin (9pt+\theta_4)+\text{etc.},$$

which will give rise to a capacity current depending on the capacity between the three cores taken together and the sheath. In the Dublin cables I understand that the capacity of the two cables in parallel, taken as above, amounts to approximately 1·5 microfarads, and one might expect the currents in the earth-wire of the star to be something of the order of one ampere if B=1-10 of A, or greater if E is present, as the latter will produce three times as great an effect as B for the same values, owing to its higher frequency.

Large currents have been observed in the earth-wire of the star system in Dublin which cannot be attributed to faulty insulation, and the above considerations have been arrived at in attempting to find a satisfactory explanation of these currents.

No doubt the results pointed out are familiar to those working with polyphase machines, but being new to the author, he thought they might also be of interest to some of the members of the Local Section now that three-phase current is available in Dublin.

The truth of the last deduction relative to the capacity current in the earth-wire of star could easily be tested by bringing a coil connected to a telephone near to the earth-wire and observing the pitch of the note in the telephone, and the author hopes to make this test shortly.

## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion sat again on Thursday and Friday last week at the Westminster Palace Hotel, the chairman, Sir David Barbour, presiding.

**Dr. T. B. Crosby,** an alderman of the city of London, said that in his judgment the introduction of tramways into the City at any part would necessarily enormously increase the difficulties which now had to be contended with, and should be strenuously resisted. He had no hesitation in condemning as unwise the proposal to run tramways over any of the Thames bridges, as more or less permanent obstruction would obviously ensue, the tramways being only suitable to wide thoroughfares where "give and take" locomotion was not needed. The City bridges were most unsuitable for tramways, and he was of opinion that omnibuses should as far as possible be excluded from the centre of the City, where they interfered with the pedestrian and the quicker vehicular traffic of cabs and carriages. He put in a plan by which he sought to show how the obstruction might be obviated by the construction of more tube railways bringing persons into and taking them from the City and directing the route of omnibuses in a circular form connecting these tubes one with another. His plan had been largely influenced by the desire not to increase the tax on the already overburdened ratepayer, but to leave to private enterprise the construction of suitable tubes or underground railways, and to omnibus companies the rearrangement of the omnibus traffic.

**Mr. W. R. Pryke,** chairman of the Bridge House Estates Committee, gave evidence in regard to the several bridges under the control and management of the Corporation. He declared strongly against the introduction of tramways. In four cases tramway lines were constructed close up to the City boundary—in Aldgate, Finsbury-pavement, Aldersgate-street, and Gray's-inn-road—affording facilities for persons desiring to go to the City.

**Mr. A. Murray,** surveyor to the Corporation of London, suggested that greater powers should be given to the local authorities to prevent the breaking up of streets in the City and other parts of the Metropolis.

**Captain J. W. Nott-Bower,** Commissioner of City Police, said the traffic in the City was steadily increasing. During the period between April, 1900, and March, 1902, the City was in a state of chaos owing to the number of main thoroughfares that were opened up at the same time by various authorities, in many cases two parallel streets being opened simultaneously, thus increasing the confusion. During this period New Bridge-street was broken up five times, and Upper Thames-street four times. Another grievance calling for redress was the practice of breaking up a street almost immediately it had been repaired at great expense. Although notices were now received by the police from the Post Office authorities of their intention to open manholes, it often happened that the men had actually been at work for hours before the notice was received, and in the case of the electric lighting companies no notice whatever of opening manholes and boxes was received by the police, notwithstanding that, owing to their position, serious inconvenience and obstruction were caused. Litigation was at the present time pending between the Corporation and the Post Office as to the powers of the police to deal with obstructions in the streets caused by the opening of these manholes, the Post Office contending that their employés, as servants of the Crown, were exempt from interference by the police. The companies also contended that the statutes regulating them overrode previous statutory enactments obtained by the Corporation. Regulations had been made by the Corporation prohibiting the opening of these manholes, except in case of emergency, between the hours of 8 a.m. and 8 p.m. In case of large undertakings being sanctioned in the future in the city of London, the police should be given power to regulate the order in which the streets should be broken up, and thus prevent a repetition of the trouble experienced in the past, and he regretted that the Bill promoted by the Corporation in 1902 for dealing with this question was not passed into law. Work should only be permitted to be carried on during the night, or, where a longer time was required, by day and night continuously, and he suggested that the same thing should be done with regard to ordinary repaving works and the temporary breaking up of streets. At present in a large number of places this work was carried on only during the ordinary working hours of the day. The suggestion of the representatives of the London County Council when promoting the Council's Tramway Bill last session—that the proposed tramway would relieve the traffic in Fleet-street and the Strand—he entirely disagreed with.

By Sir J. Dickson-Poynder, M.P.: His objection to the tramways did not so strongly apply to the outer belt of the City. His great objection to tramways over Blackfriars Bridge was owing to the density of the traffic and the obstruction they would cause. He did not see how the public would benefit much by trams over Blackfriars Bridge.

**Lord Ribblesdale:** It is a matter of common knowledge that the vast traffic in and out of the City as the terminus is very much interfered with by heavy vans and good traffic?—Yes.

As regards your objection to tramways, your view is that tramways and the heavy van traffic, which you cannot get rid of altogether, cannot get a *modus vivendi* in the City which would be satisfactory to you?—I think not.

**Mr. Frank Francis,** executive superintendent of the city of London police force, gave corroborative evidence, and expressed the opinion that the introduction of tramways into the City would be the means of adding a further serious element of obstruction to the City streets. The provision of further subways for pedestrians would practically amount to a waste of money, having regard to the very limited use made of those already existing, more particularly those in front of the Mansion House, where, if anywhere, they were a real necessity.

The Commission adjourned.

## FORTHCOMING EVENTS.

FRIDAY, JAN. 29.

**Institution of Civil Engineers** (Students' Section).—At 8 p.m., ordinary meeting. Lecture on "Metallurgy as Applied in Engineering," by Mr. A. P. Head.

**Institution of Mechanical Engineers.**—At 8 p.m., extra meeting. Discussion on "Sixth Report to the Alloys Research Committee on the Heat Treatment of Steel."

SATURDAY, JAN. 30.

**Electrical Engineers (R.E.) Volunteers.**—At 8 p.m., at headquarters, Bohemian concert; uniform, tunic or mess.

MONDAY, FEB. 1.

**Society of Engineers.**—At 7.30 p.m., ordinary meeting. Inaugural address by Mr. David B. Butler, president.

TUESDAY, FEB. 2.

**Institution of Electrical Engineers** (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Steam Turbines," by Mr. W. Chilton

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper to be further discussed: "The Sanding-up of Tidal Harbours," by Mr. A. E. Carey. Time permitting: "Tonnage Laws and the Assessment of Harbour Dues and Charges," by Mr. H. H. West.

**Faraday Society.**—At 8 p.m., ordinary meeting Papers: "Notes on Aluminium Welding" (illustrated), by Mr. Sherard Cowper-Coles; "Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another," by Mr. A. Hollard.

WEDNESDAY, FEB. 3.

**London Electrical Contractors' Association.**—At 6 p.m., Holborn Restaurant, ordinary meeting. Paper: "On the Rights and Liabilities of Electrical Contractors under the Electric Lighting and Other Acts," by Mr. R. Tweedy Smith. Supply companies' engineers are invited to attend.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the Plumstead Electricity and Destructor Station.

**Society of Arts.**—At 8 p.m., ordinary meeting. Paper: "Steam Cars for Public Service," by Mr. Thos. Clarkson.

THURSDAY, FEB. 4.

**Rontgen Society.**—At 8 30 p.m., discussion evening. Subject: "Production of Photographic Reversal through the Action of Various Radiations."

**Chemical Society.**—At 8 p.m., ordinary meeting.

SATURDAY, FEB. 6.

**Institution of Electrical Engineers** (Glasgow Section).—Second annual smoking concert.

**Glasgow Scientific Society.**—Twelfth anniversary dinner.

**Birmingham Mechanical Engineers.**—Ordinary meeting. Paper: "Prime Movers for Electrical Stations," by Mr. C. A. Smith.

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## THE JUNIOR ENGINEERS.

This institution has been exceedingly happy in its selection of presidents, and this year proves no exception to the rule, for J. Fletcher Moulton, Esq., K.C., F.R.S., M.P., although not an acting engineer, is so closely connected with the profession, and is so able a man, that any presidential address he might deliver could not help being interesting and useful. A long time ago a careful observer said that almost all improvements came from without; and while this is true in considerable measure, it is perhaps less true in some branches of engineering than in any other direction, but if we restrict our examination to electrical development it will be found to hold good generally. Davy, Faraday, Bell, Kelvin, Hughes, Daniell, Paccinotti, Galvani, to mention a few names, were not engineers in the ordinary sense, but each left his mark on the history of electrical development. We merely mention this to show that Mr. Fletcher Moulton needed no such excuse as his connection with engineering and mechanical science having been "that of a spectator watching" to warrant his selection to the presidential chair. His watching has been with a purpose, and the results obtained from that watching give the greatest possible interest to this address, which might be termed a lecture upon invention. None knows better than the learned author of this address how often an invention is reinvented, and he therefore lays great stress upon the value of the knowledge of what has been done before. "Invention has been busy in the past, and it has left to the inventor of to-day a rich heritage of knowledge, and while he has its help in his onward struggle he has also its responsibility." In most directions the invention of to-day is merely a step in the perfecting the elements of mechanism invented in the long-forgotten past. When, however, we come to speak of electrical inventions we have less history and greater concentration. They have been mostly within the memory of man, and they seem to have begun a new era in the history of the world. What the ultimate development will be the mind of the living man of science cannot conceive. He sees possibilities, but not yet how to achieve the ends sought. "The days when electricity was a thing apart, having no legitimate place in mechanical work, are gone for ever." The transmission of power within limits narrowed by gearing is no longer necessary. A wire seemingly playing no part in the operations, except getting heated, connects two sections of power plant miles apart, yet the turning of a switch or the pressure of a button brings into operation the whole apparatus. "And," says the president, "in the near future we have promise of still greater freedom. The Hertzian waves give us control at distances far beyond any mechanical needs, and already many inventors have schemed out how by their aid to direct and set in action torpedoes moving freely in the sea." It ought to be made clear here that, although schemes do exist, it is extremely doubtful if anything practical has as yet been devised. They are schemes, and nothing more. The first part of this address dealt with the equipment of the inventor, which includes all that has gone before; the latter and longer part dealt with the task of the inventor, which is really to do something which needs invention, and here we have the views of the expert. He concludes that "no definition of invention can be found which is of the slightest assistance to anyone in a case of difficulty." Of course, in a great number of cases no question arises as when "it involves a new cycle or a wholly new mechanism for accomplishing an old cycle," the difficulty comes in when "it consists of an improvement on old mechanism by the substitution of different but equivalent devices." Those

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who have to watch the Patent Office publications know that the moment an inventor has indicated a new departure, hundreds of professional inventors immediately try all manner of dodges to get round the original patent and arrive at the same result. Unlike the learned president, we do feel great sympathy with the unrewarded original inventor. It is he who gives the directive force to that particular field of invention, which too often is swept clean by a follower who would never have originated, but who can and does make practical what the originator left incomplete. The real inventor does not always lack patience, but more often money; few are like Babbage, with imaginative brains which outrun in conception the completion of any invention. We can merely call attention to a few of the points made in this address, and may fitly conclude with the advice it gives. The aim of an invention "is to enable mankind to do some new thing, or to do an old thing better or proper or more simply," and taking this view the author says: "Don't seek originality or change for its own sake. Have a single eye for efficiency, and be content with the work of others until you can surpass it, remembering always that well-trodden paths are easiest to follow, and that it needs some substantial gain to warrant your leaving them. But never lose the hope that you may be able at some time and in some way to help the advance of science by some contribution of your own which may merit in every sense the title of invention."

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### THE BRISTOL FIRE.

SIR,—Those engineers who remember what a high-tension switchboard was like before the introduction of the Ferranti single-pole cellular board will be thankful that the serious calamity at Bristol referred to in Mr. Clothier's recent report did not occur before the now generally recognised merits of this board were fully established. The system has been introduced into so many stations, and there have been so few breakdowns of a really serious nature, that it has been considered by many to be the acme of safety, simplicity, and reliability, and those of us who have expressed the opinion that there were some weak points in the design have been considered pessimistic faddists. There can now, however, be no doubt that very serious dangers do exist, and although it may be several years before another such outbreak occurs, those engineers who are responsible for systems similarly equipped are bound to realise their danger. That this is so is evident from the fact that from all parts of the country we hear of steps being taken to prevent such another catastrophe.

We must all admire the way Mr. Clothier has, in his report upon the breakdown, endeavoured to face and efficiently tackle the problem, instead of attempting to belittle and hush the matter up, as he might well have been excused for doing.

It is not my intention to say much about the general design of switchgear, but rather to confine my remarks to one or two paragraphs in Mr. Clothier's report respecting the use of protecting devices. I will, however, take this opportunity of expressing the opinion that the general principle of cellular construction is undoubtedly right, but to be sufficiently safe it must be carried much further than in the present standard Ferranti board. The divisions between the cells must be capable of resisting the attack of the severest arc imaginable.

The weakest feature of the present design is the cramping together of all the high-tension connections into so small a compass, with the result that, an arc having been once started, more or less complete destruction of the board followed as a natural consequence. The advantages of compact control are, of course, obvious, but although the operating gear may be confined to a small space, it should, I think, be arranged to control switches placed at a distance from each other and from the operating gear.

It is evident from the published reports of the Bristol breakdown that the origin of the trouble was the failure of one or more generator fuses. Whether the blowing of the fuse was due to a fault on a generator, to a loose connection in the fuse, or to mere deterioration of the fuse wire, will probably never be known. The one thing apparent is that if fuses had not been used in the generator circuits, the trouble would not have occurred.

It is now nearly 12 years since Mr. Raworth first pointed out the danger of using fuses in the generator circuits. Since that time the danger has been repeatedly referred to by different writers, and only a few weeks ago, Mr. Eborall, in his interesting series of articles in *Engineering* on switchgear, again drew attention to it.

The question now arises as to whether, if fuses are done away with, it is necessary to replace them by any other device. It is argued against such replacement that an attendant must be kept on the board, and he can instantly operate the switch controlling any generator that shows signs of failing. If the fault on the generator is a breakdown to earth, the noise and fireworks accompanying the failure will doubtless be ample indication as to which machine it is that is running amuck. But a generator may fail in several ways without giving any such visual or aural indication that it is behaving abnormally.

What, for instance, is more likely to occur than the interruption or short-circuit of the field current of the exciter of a separately excited alternator connected in parallel with others? This alternator, of course, becomes a short-circuit on the 'bus bars, and the first notification the switchboard attendant has of the trouble is a general drop of pressure across the main 'bus bars. He immediately looks at his ammeters to see the cause. The ammeter of the faulty machine will be hard over, because of the short-circuit current passing through it, but the ammeters of the healthy generators are now carrying the whole of the outside load in addition to the short-circuit current feeding the faulty generator, and as a consequence these ammeters will also be hard over. The pressure continues to fall, and the attendant looks anxiously at the generators for some further indication to guide him in his operations. To his great relief, he sees one of the generators smoking and instantly switches it out, reasonably imagining that it is the faulty generator. He finds, however, to his horror, that he has switched out one of the healthy machines that was doing more than its share of the work, and the burden upon the others is in consequence enormously increased. Nothing can now save the situation but a complete shut down and a fresh start, with all the delay of reparalleling and switching on of feeder sections one by one.

The next point to be considered is, should the discriminating device be used merely as a current-direction indicator, as I gather Mr. Clothier recommends, and the actual switching operations be left to the attendant, or should it be used to operate an automatic circuit breaker? It is probable that the radical alterations necessary to equip the majority of existing switchboards with automatic circuit breakers will deter engineers from considering the latter alternative. Where, however, new boards are being erected there is much to be said in favour of installing reverse-current circuit breakers, as is being done on the Continent and in the United States.

As Mr. Clothier explains, alternating-current discriminating cut-outs can be relied upon to effectually isolate any fault except a low-resistance short-circuit across the generator leads, but he should have added that under these very exceptional conditions the cut-out will not introduce any further elements of risk; it will merely remain inoperative, and the conditions will be the same as if the cut-out had not been installed—that is to say, it will be necessary to depend upon hand operation only. In the event of any other fault occurring, such as a failure of the generator field, a breakdown of the engine, or the flashing to pole-pieces of the armature, the cut-out will behave as required. If these cut-outs are made to operate on a reverse current

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of not less than 30 per cent. of the full-load current, it is not necessary to cut them out of action during synchronising operations.

Mr. Clothier suggests that if a discriminating cut-out possesses some time element, it is no better than a fuse in respect to the instantaneous isolation of the fault. This, however, is not the point. As he himself shows earlier in his report, the use of fuses on generator circuits is theoretically wrong, *because the fuses on the healthy generators are liable to blow before the fuse on the faulty generator.* That this does not always happen merely shows that fuses cannot be relied upon to always blow at the current they are set for. There is, however, another point in favour of automatically-operated cut-outs as compared with fuses. The blowing of a fuse is bound to volatilise a considerable quantity of metal, and this forms a highly conducting vapour, which tends to maintain the arc Although in many modern fuses this arc is in the majority of cases effectually extinguished, it is doubtful whether any design of fuse has yet been introduced that can be relied upon to do so under all conditions. Now, in a properly designed oil circuit breaker no metal is volatilised and no arc is formed.

I do not wish to convey the idea that the design of a reliable discriminating cut-out for alternating currents is by any means a simple matter. I have closely studied the behaviour of these interesting devices under actual working conditions for over nine years, and have at times almost despaired of surmounting all of the many difficulties that have from time to time arisen. The actual conditions under which these cut-outs have been tried include short-circuits on feeders, failures of engines, open circuits in field windings, etc. By investigating the respective conditions by aid of a Duddell oscillograph, we have been able to so modify the design of our cut-out release as to ensure its working under all conditions except that of a dead short across the generator leads.

The conclusions we have come to may be briefly summarised as follows: Alternating-current discriminating cut-outs cannot be relied upon to isolate a low-resistance fault on generator loads or on duplicate feeders. A cut out that will isolate a generator should it lose its field may fail to isolate a generator the engine of which has broken down, or *vice versâ*, unless the cut-out is specially designed to deal with both conditions. Some types of discriminating cut-outs will operate on a heavy forward current, and are in consequence no better than fuses. Some cut-outs that will operate on a small reverse current will fail to do so on a heavy reverse current, or *vice versâ*. Alternating-current discriminating cut-outs can be made that will under no conditions cut off a generator so long as it continues to supply current to the 'bus bars, but will isolate a failing machine immediately it tends to short-circuit the 'bus bars, whether the failure be due to a broken-down engine, a loss of excitation, or to an earth in the armature, provided such earth is not a very low-resistance fault on the terminal connected to an unearthed 'bus bar.

It is an interesting fact that so long as the supply was kept on at Bristol the pressure across the 'bus bars did not fall below 60 per cent. of normal pressure, although the 'bus bars were the whole time short-circuited by a most destructive arc.—Yours, etc., LEONARD ANDREWS.

## COAL CONSUMPTION IN CENTRAL STATIONS.

SIR,—It is a little bit rough on me, after devoting the past two years exclusively to the reintroduction of superheating into this country, that your reporter should misquote what I said upon the subject in the discussion that followed Mr. Giles's paper in Manchester on Tuesday last, to the extent of making me appear to have said that I thought "superheaters spoilt the users' chances of going to heaven!"

What I *did* say, was: In my opinion, the chief drawback to the more extended use of superheaters, was that the U-tube type of superheater now so commonly used in conjunction with Lancashire boilers has given considerable trouble owing to leakage at the tube-plate, and I added that I had come across users of this type of superheater who had been so seriously inconvenienced by leakage that when they got on to the topic of superheating "they were apt to endanger their chances of going to heaven." I then proceeded to point out that my firm (Messrs. Easton and Co., Limited, of Erith) had got out a down-take superheater on the Field tube principle, an extended experience of which has proved that it is absolutely free from this serious defect—viz., leakage.

In the unofficial discussion that followed the gastronomical function to which you also refer I was glad to find that the point I had raised was fully appreciated, and I feel sure that in justice to me you will find room for this correction in your next issue.

Far from being opposed to superheating, no one is more keenly alive to its advantages than I am, and I can claim to have had exceptional opportunities of ascertaining these advantages.—Yours, etc., G. D. SEATON.

49, Deansgate, Manchester, Jan. 22, 1904.

## NOTE HEADINGS.

SIR,—Under the headings of "Contracts for Electrical Supplies," "Results of Contracts," and "Business Notes," you publish every week a large number of short paragraphs which are of very great use to contractors and others engaged in electric lighting and power work. Each of these paragraphs is preceded by the name of the town, village, or other authority, in heavy type. The writer fully appreciates the care and trouble which you bestow on these paragraphs, but believe that if they can be made still more useful, you will be only too glad to make them so, even at the cost of a little more time and trouble.

Could you not place the name of the county after the name of the town or village? In some few cases this is done, but generally it is not. For instance, in the current issue, on p. 155, are two names (Rawmarsh and Heywood). The writer must confess to entire ignorance as to what part of England these two places are situated in, and doubtless there are others similarly situated who are equally ignorant as to their whereabouts. The writer has long been a reader of the *Electrical Engineer*, and trusts that his criticism will be accepted as a purely friendly one, and subscribes himself, Yours, etc., PURVEYOR.

[In the case of small places or of towns where there are more than one of the same name in the United Kingdom, we shall endeavour to follow "Purveyor's" suggestion.—ED., *E. E.*]

## PERSONAL.

Mr. E. Rotter, A.M.I.C.E., 47, Victoria-street, Westminster, and Pearl-buildings, Portsmouth, has taken into partnership Mr. T. Harison Jones, and the firm will in future be known as "Rotter and Jones." We are informed that Mr. Harison Jones has had large experience in tramways, mining, and power work in America.

In addition to the very handsome silver tea and coffee service presented to Mr. H. E. Blain by his colleagues in the tramways department on his retirement from the service of the Liverpool Corporation to take up the position of manager of the West Ham tramways, a further presentation, consisting of a beautiful canteen of plate and silver table centre ornament, subscribed by about 500 officials, was made to him on Monday.

Mr. H. D. Haigh, of Huddersfield, has been appointed manager of Psychiloid, Limited, Insulating Works, Love-street Sheffield, in succession to Mr. R. G. Mercer, A.M.I.E.E., who has resigned in order to take up an appointment with the British Westinghouse Manufacturing Company.

Mr. T. L. Boyden, who has been for more than nine years chief of the continuous-current dynamo department of the Electric Construction Company, Limited, of Wolverhampton, has been appointed general manager to the Lister Electric Manufacturing Company, and is taking up his duties forthwith.

**Electrical Engineers Volunteers.**—At the headquarters of the corps of Electrical Engineers (R.E.) Volunteers on Wednesday evening, Colonel W. Pitt unveiled the memorial that has been erected to the memory of the eight members of the corps who fell in the South African war. Colonel Crompton, who commanded the corps during hostilities, was present, and remarked that, although the men they had lost died not in battle but of disease, they had plenty of hard fighting to do, and they did it. It is an interesting fact that this corps furnished the largest number of men sent out to the war by a volunteer corps, the total complement of the various contingents being 319. After the unveiling ceremony the "Last Post" was played.

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## ST. MARYLEBONE LIGHTING.

An adjourned meeting of the Borough Council was held on Monday, the Mayor (the Rev. H. Russell Wakefield) presiding. The whole of the sitting, lasting nearly three hours, was occupied by a discussion on the electric lighting question, the proceedings being at times of a very heated character. The resolution in question was worded as follows: "That the Electric Supply Committee be empowered to enter into a provisional agreement on the lines of the letter of the General Electric Company of Jan. 19, 1904, either with them or any other firms of sufficient stability, and that such legal assistance as is necessary be employed." We give in full the correspondence above referred to:

"The General Electric Company, Limited,
"71, Queen Victoria-street, London, E.C.,
"Jan. 19, 1904.

"J. Wilson, Esq., town clerk, Marylebone Corporation.

"Dear Sir,—With reference to the interview which Mr. Clirehugh had with Mr. Ernest Debenham and Mr. Arthur Wright, we have now the pleasure of submitting to you a proposal in connection with your electricity scheme as follows:

"1. This company is prepared, subject to receiving the order for the plant and materials required, on terms as subsequently defined, to undertake the management of your electric lighting undertaking, and to guarantee the payment to your Corporation of the interest and sinking fund on your capital expenditure and on the amount to be paid under the award to the Metropolitan Electric Supply Company subject to the following conditions: (*a*) that this company shall take the entire management and responsibility and bear the whole of the expense incurred in the generation of current at your new generating station and its proper distribution to your customers, including the rendering and collecting of accounts and all management charges and expenses for a minimum period ending December, 1910; (*b*) during the said period the company shall be entitled to take all revenues derived from the undertaking arising from the sale of electricity, meter rents, etc.; (*c*) the company will, during the said term, pay to the Council a sum sufficient to meet the interest and sinking fund on the capital expenditure of the Council as it becomes due. Provided always that the Council borrow such money at a rate of interest not exceeding 3¾ per cent. per annum, and that the time for the repayment of the loan is spread over 42 years, and that the payment of the sinking fund on the new capital expenditure is deferred for three years.

"Provided also that every facility shall be given to the company for the purpose of investigating and verifying the accuracy of the data concerning the revenue now or hereafter to be derived from the Marylebone area, and that such investigation shall prove satisfactory to the company.

"Provided that an agreement is entered into by the Council satisfactory to the company, whereby the supply of electricity is obtainable at a price not exceeding 2·65d. per unit, until the new generating station is in a position to supply all the current required.

"(*d*) It shall be provided that if the amount received by the company from the sale of electricity, etc., shall after the payment of all expenditure and the recoupment to the company of all losses incurred in previous years, plus interest on such loans at the rate of 5 per cent. per annum exceed the amount of the interest and sinking fund, then the balance shall be divisible as follows:

"Two-thirds to the Council, and
"One-third to the company.

"(*e*) If by the end of the year 1910 the profits have not been sufficient to recoup the company for the amount which they have paid to the Council for the interest and sinking fund plus 5 per cent., then the company shall continue to manage the undertaking until such time as this result be achieved.

"(*f*) The Council shall undertake to take over from the company, when the company relinquishes the management, the whole of their staff, liabilities, etc.

"(*g*) The average price to be charged for electricity not to be less than that shown on the tables prepared by your consulting engineer, averaging 5¼d. per unit during the period under consideration, including meter rents, except with the consent of the company.

"2. (*a*) The company shall supply all plant, machinery, mains, etc., required by the Council during the period of its management, in accordance with the specification of Mr. Arthur Wright, the consulting engineer to the Corporation; (*b*) the price to be charged for the above material to be cost price, plus 10 per cent.

"It is, of course, impossible to embody every detail in the form of a letter, and the above proposal is subject to a proper contract being into and approved by the solicitors of the company.

"We trust, however, that we have made the main features of the proposition clear to you, and should your Council consider the matter favourably, we shall be glad to submit a full draft agreement to your consideration.—We are, yours faithfully, THE GENERAL ELECTRIC COMPANY, LIMITED (A. Byng, chairman).

"The British Westinghouse Electric and Manufacturing Company,
"Limited, Westinghouse Building, Norfolk-street, Strand,
"London, W.C., Jan. 19, 1904.

"Town Clerk, Marylebone Town Hall, Marylebone, W.

"Dear Sir.—We have carefully considered the proposed Marylebone electric installation as explained to us by Mr. Ernest Debenham, and more fully set forth in the letter addressed to Mr. Debenham by Mr. Arthur Wright on Oct. 19, 1903, and we shall be pleased to undertake to supply and erect the plant required up to the year 1906, as scheduled by Mr. Wright, for the sum of £449,260.

"We guarantee that the total cost of current, exclusive of capital charge and depreciation, shall not exceed the sum of 2·2d. per unit sold, based on an output of not less than 7,300,000 units per annum.—Yours faithfully, W. H. WELLS, manager."

At the beginning of the meeting the Mayor read the following letter from the secretary of the company: "Referring to your call on Saturday, when you communicated to me the request of the Borough Council that the company should consent to payment of the £60,000 due on 31st inst. being postponed until after the result of the poll of the ratepayers has been ascertained, I am instructed to say that, while the company will be pleased to assist the Council in the present position of matters by every reasonable means in their power, the directors think it would be improper to take any step to interfere with the carrying out of an order of the High Court." The Mayor then stated that the opinion of their own counsel, Mr. Buckmaster, was that there would be no contempt of court, and that whatever the feeling the judge might have about it, there was no personal contempt by their not paying the money by Jan. 31. It was very important that the Council should make up their minds whether negotiations with the company should still continue. He himself was strongly of opinion that they should. He had consulted counsel as to the consequences of their not paying the money, but he was doubtful whether at the present moment he ought to say what that opinion was. The Court would not move till the company moved, and the company had practically told him that they would not interfere.

It was eventually agreed that the negotiations should go on, the following two amendments having been lost: (1) "That the negotiations should be continued in order to ascertain if the company were prepared, in view of the result of the meeting at Queen's Hall, to make any proposals for compromising the award of the umpire"; (2) "That the Electric Supply Committee be empowered to enter into negotiations with the General Electric Company or other firm of sufficient stability as to the future management of the electric supply of the borough, and to report the result to the Council."

The question is to be further discussed at a special meeting of the Council on Monday next, but there is on the agenda for a special meeting, which was convened for last night, the following paragraph: "Electric Lighting—Payments to Metropolitan Electric Supply Company, Limited, and Messrs. Barlow and Barlow.—(1) To resume debate on motion: 'That the sum of £60,000 be paid to the Metropolitan Electric Supply Company, Limited, being the amount to be paid in pursuance of the order of the Court, and the sum of £25. 15s. 10d. be paid to Messrs. Barlow and Barlow, interest on amount of their costs from May 21 to June 12, 1903,' pursuant to following resolution passed by Council at their meeting on Thursday last: 'That the consideration of the question of the payments be adjourned until Thursday next, and that in the meantime the Mayor be requested to approach the company and ask for the payment to be deferred until the poll of the electors has been taken.'"

## APPOINTMENTS VACANT.

**Chief Assistant Electrical Engineer**, Croydon. £200. Applications by Jan. 30 See advertisement in former issue.

**Assistant Superintendents of Telegraphs**, Ceylon. Salary Rs.3,500, rising to Rs.5,000 by biennial increments of Rs 500. Applications to Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by Jan. 30.

**Electrical Superintendent** at Northumberland and Albert Edward Docks and Staiths. Salary £150 per annum. Applications by Jan. 30. See advertisement in last issue.

**Various Tramway Staff Appointments** at Leicester. Assistant Electrical and Mechanical Station Engineer, £160 per annum. Power Station Shift Engineer, 45s. per week. Switchboard Attendants, 35s. Engine Drivers, 34s. Engine Fitter and Spare Engine Driver, 34s. Foreman for Maintenance and Repair of Overhead Work, £2. 10s. Linesmen for Overhead Work, 35s. Chief Motor Inspector 45s. Motor Inspectors, 36s. Motor Instructors, 45s. Applications by Feb. 2. See advertisement in last issue.

**Electrical Fitter**, St. Giles Infirmary, Camberwell. Salary £1. 5s. per week, with board, lodging, washing, and uniform. Particulars from the Guardians' Offices, 29, Peckham-road, S.E. Applications by Jan. 30.

**Electrical Engineer** for small electric lighting station in country district. Apply to K., *Electrical Engineer* Office. See advertisement.

**Test-House Assistant** for large electrical engineering firm in the Midlands. Apply to No. 676, *Electrical Engineer* Office. See advertisement.

**Electrical Mechanic.** Apply to Box No 977, *Electrical Engineer* Office. See advertisement.

**Arc Lamp Trimmer.** Wages 30s. per week. Apply 11 a.m. on Jan. 30 to Engineer and Manager, 27, Osborn-street, Whitechapel, E. See advertisement.

**Junior Draughtsman.** Salary to commence 25s. Apply to Z. P. 866, care of Messrs. Deacon's, 154, Leadenhall-street, E.C. See advertisement.

**Borough Electrical Engineer and Tramways Manager,** Doncaster. Salary £300 per annum. The person appointed will be required to devote his whole time to service of Corporation. No one need apply who has not had large experience in working of both an electric light station and tramways. Applications by Feb. 9. See advertisement.

**Assistant** for mains department North London. Salary 30s. per week. Apply R S., *Electrical Engineer* Office. See advertisement.

**Improver** in company's light and power station Wages 10s. per week. Apply F 95, *Electrical Engineer* Office. See advertisement.

**Clerk, etc.,** West Ham Borough Council. Applications by Feb. 5. See advertisement.

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## TRADE NOTICES AND NOVELTIES.

### New "Ediswan" Leaflets.

From the Edison and Swan United Electric Light Company, Limited, we have received a further large budget of new leaflets. Firstly, there are four leaflets of electric light fittings, these being supplementary to the firm's catalogue, Section VI. Illustrations are given of some fancy pendants and table standards of new design, at prices which should bring them within the reach of the smallest users of electric light; also of some very ornamental modern styles of electroliers and floor standards. Electric lighting accessories are represented by leaflets Nos. A 2,016 and A 2,023, patent pear switches and "Safety" tumbler switches respectively. The pear switches are a distinct novelty; the old pressel bar movement having been abolished, and that of the well-known "Ediswan Wedge" tumbler switch substituted. These pear switches are made in two styles (see Figs. 1 and 2)—*e.g.*, with tumbler handle, or with sliding rod which operates the contact lever inside. They are a distinct improvement on previous types of pear switch, and are claimed to be absolutely reliable for high-voltage purposes, combining good contact and quick break with good insulation and arc-proof qualities. The "Safety" tumbler switch (Fig. 3) is a high-voltage all-china switch with a new movement ensuring a very long and quick break. Owing to its construction, "earth" troubles or shocks are an impossibility. It is provided with sunk terminals separated by a china bridge piece, and with conical loop-in holes. Leaflet No. B 2,020 illustrates the O.K. dry cell, which retails at a low price, and compares favourably, it is claimed, as regards efficiency, life, and behaviour under changes of temperature with more expensive cells of a similar nature. Leaflet No. 2,027 describes the "Ediswan" dynamo and motor brushes, comprehensive tables being given. Leaflets Nos. W 2,025 and W 2,026 are entitled "Ediswan" vulcanised flexible cords and C.M.A. flexible cords respectively, and buyers should find in these all their requirements in the direction of flexible cords. Leaflet No. H 2,028 describes "Ediswan" electric light carbons, which are claimed to be superior to any, giving maximum light, with no noise and no dropping of ash, and being suitable for any make of arc lamp. They are listed in many sizes, both cored and solid, for open and enclosed lamps.

FIG. 1.—Pear Switch with Tumler Movement operated by Handle.

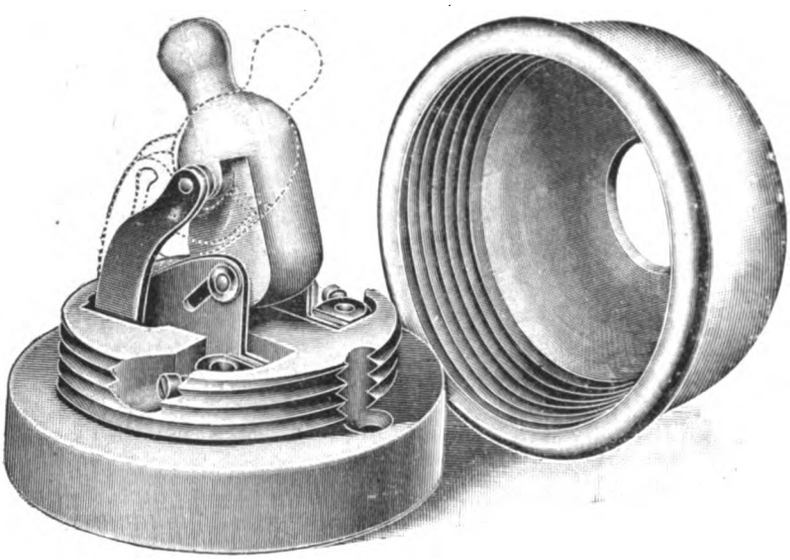

FIG. 3.—Safety Tumler Switch.

FIG. 2. Pear Switch with Tumler Movement operated by Pressel Bar.

### Cranes.

We have received from Messrs. Chambers, Scott, and Co. Dalziel Engineering Works, Motherwell, N.B., a copy of their 1904 pamphlet on electric overhead travelling cranes. The descriptive matter which this pamphlet contains is brief, but to the point, and some good illustrations are given.

### Carbon-Copper Brushes.

Messrs. the Crypto Works Company, Limited, 29, Clerkenwell-road, London, E.C., inform us that they are placing on the market a new carbon-copper brush. This brush is composed of copper, very finely divided, mixed with pure graphite, which very materially decreases the resistance, and at the same time reduces the wear on the commutator. The company have for a considerable time been using this type of brush on their own machines, and have found that the efficiency of the machines has been thereby improved, whilst the commutation has not suffered. The brush is made in two qualities—higher and lower specific resistance—to suit the requirements of different dynamo designers. Further information relating to this brush is contained in a circular just issued by the above firm. The same circular also deals with the pure carbon brushes supplied by them.

### Wires, Cables, etc.

From Mr. A. H. Hunt, 115-117, Cannon-street, London, E.C., who is acting as representative in this country for Messrs. Geoffroy and Delore, cablemakers, Clichy-la-Garenne, France, we have received a price list of wires and cables, of which latter he offers to forward samples cut from stock coils to show the quality of insulation and finish. High quality and exceptionally low prices are the inducements held out to prospective purchasers. We have also a list illustrating best English crystal cut globes from the same office.

### Incandescent Lamps.

The British Thomson-Houston Company, Limited, Rugby, have sent us a copy of their latest pamphlet dealing with B.T.H. Edison incandescent lamps. This publication includes a volume of information relating to incandescent lamps generally which users would do well to study. Particular attention is called to a 12-c.p. lamp which the company have recently introduced. It is designed for use on circuits of 200-250 volts, and has, we are told, proved very popular for many places where 8 c.p. is insufficient and 16 c.p. more than sufficient.

### Calendars.

We have received further calendars, etc., from Peckett and Sons, Atlas Locomotive Works, Bristol (speciality, tank locomotives). — Cox Walker's North-Eastern Electric Works, Darlington (speciality, switchboards).—McClure and Whitfield, Mersey Dynamo Works, Stockport. The new and thoroughly up-to-date works which have been erected by this firm, owing to increase of business, in Range-road, Adswood, Stockport, are now in full working order. In a neat and well-bound notebook for 1904 just received we note an inset giving description, prices, etc., of the "Mersey" multipolar type generator, from 30 kw. capacity; of protected-type "Mersey" dynamos and motors; and of "Mersey" two-pole over-type dynamos, the latter varying in size from 1 kw. to 24 kw.

## LEGAL INTELLIGENCE.

### GEIPEL'S PATENT FOR STEAM-TRAPS.

In the Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on Monday the hearing was concluded of an appeal from an order of Mr. Justice Buckley on a petition for revocation of Geipel's patent for steam-traps, and there was also a cross appeal by the patentee on the question of the terms on which he should be allowed to disclaim, his Lordship having found that the patent was involved in certain particulars. The patent had reference to steam-traps, an apparatus for automatically letting out the condensed water from hot-water pipes. Counsel stated that in the case of buildings heated by hot water the steam was constantly condensing, and if not got rid of the pipes would get blocked. The device by which Wm. Geipel's invention worked was founded on the differential expansive action of two metals which were heated by the steam. When the steam condensed the water got gradually cold and by the cooling of the pipe was discharged. Steam then was let in and expanded the portion which the water had cooled. There were other

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patents which utilised the expansion and contraction of the pipes for the opening and shutting of the valves automatically, and they had been attended with more or less successful results. Geipel's apparatus consisted of an upper and lower pipe fitted to the bottom of the hot-water pipes and joined together, so that with the expansion and contraction the point of junction moved up and down, and thus operated upon the valves. The upper pipe was made of brass and the lower of iron, and as brass expanded more than iron the effect of sending a current of steam through the two was that one got longer and the other shorter, and thus a considerable amount of motion at the point where they joined was obtained. Mr. Justice Buckley held that the patent was bad in two respects. First, that one of the figures attached to the specification in which the pipes were bent into a circle showed an arrangement that would not work, and, secondly, that a modification of the device shown in another figure, in which the triangular form was adhered to, but one of the legs was the tie-rod instead of a tube, was not within the provisional specification. The inventor accepted the first part of the decision, but challenged the second, and asked that it might be reversed.

For the petitioners, **Mr. C. H. Berry**, of Manchester, said it was submitted that at the date of the patent there were hundreds of steam-traps on the market, and several that depended upon the expansion and contraction of metal by the action of steam. The respondent appealed against that part of the order which imposed as a condition on which the patentee should be allowed to apply to the comptroller for the amendment of his claim that he should not ask for an injunction founded upon anything done from the date of the amendment, unless the Court in trying the subsequent action was of opinion that the specification was passed originally in good faith, and with reasonable skill and knowledge. For petitioners it was said that they had been making these traps for years. They took this action to protect their customers, and it was only reasonable for the Court to say that no action should be brought in respect of traps made before the judgment.

Their Lordships dismissed the respondent's cross appeal, and reserved judgment on the remainder of the case.

## BRITISH ACCUMULATOR COMPANY, LIMITED.

In the Chancery Division of the High Court of Justice on Friday Mr. Justice Kekewich had before him a motion by the British Accumulator Company, Limited, and the Allgemeine Accumulatorenwerke Actiengesellschaft to restrain Arnold Kramer from carrying on business of any description under the style or title of the British Accumulator Company, Limited, and from receiving and opening any letters addressed to that company. It also sought to restrain him from acting as manager and agent of the company, and claimed delivery up of the furniture, books, and other effects in the office at Victoria-street, Westminster.

**Mr. Warrington, K.C.**, who appeared in support of the motion, stated that the German company carried on the manufacture and sale of electric accumulators at Vienna. In 1902 they were minded to establish a branch of their business in London, and for that purpose they employed the defendant as their manager. The agreement set forth that the defendant undertook the management of the agency in London for the sale of accumulator batteries. Besides a salary, he was to receive 10 per cent. of the net profits of the London agency. The contract, it was further stated, could not be cancelled during the term of 18 months from the date on which it was signed. For the purposes of the branch business defendant took offices in Parliament-street, Westminster, the rent and furniture being paid by the plaintiff company. From the first it seemed to have been contemplated that eventually the British business would be turned into a limited company under the Act of 1862. In 1903 the British Accumulator Company, Limited, was incorporated, and a verbal agreement was made that the business and all the assets of the British Accumulator Company should be transferred to the limited concern. The defendant refused to hand over the books and the other assets, and on Dec. 19, 1903, a letter was written to him by plaintiffs' solicitors stating that they had been instructed to take all steps necessary to obtain a transfer of the effects of the company. Defendant called himself chief engineer and manager of the company, although he had been appointed to no position by the limited company. On Dec. 21, 1903, the defendant wrote to the Vienna company that they had been breaking the terms of the contract time after time, and that he considered it necessary to inform them that he regarded it as having come to an end. Defendant then made certain claims for compensation. Counsel, proceeding, read an affidavit by James Wilson, Wandsworth, in which it was stated that in December, 1903, he entered into a contract with the defendant on behalf of the British Accumulator Company for the erection of electric plant at Rickmansworth. A cheque for £50 in part payment of the account was given by him to defendant. Letters which he received from defendant were headed British Accumulator Company, and were signed "A. O. Kramer, managing director."

**Mr. Stewart Smith, K.C.**, for the defendant, read a long affidavit, in which Mr. Kramer set forth that the offices were taken in his name as the landlord was not willing to let them to a foreign company. Defendant was therefore presumably liable for the rent. He had never represented the business as his own, and had always been willing to transfer the office and furniture to the plaintiff company provided the company paid the rent due to the landlord and freed him from all personal liability. He had received accounts on behalf of the plaintiff company, but there was a considerable balance due by the plaintiff company to him. The learned counsel, in the course of further remarks, stated that there was a substantial counter-claim by defendant for wrongful dismissal.

After some discussion, it was agreed that the plaintiffs should give an undertaking to pay the rent due, and that the defendant should deliver to plaintiffs all furniture, fixtures, plant, books, contracts, papers, and other effects in the office in Parliament-mansions, Victoria-street. Further, that on sufficient undertaking being given by plaintiffs against a covenant contained in the agreement of tenancy, the defendant should deliver up possession of the premises to the plaintiff company.

**His Lordship** said the costs of the motion would be costs in the action.

## INJURIES FROM FALLING WIRES.

In the King's Bench Division last week the Corporation of Sunderland appealed from a decision of the local county court, under which a Mrs. Watson was awarded £25 damages for injuries. The case raised an important question as to the liability of owners of electric tramways on the overhead trolley system for injuries caused by falling wires.

The plaintiff was travelling with her daughter on one of the Corporation's tramcars, when, owing to the falling of a live wire, she received an electric shock, and was personally injured. The defence set up was that there was a weekly inspection of the whole system, and that the breaking of the wire had not occurred through any negligence. The Corporation had not failed in their duty, and therefore ought not to be held liable.

**Mr. Justice Wills**, in dismissing the appeal, said these overhead wires were not expected to tumble down of themselves, and if there was to be no liability for that kind of accident, Parliament would be very slow to grant the powers which it had granted. He thought it fair to conclude there must have been something wrong with the wire or the way it was fixed or joined. Therefore, the county court judge was right in letting the case go to the jury, whose verdict would be confirmed.

**Mr. Justice Kennedy** concurred, and the appeal was dismissed with costs, leave to appeal further being refused.

## SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER.

In the Court of Appeal, composed of Lords Justices Vaughan-Williams, Stirling, and Cozens-Hardy, on Wednesday, the case of Greenhouse *v.* the South Lancashire Electric Traction and Power Company, Limited, and others was heard, on a motion on behalf of the defendants to advance the hearing of this appeal.

**Mr. Hughes, K.C.**, in support of the motion, said the company had raised first debenture stock to the extent of £550,000. Recently it had become necessary to raise further capital for the purpose of the undertaking, and a scheme was prepared to which, of course, the assent of the debenture stockholders was necessary. It was required to be given in a particular way under the trust deed. Of the debenture holders who voted on this matter, £480 000 supported the scheme and £28,000 opposed it. The plaintiff represented the dissentients, and had brought an action to restrain the company from carrying out the scheme, and the Vice-Chancellor dismissed it without calling on the other side. The plaintiff had entered an appeal, but the trustees could not act on the resolution while the appeal was pending, and it was vital that the money should be raised without delay. Hence the present application.

Their Lordships directed that the appeal should be in the lists on the next day on which County Palatine appeals were taken.

## BRITISH ELECTRIC CAR COMPANY.

In the Chancery Division of the High Court of Justice on Tuesday the case of Sinclair *v.* the above company came before Mr. Justice Kekewich on a motion for judgment.

**Counsel** stated that the action was by a debenture holder. Mr. Justice Joyce had appointed a receiver and manager. There were a number of contracts which had to be carried out.

**His Lordship** made the usual order for accounts and enquiry in a debenture-holders' action, and continued the manager's appointment until July 31.

## SHIPWORTH v. NATIONAL ELECTRIC TRACTION.

On Saturday, in the King's Bench Division, Mr. Justice Grantham had before him the case of Shipworth *v.* National Electric Traction Company, Limited.

**Mr. Wootten** said this was an action for the return of £198. 1s. 6d., money paid by plaintiff to the defendant company for certain shares in the City and Surrey Electrical Railway Company. These shares had never been delivered; but an affidavit was put in under Order 14, in which it was asserted that other shares in lieu thereof had been delivered. That was not accurate, and there was no defendant present.

**Plaintiff** was called, and said he was a merchant in the City. In July, 1902, he paid the defendant company £200 for the shares. These shares had never been delivered. He had accepted no shares in lieu thereof, but he had received £1. 18s. 6d., for which he had given credit.

**His Lordship** gave judgment for the amount claimed, with costs.

## RYDE ELECTRIC LIGHT WORKS.

Last week, in the case of Knight *v.* the Isle of Wight Electric Light and Power Company, Limited, Mr. Justice Joyce, in the Chancery Divison, gave judgment.

**His Lordship** said that the plaintiff was the lessee for the residue of a term of 21 years, at a rent of £250, of a house and gardens in the borough of Ryde, and was carrying on there a high-class boarding school for young ladies. The defendants acquired some adjoining land on which they had erected plant for the supply of electrical energy for public and private purposes within the borough. The plaintiff complained of serious annoyance to the inmates of her establishment by noise and vibration of the defendants' works, and she instituted her

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action on Sept. 29, claiming an injunction and damages in respect of the alleged nuisance. The action was tried for several days during the Michaelmas sittings, and a large body of evidence was adduced before him. The result of it was that he saw no reason to doubt that at various times during the month of September and subsequently the works of the defendants were so carried on as to cause offensive smells and in some degree vibration, which occasioned serious interference with the ordinary comfort of the plaintiff and the inmates of her home and the carrying on of her business. Under the circumstances he thought the plaintiff was entitled to relief. The nuisance was not, in his opinion, trivial or of a kind to be expected from any ordinary and reasonable use of the land acquired by the defendants, nor was it by any means of a kind which would be complained of only by an unreasonable and fastidious person. No doubt since the commencement of the action the nuisance had been lessened by various expedients. The plaintiff had submitted to the inconvenience that arose from the mere construction of the defendants' works. What she complained of was what she had suffered and was from time to time suffering from—the working of the generating station and the operations there carried on, and which would continue to be carried on. He held it not to be an ordinary user of the defendants' property, or in any sense reasonable, if serious nuisance were occasioned to occupiers of adjoining property. On the whole, he held that the acts complained of from time to time and frequently up to the trial materially interfered with the ordinary comfort and enjoyment of the residence of the plaintiff, and, secondly, that these acts were of such a character as, having regard to the circumstances, were in excess of the natural and ordinary course of enjoyment of the plaintiff's property. The consequence was that there must be an injunction during the continuance of the plaintiff's lease to restrain the defendants from so working or permitting their engines, etc., to be worked, and from so carrying on the manufacture of electric light, as by the production of noise, noxious or offensive smells, or vibration, or otherwise to be or occasion an annoyance or nuisance to the plaintiff as lessee or occupier of the house, gardens, and premises comprised in her lease. He directed an enquiry as to damages, reserving the costs, and suspended the operation of the injunction for six weeks.

### TRAM AND 'BUS COLLISION.

In the King's Bench Division Mr. Justice Grantham and a special jury awarded a Mr. Phillips and his wife £2,500 damages and £430 expenses against the London General Omnibus Company and the London United Tramways Company. It appeared that plaintiffs were riding on a 'bus through the Chiswick High-road, when it was run into from behind by an electric tramcar. The 'bus was overturned, and Mr. and Mrs. Phillips sustained severe injuries.

### ASSESSMENT OF TELEPHONE WIRES.

At Dumbarton, before Sheriff-Substitute P. J. Blair, parties were heard in two appeals at the instance respectively of the National Telephone Company, Limited, and the Corporation of the city of Glasgow against the Town Council of Clydebank. The appeals, which raise an entirely new point, and one of considerable importance to both sides, had reference to the interpretation of Section 347 of the Burgh Police (Scotland) Act of 1892, which states: "The annual value of the following lands and heritages shall, for the assessment under this Act, be held to be one-fourth of the annual value thereof entered in said valuation roll"; and then, in specifying the lands and heritages referred to, says in Sub-Section 2: "All the underground gas and water pipes or underground works of any gas or water company or corporation." The appellants both possess underground telephone wires in the burgh of Clydebank, and they maintained the words in the sub-section "or corporation" extend the interpretation of the section so as to give them the benefit of the three-fourths reduction of the police assessments. The respondents, on the other hand, contended that the section of the Act must be construed literally, and that therefore it only applies to gas and water.

The Sheriff made avizandum.

## COMPANIES' MEETINGS AND REPORTS

### CENTRAL LONDON.

The report of the directors for the half-year ended Dec. 31 last states that the amount expended on capital account during the half-year was £44,226. Receipts from all sources of revenue amount to £175,235 and working expenses to £97,363, leaving a balance of £77,871 carried to the net revenue account. The number of passengers carried was 21,774,850, a decrease of 650,926. In the half year ended Dec. 31, 1902, the ordinary daily traffic was exceptionally increased by the attraction of his Majesty's Coronation and its attendant festivities. The workmen carried in the half-year were 3,012,210, being about 14 per cent. of the total number of passengers conveyed. After providing for interest on the debenture stock, the net revenue account shows an available balance of £116,504, including £10,426 reserved to meet the dividend on the deferred stock and £45,406 brought forward from last half-year. The directors recommend the declaration of the following dividends for the half-year: On the undivided ordinary stock at the rate of 4 per cent. per annum, on the preferred ordinary stock at the rate of 4 per cent. per annum, and on the deferred ordinary stock 4 per cent. per annum for the whole year. Reviewing the working of the Company's undertaking for the year 1903, the following résumé gives the financial result; brought forward from half-year ended December, 1902, £27,717; total net revenue, half-year June, 1903, £120,617; deduct debenture interest and dividend, etc., £64,785; and reserved for dividend on deferred stock, £10,426, leaving balance carried forward June 30, 1903, £45,406. Total net revenue half-year December, 1903, £134,755. Deduct debenture interest and dividend (including £10,426 reserved from June half-year), etc., £88,656, leaving balance unappropriated at Dec. 31, 1903, £46,078. The Board recommends that £10,000 be added to the reserve fund, increasing the latter to £30,800, and that the balance of £36,078 be carried forward. The additional sub-station at Bond-street is practically complete, and will be brought into service shortly. The large fan at Shepherd's Bush is now in regular working order, with the result that the air in the tunnels has been considerably improved. The new motorcars are also found to work satisfactorily. The Company have arrived at a final settlement with the Electric Traction Company, all points of difference having been submitted to and decided by the arbitrator, Sir Benjamin Baker.

### METROPOLITAN RAILWAY.

The report of the directors for the half-year ended Dec. 31 last states that total receipts for the half-year (deducting the Company's proportion of the revenue of the City lines and extensions) have been £438,657, and the expenses £207,779, leaving a profit of £230,878. The receipts show an increase of £12,347, and the expenses a decrease of £1,197. The directors recommend a dividend upon the ordinary stock for the past half-year at the rate of 3 per cent. per annum, carrying forward £21,294. The work of electrification is being proceeded with rapidly by the Company's engineering staff. The building of the power station at Neasden is practically completed and ready for the reception of the machinery, which is being constructed at the works of the British Westinghouse Electric and Manufacturing Company. The new reservoir adjoining the power station is filled, and the wells continue to show an ample supply of water. The building of the necessary sub-stations and the equipment of the permanent way are proceeding. Negotiations are in progress for the acquisition of the property in the neighbourhood of Baker-street Station required for the projected enlargement and improvement of that station. The new railway from the Company's line at Harrow to the town of Uxbridge is nearly completed, and it is expected that it will be opened for public traffic during the present half-year. At the meeting of the proprietors in January, 1892 the directors were authorised to contribute an annual sum of not more than £1,000 to the Railway Clearing House Superannuation Fund, on behalf of the Company's salaried officers and clerks. Owing to the increase since that time in the staff of the Company eligible to join the superannuation fund, it is necessary to extend the limit of the Company's subscription, and a resolution on the subject will be submitted to the meeting. A Bill is being introduced into Parliament in the coming session in which powers are sought to convert and consolidate the Company's debenture and preference stocks, and to raise additional capital to the extent of £750,000, with the usual borrowing powers mainly for the purpose of paying for the electrical equipment of the line. Various Bills affecting the interests of the Company have been deposited, and will be carefully watched by the Board. Gross receipts for passengers, goods, minerals, and tolls for 1903 amounted to £812,685, an increase of £20,644. The passengers carried totalled 94,000,150, an increase of 4,125,307.

### CALAIS TRAMWAYS.

The report of the directors for the past year states that, notwithstanding the unfavourable weather, the receipts show an increase of £188, and there has been a saving in expenses of £372, due chiefly to reduced cost of forage and to a smaller outlay upon maintenance. The net revenue account shows a balance of £1,773, out of which an interim dividend of ½ per cent. was distributed early in July, and the directors now propose the payment of a balance dividend of 1½ per cent., making 2 per cent. for the year, as against 1½ per cent. for 1902, and the transfer to reserve of £400 (increasing that fund to £2,830), leaving £428 to carry forward. The Company's application for an extension of their concession, and the conversion of their lines to electrical traction, is still under consideration by the authorities at Paris.

### MARCONI INTERNATIONAL MARINE COMMUNICATION.

The report of the directors for the year ended June 30 last states that the chief efforts of the Board have been directed towards obtaining a permanent basis for profitable business in the future, and a very considerable further extension of the operations of the Company has resulted. This extension has been principally in connection with the equipment of further ships, the coast stations mentioned as available for communication in last year's report having served for a great part of this increased shipping traffic. Preparations have, however, been made for a wireless service on new routes other than the Atlantic, and to this end nine new coast stations have already been equipped, and there are on order 14 further coast stations. The opening of these stations will, it is thought, result in profitable contracts with lines of ships voyaging on these routes. In particular is mentioned a contract, now practically concluded, relating to the equipment of a whole fleet taking the Mediterranean route. Other important ship contracts are in negotiation. The stations which have been erected, or are in course of erection, by this Company and its associated companies, which include also Lloyd's stations, over which this Company has exclusive rights for wireless telegraph purposes for 14 years from Sept. 26, 1901, number 54. An arrangement has recently been made with Reuter's News Agency for the regular transmission through the Company's stations to vessels fitted with the

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Marconi system of Press telegrams. Even at the present time the Company is deriving a considerable profit from this business, although the range of transmission has been limited. When the latest and highly successful results obtained by Mr. Marconi in his long-distance experiments are applied to coast stations, and a daily wireless news service can be maintained throughout the Atlantic voyage, this branch of the business will, it is confidently anticipated, prove a very large source of revenue. An agreement has recently been concluded with the Government of Newfoundland for the installation of a number of stations on the coasts of Newfoundland and Labrador, which will begun in the spring. These stations will be available for ships equipped with the Marconi apparatus. Mr. Marconi has been busily engaged throughout the year in perfecting apparatus for long-distance communications, and for the purpose of testing improvements in the apparatus, and as a demonstration to independent persons of its capabilities, in his voyage across the Atlantic in August on board the "Lucania," and in a voyage on H.M.S. "Duncan" to Gibraltar in October, messages were transmitted to the ships throughout their passages. The profit and loss account shows a debit for the year of £14,960.

## EAST LONDON RAILWAY.

The half-yearly general meeting of this Company took place on Tuesday at the Cannon-street Hotel, the Hon. A. E. Gathorne-Hardy presiding.

The **Chairman,** in the course of his speech, said three factors seemed to point to possible advantage to their undertaking—the improving goods and coal traffic, the Royal Commission now engaged on the question of the development of railways and tramways in the Metropolis, and the question of electric traction. With regard to the last-mentioned point, the deadlock between the Metropolitan and District and the other leasing companies still continued. As chairman of the East London Company, he (the chairman) held no brief for the lessees. He was only anxious that the improvement should be carried out. All probabilities pointed to the suburban parts of all metropolitan lines being electrically worked before long, and in that case all who used the installation would bear their proportion of the cost. It did not seem to him an unreasonable proposition that in the first instance those who desired to use the line electrically should bear the cost. If the installation was made, the only benefit it could confer on the companies not using the electrical method of traction would be that they would get their proportion of 44 per cent. of the increased traffic towards their loss on working expenses. He agreed, however, with the underground companies that if they electrified their line and not the East London Railway, the present method of working would really become impossible. The legal position was this: Although no individual company could be compelled to work, the lessees as a body were under the obligation to maintain and work the line, and if the present method of working became impossible, the joint committee would have to devise a new method, and the two underground companies would have to provide one-third of the cost of establishing some new and efficient method of working the line. Those companies' proportion of the loss on working would be augmented by any loss of traffic consequent upon the new method of working to the extent of their third share of the 44 per cent. received for working expenses. The Metropolitan and District Companies would also experience other disadvantages. He believed, however, that the East London Railway would soon be electrified, and he knew that experimental cars had been run over their line by the underground companies to see how they could be worked. The worst that could happen to the East London Company—which he did not in the least anticipate—would be a temporary stopping of working while the various lessees were adjusting their differences. This would be far more serious for the lessees than for this Company, who would still receive their fixed rent of £30,000, and a public outcry would certainly follow, which would call attention to the anomalous condition of affairs, and would lead to parliamentary and judicial intervention.

## EASTERN TELEGRAPH

The half-yearly general meeting of the shareholders of this Company was held on Wednesday at River Plate House, E.C., under the presidency of Sir John Wolfe Barry, K.C.B.

The **Chairman,** in moving the adoption of the report (which appeared in our last issue), complained of the competition to which cable companies were subjected by the subsidised Pacific cable. Alluding to a decrease in the income from the Cape joint purse, Australian, and China, Japan, and Manila traffics, he said the falling off was partly accounted for by a reduction of rates for South Africa. Although the volume of messages had increased, a much larger development must take place before the Company was recouped for the reduction of charges. The traffic with Australia showed a considerable falling off, owing to what might be justly described as the unfair and unstinted competition of the British Government Pacific cable, but the loss of revenue was no more than the Company had anticipated. He held the view that the policy of establishing State-aid competition with a commercial undertaking, especially when that undertaking had served the State as well as the Eastern Telegraph Company had done, was an unsound one. In this case it had proved unprofitable to the State and a most serious discouragement to commercial cable enterprise. The establishment of this Government cable could only be justified on strategic or Imperial grounds; but, supported by the home and Colonial Governments, it had become an active and unfair competitor with British commercial interests. Those interests should be considered identical with the interests of the Empire, and should not be opposed with taxpayers' money. He did not think anything could be more suicidal for a great country than to employ its funds in checking private effort. The action of the Government in competing for Australian traffic was such a discouragement for all commercial enterprises that if it had taken place 30 or 40 years ago, the world would not be enjoying anything like the present amount of telegraphic and cable communication. It was surely an anomaly that they should be obliged to contend against British as well as foreign subsidised cables at a time when so much was being said as to the necessity of encouraging British and Colonial enterprise on account of foreign competition. The Indian, Egyptian, and Turkish receipts had risen, and there was a substantial increase in the traffic with Aden, due to the heavy Government and Press cablegrams arising from the trouble in Somaliland. As the result of the half-year's working, after providing for debenture interest and the usual quarterly dividends on the preference and ordinary stock, they were able to place £127,000 to reserve, and to carry forward £33,000.

The report was adopted.

## CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

The report of the directors for the year ended Dec. 31, 1903, records satisfactory results of the year's trading in both their West-end and City areas of supply. Speaking of the West-end undertakings, the report says that, notwithstanding the fact that several large premises to which supply has hitherto been given have been demolished in connection with the County Council and other improvements, the number of lamps added is 55,326, exceeding by nearly 21,000 lamps the number added in 1902. The engineer-in-chief certifies that the plant and machinery have been maintained in a high state of efficiency. The total mains now laid amount to 221 miles. The revenue from sales of current for 1903 amounts to £110,083. 12s. 2d. The balance of the net revenue account is £53,890. 4s. 2d.; £14,000 was distributed as interim dividend at the rate of 8 per cent. for the half-year ended June 30, 1903. There remains a sum of £39,890. 4s. 2d., which the directors propose to deal with as follows: dividend on 4½ per cent. preference shares apportioned to Dec. 31, 1903, £15,750; to pay a dividend at the rate of 12 per cent. for the half-year ended Dec. 31, 1903, on ordinary shares, making, with the interim dividend paid in August, 1903, 10 per cent. for the whole year, £21,000; and to carry forward £3,140. 4s. 2d. As regards the City undertaking the distributing station buildings in Beech-street, Barbican, have been completed, and machinery is being installed there. The total mains now laid amount to 215 miles. The plant and machinery have been maintained in a high state of efficiency. There have been connected up to the City mains during the past year 91,384 additional 8-c.p. lamps, making, with 150,729 lamps connected at December, 1902, a total of 242,113 lamps. The progress of the business has more than realised the expectation of the directors. The gross revenue from sales of current during the year amounted to £56,036. 8s. 11d., or over 100 per cent. more than the gross revenue obtained in 1902. The net revenue account shows a profit of £11,499. 11s. 1d. The 4½ per cent. preference shares dividend to Dec. 51, 1903, guaranteed by the Corporation's West-end undertakings has been paid. The extension of the Company's business renders it necessary to increase its capital. The directors who retire by rotation are Mr. W. F. Fladgate and Mr. Stefano Gatti, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

*West-end Accounts.*

REVENUE ACCOUNT.

| Dr. Generation of Electricity. | £ | s. | d. |
|---|---|---|---|
| Coal or other fuel | 16,823 | 10 | 3 |
| Oil, engine-room, and station expenses | 1,755 | 9 | 8 |
| Proportion of salaries of engineers, etc. | 1,455 | 0 | 9 |
| Wages and gratuities at stations | 6,704 | 17 | 4 |
| Purchase of current in bulk | 7,690 | 1 | 5 |
| Repairs and maintenance—Buildings | 693 | 11 | 0 |
| Boilers, engines, dynamos, motors, etc. | 4,429 | 18 | 9 |
| Accumulators and accessories | 1,034 | 11 | 5 |
| **Distribution of Electricity.** | | | |
| Proportion of salaries of engineers, etc. | 1,542 | 15 | 5 |
| Wages, etc., linesmen, fitters, labourers | 199 | 0 | 0 |
| Repairs, etc., and renewals of mains | 3,926 | 5 | 1 |
| Repairs, etc., renewals of meters, etc., on consumers' premises | 1,199 | 14 | 3 |
| Wayleaves and licenses | 1,339 | 5 | 9 |
| Public lighting maintenance | 884 | 18 | 9 |
| Rents, rates, taxes, and insurances | 6,938 | 12 | 1 |
| **Management Expenses.** | | | |
| Directors' remuneration | 1,050 | 0 | 0 |
| Salaries of secretary, accountants, clerks, etc. | 3,932 | 15 | 0 |
| Stationery and printing | 385 | 10 | 4 |
| General establishment charges | 741 | 9 | 5 |
| Auditors of Company | 75 | 0 | 0 |
| Auditor under provisions of order | 85 | 0 | 0 |
| Law costs and expenses | 735 | 11 | 5 |
| Accident compensation claims | 559 | 5 | 4 |
| Depreciation—buildings, plant, machinery, etc. | 10,000 | 0 | 0 |
| Total expenditure | 74,182 | 4 | 3 |
| Balance carried to net revenue | 39,111 | 16 | 7 |
| | £113,294 | 0 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current, less rebates allowances | 110,083 | 12 | 2 |
| Rentals of meters, etc., on consumers' premises | 2,546 | 18 | 10 |
| Transfer fees and sundry receipts | 221 | 17 | 5 |
| Rents receivable | 441 | 12 | 5 |
| | £113,294 | 0 | 10 |

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BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 1,078,000 | 0 | 0 |
| Sundry creditors | 41,680 | 2 | 5 |
| Net revenue account—balance at credit thereof, less preference and interim dividends | 24,140 | 4 | 2 |
| Depreciation fund account | 65,000 | 0 | 0 |
| Leaseholds depreciation fund account | 20,000 | 0 | 0 |
| Share premium account | 83,855 | 4 | 10 |
| Debenture premium account | 3,933 | 11 | 2 |
| Reserve fund (capital) account | 30,000 | 0 | 0 |
| | £1,346,609 | 2 | 7 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended | 923,814 | 2 | 10 |
| Stores on hand | 11,574 | 19 | 7 |
| Freehold premises not used by the Company | 7,145 | 18 | 2 |
| Leasehold premises not used by the Company | 468 | 16 | 0 |
| Sundry debits | 35,575 | 19 | 11 |
| Cash at bankers and in hand | 7,529 | 6 | 1 |
| Investments in Charing Cross and City Electric Company, Limited—Debentures, 5 per cent. | 160,500 | 0 | 0 |
| Ordinary shares | 200,000 | 0 | 0 |
| | £1,346,609 | 2 | 7 |

The Company undertook to make up any deficiency in the dividends on £200,000 of £4½ per cent. City undertaking preference shares, 1901 issue, until Dec. 31, 1903, and has advanced £5,044. 10s. 2d. for the purpose; it has also guaranteed the dividend on £200,000 further 4½ preference shares City undertaking until June 30, 1906.

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Quantity generated or bought in B.T. units | | | 10,527,639 |
| Quantity sold | Public lamps | 293,104 | 7,392,791 |
| | Other sales | 7,099,687 | |
| Quantity used on works | | | 2,757,527 |
| Total quantity accounted for | | | 10,150,318 |
| Quantity not accounted for | | | 377,321 |
| Number of public lamps | | | 113 |
| Total maximum supply demanded (kilowatts) | | | 4,284 |

*City Accounts.*

REVENUE ACCOUNT.

| Dr. Generation of Electricity. | £ | s. | d. |
|---|---|---|---|
| Coal and other fuel | 11,696 | 5 | 3 |
| Oil, engine-room, and station expenses | 474 | 15 | 10 |
| Proportion of salaries of engineers, etc. | 931 | 6 | 4 |
| Wages and gratuities at stations | 4,635 | 17 | 10 |
| Purchase of current in bulk | 1,063 | 0 | 11 |
| Repairs and maintenance—Buildings | 100 | 18 | 9 |
| Boilers, engines, dynamos, motors, etc. | 514 | 19 | 8 |
| Accumulators and accessories | 1,211 | 2 | 0 |
| Distribution of Electricity. | | | |
| Proportion of salaries of engineers, etc. | 931 | 10 | 0 |
| Repairs, etc., of mains | 2,345 | 6 | 8 |
| Repairs, etc., of meters, switches, fuses, etc., on consumers' premises | 387 | 10 | 7 |
| Wayleaves and licenses | 111 | 17 | 8 |
| Rents, rates, taxes, and insurances | 5,278 | 2 | 3 |
| Management Expenses. | | | |
| Directors' remuneration | 525 | 0 | 0 |
| Salaries of secretary, etc. | 3,954 | 10 | 2 |
| Stationery and printing | 279 | 10 | 3 |
| General establishment charges | 846 | 2 | 5 |
| Auditors of Company | 30 | 0 | 0 |
| Law costs and expenses | 500 | 4 | 11 |
| Contribution to electrical inspector's salary | 200 | 0 | 0 |
| Total expenditure | 36,018 | 1 | 6 |
| Balance taken to net revenue account | 21,700 | 18 | 9 |
| | £57,719 | 0 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sales of current, less rebates and allowances | 56,036 | 8 | 11 |
| Rental of meters, etc., on consumers' premises | 1,648 | 11 | 4 |
| Transfer fees and sundry receipts | 34 | 0 | 0 |
| | £57,719 | 0 | 3 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 1,106,400 | 0 | 0 |
| Sundry creditors | 24,656 | 8 | 8 |
| | £1,131,056 | 8 | 8 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 960,800 | 2 | 7 |
| Stores on hand | 1,074 | 14 | 10 |
| Investment in 5 per cent. debentures of the Charing Cross and City Electric Company, Limited | 139,500 | 0 | 0 |
| Preliminary expenses | 1,358 | 9 | 6 |
| Sundry debtors | 23,654 | 6 | 8 |
| Cash at bankers and in hand | 3,889 | 1 | 7 |
| Balance of net revenue account | 779 | 13 | 6 |
| | £1,131,056 | 8 | 8 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | |
|---|---|
| Quantity generated or bought in B.T.U. | 7,274,568 |
| Total sold | 5,033,880 |
| Quantity used on works | 1,961,080 |
| Total quantity accounted for | 6,994,960 |
| Quantity not accounted for | 279,608 |
| Total maximum supply demanded (kilowatts) | 5,713 |

## GREAT NORTHERN AND CITY RAILWAY.

The report of the directors for the half-year ended Dec. 31, 1903, states that the railway between Moorgate-street and Finsbury Park is now practically completed, and for some time past a service of trains has been running experimentally almost daily. The line will be opened for public traffic between these two points when the necessary certificate from the Board of Trade has been obtained. The underground work for the new station at Highbury is well advanced, and the extensions from Moorgate-street to the Bank at Lothbury will be proceeded with as soon as possible. The sanction of the proprietors will be asked for a Bill in the next session of Parliament, which merely seeks for an extension of time for the completion of a small portion of the line at the south end of Moorgate-street Station. At the conclusion of the Wharncliffe meeting a train will be in readiness at Moorgate-street Station to run to Finsbury Park Station and back, and shareholders are invited to take this opportunity to inspect the undertaking.

## DUBLIN UNITED TRAMWAYS.

The report of the directors for the half-year ended Dec. 31 last, together with the accounts of the Dublin United (Old) and the Dublin Southern District Companies, states that the amount available for division is £48,950, out of which dividends for the half-year are recommended at the rate of 6 per cent. per annum on the preference shares and at the rate of 6 per cent. per annum on the ordinary shares. A sum of £4,000 has been placed to credit of reserve fund, £2,000 to maintenance during the current half-year, and £1,000 to an accident insurance fund.

## CITY AND SOUTH LONDON RAILWAY.

The report of the directors for the half-year ended Dec. 31, 1903, states that the receipts from all sources for the past half-year have amounted to £75,811, and the cost of working has been £36,284. 4s., leaving a profit of £39,526. 16s. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £41,026. 16s. 11d. After making provision for the debenture stock interest, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £28,296. 10s. 4d. Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896, and 1901, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £746. 10s. 4d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway:

| Half-year ended | Number of passengers (exclusive of season-ticket holders). | Receipts (including season tickets). |
|---|---|---|
| Dec. 31, 1890 (11 days) | £165,000 | £1,568 3 9 |
| June 30, 1891 | 2,412,343 | 19,403 6 9 |
| Dec. 31, 1891 | 2,749,055 | 19,798 16 6 |
| June 30, 1892 | 2,813,163 | 20,931 4 2 |
| Dec. 31, 1892 | 3,117,602 | 22,002 17 5 |
| June 30, 1893 | 3,146,656 | 23,458 6 9 |
| Dec. 31, 1893 | 3,093,351 | 22,067 14 10 |
| June 30, 1894 | 3,383,154 | 23,564 10 6 |
| Dec. 31, 1894 | 3,275,649 | 23,540 12 4 |
| June 30, 1895 | 3,113,199 | 23,711 5 8 |
| Dec. 31, 1895 | 3,172,438 | 23,780 3 7 |
| June 30, 1896 | 3,192,672 | 24,021 13 0 |
| Dec. 31, 1896 | 3,368,480 | 25,456 6 9 |
| June 30, 1897 | 3,437,810 | 26,403 3 6 |
| Dec. 31, 1897 | 3,337,861 | 25,472 12 10 |
| June 30, 1898 | 3,478,977 | 26,356 16 4 |
| Dec. 31, 1898 | 3,462,814 | 26,319 14 10 |
| June 30, 1899 | 3,540,098 | 26,749 3 0 |
| Dec. 31, 1899 | 3,442,942 | 26,197 14 10 |
| June 30, 1900 | 4,169,717 | 33,608 2 3 |
| Dec. 31, 1900 | 5,018,842 | 44,716 3 11 |
| June 30, 1901 | 5,887,786 | 51,013 17 3 |
| Dec. 31, 1901 | 7,008,842 | 59,734 14 8 |
| June 30, 1902 | 9,192,120 | 76,843 12 3 |
| Dec. 31, 1902 | 9,877,199 | 82,131 7 1 |
| June 30, 1903 | 9,511,450 | 78,384 19 9 |
| Dec. 31, 1903 | 8,711,062 | 72,286 3 6 |
| Total since the opening of the line | 117,080,281 | £928,524 8 0 |

The directors regret that the receipts of the line during the past half-year show so considerable a decrease as compared with the corresponding period last year, but it must be borne in mind the receipts during that period were abnormally increased owing to the interruption of the tramways while under reconstruction for electric working, and also to the increased traffic due to the ceremonies in connection with the Coronation. Apart from these sources of revenue, the general traffic of the line has been maintained, and is slowly but steadily recovering from the competition of the electric tramways. It has been found

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necessary to reduce the fares over some portion of the line; also to popularise the issue of season tickets both by reducing their cost and issuing them for shorter periods. It is expected that the Great Northern and City Railway will be open for traffic early in February. The negotiations are proceeding with the various railways interested as to the nature of the works and other arrangements in connection with the extension to King's Cross, St. Pancras, and Euston. When these are settled, the directors will have to consider the best mode and the most opportune time for raising the necessary capital.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Maintenance of way, works, and stations | 1,686 | 17 | 3 |
| Locomotive and generating power | 10,964 | 9 | 1 |
| Carriage repairs | 1,258 | 18 | 9 |
| Traffic expenses | 16,153 | 12 | 6 |
| General charges | 2,984 | 10 | 3 |
| Law charges | 58 | 12 | 11 |
| Rates and taxes | 2,962 | 6 | 5 |
| Passenger duty | 214 | 16 | 10 |
| | 36,284 | 4 | 0 |
| Balance carried to net revenue account | 39,526 | 16 | 0 |
| | £75,811 | 0 | 0 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Passengers | 68,397 | 18 | 10 |
| Season tickets | 3,888 | 4 | 8 |
| Parcels, etc. | 415 | 15 | 2 |
| | 72,701 | 18 | 8 |
| Transfer fees | 40 | 0 | 0 |
| Rent of property, etc. | 2,924 | 9 | 6 |
| Sundry receipts | 144 | 11 | 10 |
| | 75,811 | 0 | 0 |

| Dr. GENERAL BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Balance from net revenue account | 28,296 | 10 | 4 |
| Unclaimed interest and dividends | 169 | 17 | 3 |
| Interest payable or accruing and provided for | 3,581 | 12 | 11 |
| Sundry outstanding accounts | 12,457 | 0 | 6 |
| Contractor's retention fund | 600 | 14 | 1 |
| Renewal account | 2,233 | 12 | 8 |
| Temporary loans | 15,000 | 0 | 0 |
| | £62,339 | 7 | 9 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Cash at bankers, current accounts, and on hand | 7,790 | 16 | 5 |
| General stores | 9,546 | 0 | 11 |
| Sundry outstanding accounts | 2,725 | 10 | 7 |
| Payments to date in respect of Islington and Euston Bill | 8,285 | 3 | 9 |
| Balance from capital account | 33,991 | 16 | 1 |
| | £62,339 | 7 | 9 |

## DIRECT UNITED STATES CABLE.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at Winchester House, Mr. E. M. Underdown, K.C., presiding.

The **Chairman,** in moving the adoption of the report (which appeared in our last issue), said that the revenue for the six months, after deducting payments, amounted to £47,815. The working and other expenses, including income tax, but leaving out repairs, were £21,816. The revenue showed a falling off, but that did not arise from any circumstances peculiar to the Company, but was due to the general torpidity of business. As the Company's traffics were always an index of the activity of business, the shareholders could not but expect to see a decrease in revenue with the falling off of business between Great Britain and the United States. It was to be hoped that it was only temporary. He had previously told the shareholders that there had been some heavy repairs to the main section. A certain portion of the sum expended on that account had had to be brought forward, and it formed a charge on the six months under review. The directors had put those repairs against the reserve fund, and they continued to make up the reserve by the steady application of a reasonable amount. The total amount of the Company's investments stood at a somewhat lower figure, but the directors would proceed to make that up, leaving, they hoped, the net profits unaffected. The directors were quite content with the way in which the business was going on. His son had visited all the stations in the United States, Canada, and Nova Scotia, and had found everything in perfect order and the staffs doing their work satisfactorily. He could not conclude his remarks without referring to the loss the Board had sustained by the death of Admiral Sir Henry Keppel, who had endeared himself to everybody. As the present was a time for economy, the directors did not at present propose to fill the vacancy on the Board caused by the death of Admiral Keppel.

The motion was adopted.

## NEW COMPANIES REGISTERED.

**Edmundson's Furnishing and Engineering Company, Limited.** Capital, £18,500. Object: to carry on the business of furnishers and engineers in all their branches. Registered office: 35, Capel-street, Dublin.

**East Cheshire Light Railways Syndicate, Limited.**—Capital, £3,000. Object: to establish a company with powers under the Light Railways Act, 1896, to construct, maintain, and work a system of light railways from Mottram to or near Hyde, Stalybridge, Hollingworth, Woolley Bridge, Tintwistle, Broadbottom, and elsewhere. Registered office: 129, Stamford-street, Stalybridge.

**Cambridge Electric Tramways Syndicate, Limited.**—Capital, £5,000. Object: to adopt an agreement with the British Electric Traction Company, Limited, for the acquisition of its interest in an agreement dated June 21, 1898, with the Cambridge Street Tramways Company, to construct, acquire, equip, maintain, and work by electricity or other power any tramway or tramways in the town or county of Cambridge, etc.

**Graham Lighting Company, Limited.**—Capital, £5,000. Object: to acquire and carry on the business carried on by C. Graham and W. Hotton, at 264, Goswell-road, E.C., as the Graham Lighting Company.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Woolstanton and Burslem.**—The Guardians will shortly invite tenders for supplying the workhouse with an electric light installation.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Punta Arenas, Chile (Straits of Magellanstrasse).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Hastings.**—The Corporation invite offers for the supply of alternating-current motors to consumers on a hire-purchase agreement. Proposals by Jan. 30. See advertisement in last issue.

**Hammersmith.**—The Council invite tenders for various supplies. Particulars from Mr. G. Gilbert Bell, Electricity Works, 57, Fulham Palace-road, W. Tenders by Feb. 10. See advertisement.

**Swindon.**—The Corporation invite tenders for wiring school for electric lighting. Specifications, etc., from Mr. J. G. Griffin, Electricity Works. Tenders by Feb. 15. See advertisement.

**Stockport.**—The Electricity Department invite tenders for an economiser. Specifications from Mr. A. J. H. Carter, Electricity Works, Millgate, Stockport. Tenders by Feb. 4. See advertisement.

**Bedford.**—The Electrical Committee invite tenders for high-tension switchboard. Specifications from Mr. R. W. L. Phillips, electrical engineer, Cauldwell-street. Tenders by Feb. 9. See advertisement.

**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Bristol.**—The Corporation invite detailed particulars of standard single-phase H.T. and three-phase E.H.T. switchgear. Further particulars from the City Electrical Engineer. See advertisement in last issue.

**Woodhouse (Leeds).**—Tenders are invited for electric light installation at the new Liberal Club, Woodhouse. Particulars from Messrs. T. A. Buttery and S. B. Bird, 1, Basinghall-square, Leeds. Tenders by Feb. 2.

**Marcinelle (Belgium).**—The Municipal Authorities of this town, in the province of Hainaut, require tenders for erection of an electric station and supply of current. Tenders by Feb. 26. By registered letter Feb. 24.

**Sunderland.**—The Corporation invite tenders for the supply of travelling crane and storage battery. Specifications, etc., from Mr. John F. C. Snell, M.I.C.E., Town Hall. Tenders by Feb. 26. See advertisement.

**Kirkcaldy.**—The Corporation invite tenders for seven motorcars for their tramways. Specifications, etc., from Mr. O. F. Francis, Electricity Works, Victoria-road. Tenders by Feb. 1. See advertisement in last issue.

**Islington.**—The Lighting Committee invite proposals for the carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals by Feb. 17. See advertisement.

**Pontevedra (Spain).**—Tenders are invited for the construction of an electric tramway from Mondariz to Porrino. Particulars may be seen at this office, or obtained from the Public Works Department, Madrid. Tenders by Feb. 12.

**Canterbury.**—The Corporation invite tenders for supply and erection of four motor-driven centrifugal pumps for lifting sewage. Specifications, etc., from the City Electrical Engineer. Tenders by Feb. 8. See advertisement in last issue.

**Battersea.**—The Borough Council invite tenders for a 750-kw. steam dynamo, electric pumps, etc. Specifications from Mr. H. R. Forbes Mackay, Electricity Department, Lombard-road, S.W. Tenders by Feb. 15. See advertisement.

**Hanley.**—The Corporation invite tenders for the supply, delivery, and erection of alternators, condensing plant, superheaters, etc. Specifications from Mr. C. A. Cowell, Electricity Works, Park-road. Tenders by Feb. 22. See advertisement.

**Westminster.**—The City Council invite tenders for the extension of electric light installation at the Marshall-street Baths. Specifications, etc., can be obtained from Mr. John Hunt, Westminster City Hall, Charing Cross-road, W.C. Tenders by Feb. 3.

**Edinburgh.**—The Corporation invite tenders for engine and dynamo for electricity supply station at M'Donald-road. Specifications, etc., from the Electrical Engineer, Dewar-place Station. Tenders by Feb. 22. See advertisement in last issue.

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**Zurich (Switzerland).**—The Municipality require about 200 single-phase alternating-current meters as follows: 100 five-ampere 100-volt, 50 10-ampere 100-volt, 50 15-ampere 100-volt. Tenders to the Vorstand des Bauwesens II, Stadthaus, Zurich, by 31st inst.

**West Ham.**—Tenders are invited for supply of engine-room stores, cable, recording wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Particulars from Central Electricity Station, Abbey Mills, West Ham. Tenders by Feb. 11.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Barcelona.**—Tenders for public arc lighting will be received at the Town Hall, Casos Consistoriales, by Feb. 9. Particulars may be obtained there or at the Local Government Office (Ministrelo de la Gobernacion), Madrid, or at this office. Sixty-four arc lamps are required.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Brighton.**—The Town Council invite tenders for the supply and erection of a 20-ton four-motor electrically-operated crane at their power station, Southwick. Specifications can be had at the office of Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by 10 a.m. on Feb. 8.

**Leyton.**—The Urban District Council invite tenders for the electrical wiring and fittings and hot-water heating apparatus required at Norlington-road Schools. Specification, etc., from Mr. William Jacques, A.R.I.B.A., 2, Fen-court, Fenchurch-street, E.C. Tenders by Feb. 2. See advertisement in former issue.

**Manchester Ship Canal.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection of 25 electric hoists and 10 electric fixed cranes for transit sheds. Specification, etc., can be obtained from Mr. W. H. Hunter, M.I.C.E., chief engineer, 41, Spring-gardens, Manchester. Tenders by March 1.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**London, N.**—The Hornsey Borough Council invite tenders for (Section A) two dry-back or water-tube boilers; (B) smoke-consuming apparatus; (C) two 300-kw. steam dynamos, one 100-kw. steam dynamo, two motor-generators. Specifications, etc., may be obtained of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by 10.30 a.m. on Feb. 8. See advertisement in former issue.

**Wiring.**—The May-Oatway Fire Appliances, Limited, invite tenders for wiring for following installations of May-Oatway fire-alarms for direct connection with the fire brigades at Glasgow: Messrs. Jas. Templeton and Co.'s mills, warehouses, and offices, Greenhead; (separate tenders) Messrs. Jas. Templeton and Co.'s warehouses and weaving sheds, West-street. Tenders by Feb. 3. See advertisement.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Islington.**—Tenders are invited for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors and pilot cable, with feeding, junction, and service boxes. Specifications, etc., from the Borough Electrical Engineer, 50, Eden-grove, Holloway, N. Tenders by Feb. 24. See advertisement.

**London, S.W.**—The London County Council invite tenders for the roadwork and platelaying required for the reconstruction, for the electrical traction on the conduit system, of the existing double line of cable conduit tramways from a point in Brixton-road, near Handforth-road, to the present terminus at Streatham; and for the construction, for the same system of electrical traction, of a portion of the authorised tramways in High-street, Tooting, Merton-road, and Defoe-road. Specifications, etc., from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Feb. 2.

## RESULTS OF TENDERS.

**Stalybridge.**—The Tramways and Electricity Board have accepted the tender of W. Storr, Sons, and Co., Limited, Aqueduct Sawmills, for the whole of the work required for erection and completion of receiving and suction tanks, pipes, valves, etc., at Sandy Vale, Stalybridge.

**Brighton.**—The tender of Messrs. Rowland Carr and Co. has been accepted for the supply of cast-iron bases, switch, and telephone pillars for the Corporation tramways. The same firm also reports numerous orders for their Franklin patent ventilated frames and covers, which are being specified and used in Government contracts.

**Battersea.**—The tender of Graham Morton, Limited, to supply and fix coal-raising plant for the sum of £2,327 has been accepted, subject to the usual conditions of contract. 200 additional prepayment meters are to be procured from the British Thomson-Houston Company, Limited, under the provisions of their contract.

**Wiring.**—The Scottish Office of the May-Oatway Fire Appliances, Limited, have accepted the following tenders for wiring for installation of May-Oatway fire alarms for direct connection with the fire brigades at Paisley and Dundee: Messrs. Brown and Polson, corn-flour mills, Paisley, Messrs. Allan, Arthur, and Ure; Messrs. J. Ireland and Sons, shuttle factory, Dundee, Messrs. J. Maxwell and Son.

**London County Council.**—The following tenders have been received for the supply of four 3,000-kw. three-phase generators:

| | |
|---|---|
| Siemens Bros. and Co., Limited, London and Stafford (not to specification) | £23,385 0 0 |
| Siemens Schuckert Works, Berlin (not to specification) | 23,405 12 0 |
| International Electrical Engineering Company, Limited, London and Liège (requires auxiliary heavy flywheel) | 23,435 0 0 |
| General Electric Company (1900), Limited, London and Birmingham (requires auxiliary heavy flywheel) | 24,379 0 0 |
| Witting, Eborall, and Co., Limited, London (design considered unsatisfactory) | 29,360 0 0 |
| Electric Construction Company, Limited, London and Wolverhampton (acceptance recommended) | 29,600 0 0 |
| Bruce Peebles and Co., Limited, Edinburgh | 30,558 0 0 |
| Brush Electrical Engineering Company, Limited, Loughborough | 32,872 0 0 |
| British Westinghouse Electric and Manufacturing Company, Limited, London and Manchester | 34,385 0 0 |
| Dick, Kerr, and Co., London and Preston | 36,000 0 0 |
| Richardson, Westgarth, and Co., Limited, Hartlepool | 39,342 10 0 |

We deal with these tenders fully in another column.

**Walthamstow.**—The Urban District Council have received the following tenders for the construction of electric tramways. Mr. G. W. Holmes, engineer for permanent way; Messrs. J. and S. Enright, engineers for plant, etc.:

Section A.—Permanent way.

| | |
|---|---|
| W. Griffiths and Co. | £59,914 |
| J. A. Ewart | 58,627 |
| Henley's | 57,700 |
| G. Law | 81,058 |
| R. W. Blackwell and Co. | 64,042 |
| W. Manders | 59,629 |
| Acme Wood Flooring Company | 63,939 |
| A. Fasey and Son | 67,994 |
| Callender's Cable Company | 59,567 |
| J. G. White and Co., Limited | 59,739 |
| Dick, Kerr, and Co., Limited | 57,700 |
| Macartney, McElroy, and Co. | 55,040 |
| W. Underwood | 60,467 |

Engineer's estimate, £75,693.

Section B.—Electric plant, etc.

| | |
|---|---|
| Henley's | 21,500 |
| Bruce Peebles and Co. | 20,861 |
| Lancashire Dynamo and Motor Company | 22,685 |
| F. Suter and Co. | 20,685 |
| Johnson and Phillips | 21,700 |
| Mather and Platt | 21,919 |
| Electric Construction Company | 21,921 |
| J. G. White and Co., Limited | 21,990 |
| National Electric Construction Company | 22,221 |
| Torque Electrical Engineering Company | 22,000 |
| International Electrical Engineering Company | 20,620 |

Engineer's estimate, £25,000.

Section C. Cables.

| | |
|---|---|
| W. Griffiths and Co. | 7,221 |
| Henley's | 7,343 |
| Johnson and Phillips | 6,825 |
| F. Suter and Co. | 7,255 |
| W. T. Glover and Co. | 8,101 |
| Siemens Bros. and Co. | 7,127 |
| Western Electric Company | 7,143 |
| St. Helens Cable Company | 7,676 |
| Callender's Cable Company | 7,039 |
| J. G. White and Co., Limited | 7,339 |
| Dick, Kerr, and Co., Limited | 7,343 |
| Macartney, McElroy, and Co. | 7,659 |
| British Insulated and Helsby Cables, Limited | 6,947 |
| W. Underwood | 7,959 |

Engineer's estimate, £8,450.

Section D.—Overhead equipment.

| | |
|---|---|
| W. Griffiths and Co. | 9,740 |
| Henley's | 10,883 |
| R. W. Blackwell and Co. | 9,522 |
| W. Manders | 9,522 |
| F. Suter and Co. | 9,048 |
| G. Hill and Co. | 10,793 |
| Brush Electrical Engineering Company | 9,610 |
| British Thomson-Houston Company | 9,231 |
| Callender's Cable Company | 11,189 |
| J. G. White and Co., Limited | 9,446 |
| National Electric Construction Company | 13,173 |
| Dick, Kerr, and Co., Limited | 10,883 |
| Macartney, McElroy, and Co. | 10,245 |
| British Insulated and Helsby Cables, Limited | 9,945 |
| W. Underwood | 11,092 |

Engineer's estimate, £15,890.

The tenders of Messrs. Henley have been accepted for Sections A, C, and D, and Messrs. Suter and Co. for Section B. Messrs. Dick, Kerr, and Co. are sub-contractors to Messrs. Henley for Sections A and D.

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**Kirkcaldy.**—The Corporation have accepted the tender of Messrs. Browett, Lindley, and Co., at £2,619, for a 420-kw. Browett-Laurence Scott generating set. There were 31 tenders received, which included over 150 prices for various combinations of plant. (This amount at first was erroneously reported as £4,619.)

# BUSINESS NOTES.

## TRACTION.

**Ipswich.**—Last week an extension of the tramway service was opened along a portion of the Felixstowe-road route.

**Bradford.**—The Barkerend road section of the tramways will, it is expected, be opened for traffic to-morrow (Saturday).

**Newcastle.**—A petition has been presented to the Mayor urging the extension of the Newcastle tramway service to Blaydon.

**Scarborough.**—There is a good prospect of the first section of the new electric tramways being opened for traffic in some three or four months' time.

**North-Eastern Railway.**—The company have commenced experiments at Selby with their new motor carriage. The tests are said to have been satisfactory.

**Halifax.**—In order to save current on the Horton-street tramway route—a steep incline—it is proposed to substitute single-deck cars for the present double-deckers.

**Ilkeston.**—The Town Council have made arrangements for a loan of £70,000 for the tramways and electricity undertakings. The rate of interest is to be 3¾ per cent.

**Eston.**—The Urban District Council have sealed their agreement with the Imperial Tramways Company for continuing the tramway from Middlesbrough to Grangetown.

**Dudley.**—One day last week two horses attached to a wagon were killed by coming in contact with a tramway pole which by misadventure had become charged with electricity.

**Devonport.**—A meeting of the Devonport and District Tramways Company has approved a resolution to the effect that the proposed Devonport and Plymouth light railways order be approved.

**Ormskirk and Southport Light Railway.**—The promoters of this light railway are applying to Parliament for an extension of the time given in their Bill to Feb. 31, 1907, for the carrying out of the works.

**Tees-side.**—An important conference was held in Middlesbrough on Saturday, when it was decided to urge the local authorities interested to take steps to secure the municipalisation of the tramways.

**Watford.**—The work of constructing the Watford, Edgware, and London light railways is proceeding apace. A very large body of men are at work on the railway, which is being pushed along with all speed.

**Barrow.**—Several little difficulties have arisen which may delay the inauguration of the electric tramway system for some time longer. However, the cars are ready for service, and electric current can be supplied at any moment.

**Saddleworth.**—The Bill for the abandonment of the Saddleworth and Springhead tramways, authorised by the Act of 1902, has proved compliance with the preliminary Standing Orders, and has been sent by the examiner for first reading.

**New South Wales.**—The revenue from the tramways during the December quarter amounted to £207,667, as compared with £190,951 during the December quarter of 1902. The expenditure amounted to £179,642, as compared with £167,915.

**Brighton.**—The total passengers carried on the tramways during the year just ended numbered 4,904,277, as compared with 4,226,373 the previous year, the receipts being £20,434. 9s. 9d. and £17,609. 17s. 9d. respectively—an increase of £2,824. 12s.

**Folkestone.**—At their last meeting the Town Council appointed Mr. C. Merz to prepare a report on the respective merits of the G.B. system of surface contact, the overhead system, and any other systems which the Council may have under consideration.

**Kingston (Surrey).**—At the last meeting of the Town Council it was decided to petition against the London United Tramways Bill, in which the company are applying for an extension of two years of the time for the construction of the proposed tramways in the borough.

**Morley and District Light Railway.**—The Light Railway Commissioners will hold a public enquiry on Feb. 8 as to the expediency of granting the application which has been made to them by the Yorkshire (Woollen District) Electric Tramways, Limited, for an order to authorise the above-named light railway.

**Durham.**—The County Council have decided to agree to the application of the Bishop Auckland, Shildon, and Spennymoor Tramways Company for a provisional order. It is to be noted, however, that the electric supply of the Council are now considering a comprehensive scheme of electric tramways for the county.

**Soothill Nether.**—As the result of the poll taken on the question of the District Council promoting a Bill for the construction of tramways in the district, and applying for borrowing powers for other works and improvements, 332 voted in favour of the Council's proposals and 121 against the undertakings. Effect will now be given to the Council's scheme.

**Leicester.**—The tramway construction is so far advanced that the Town Council are already advertising for applications for a whole series of staff appointments. These begin with an assistant electrical and mechanical engineer, and include power station engineer, switchboard attendants, engine-drivers, fitters, linesmen, and both inspectors and instructors.

**Leeds.**—The Corporation Tramways Committee at a meeting on Tuesday had before them the resolution adopted by the men at their meeting on Saturday midnight agreeing to a 16 weeks' trial of the new scheme, providing it was put on all the routes simultaneously, so that the trial might be a reliable one. Thus for the present the matters are amicably settled.

**Blackburn.**—The borough treasurer reports that, although 300,000 more passengers have been carried on the Corporation tramways during the last nine months than in the same period last year, the expenses show a corresponding increase. The loss on the working has gone up from £1,812 to £2,144. During the period under review two extensions of the system have been completed and opened for traffic.

**Swansea.**—At the last meeting of the Town Council the town clerk said a petition had been received from residents of Sketty expressing the fervent hope that the Council would manage to carry the proposed tramways to Sketty and not stop short at Gorrymore, and it was announced that it was now hoped that satisfactory arrangements would be made by which the scheme could be carried through.

**Sunderland.**—At the monthly meeting of the Rural District Council a report was submitted on the proposed road widening at Melrose House, Ryhope, with plans showing what was required to be done. The proposal was made by the Houghton-le-Spring Electric Tramway Syndicate, which requires the road widening on their line of route. The matter involved an alteration of the existing gradient, and was adjourned.

**New Cross.**—On Monday, for the first time, workmen's electric tramcars were run on the newly-completed London County Council system between New Cross-gate and Westminster Bridge, by way of Queen's-road, Peckham, Camberwell-green, and Walworth-road. The ordinary electric service on this route started on Sunday. The electric service between Peckham and Blackfriars and Waterloo will be running at an early date.

**Musselburgh.**—The Town Council met on Tuesday to consider a report by Mr. Sayers with regard to the adoption of the G.B. contact system. The report was favourable to this system. After some little discussion, in which it was pointed out that, in the event of the Council adopting the system, and it did not prove an unqualified success, they would have the right to revert to another system, the report was adopted.

**Liverpool Overhead Railway.**—The accounts of the company for the past half-year show an available balance of £10,882, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 1½ per cent. per annum on the ordinary shares, against 1½ per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward, £4,132.

**Stourbridge.**—At the last meeting of the District Council the Light Railway Committee reported that they had considered new proposals of the Dudley, Stourbridge, and District Electric Traction Company for the reconstruction of that portion of the Kinver tramway line *viâ* Coalbournbrook, and had instructed the clerk to inform the company that the Council would be prepared to consider favourably when they had obtained powers.

**Callington.**—The Callington Light Railway Company have obtained an extension of time from the Light Railway Commissioners. By the order of 1900 a line was sanctioned between Saltash and Callington, one of the conditions being that the compulsory purchase of land should cease after May, 1903. An extra period of three years has been granted, and stipulations are made in case the railway is to be worked by electricity. No reason is given for the delay.

**Tottenham Court-road.**—The Examiner of Private Bills having decided that the County Council Bill asking for sanction to the construction of a tramway from Hampstead-road along Tottenham Court-road to a point near Oxford-street failed to comply with the Standing Orders of Parliament in regard to the consent of the road authorities concerned, an endeavour will be made to obtain, if possible, a suspension of the Standing Orders in regard to the measure.

**South London.**—On Wednesday morning the electric tramway service between the Elephant and Castle and Peckham was dislocated for some time. It appears that in turning a sharp bend in High-street, Peckham, one of the cars, owing to the slippery state of the metals, left the line, and crashed into a brick wall before it could be brought to a standstill. The accident rendered necessary the introduction of horsed trams for the greater part of the remainder of the day.

**Cardiff.**—The new tramway route to Grangetown *viâ* the Penarth-road has been completed for traffic, and the Board of Trade are to be asked to arrange for an inspection of it at an early date. The borough engineer reports that the new line from Constellation-street through Meteor-street to opposite the main entrance to the infirmary is finished. A loop line at the Fairoak-road terminus is to be constructed, at a cost of £700, for the purpose of facilitating traffic, the amount to be paid out of revenue.

**Edinburgh.**—The directors' report of the Edinburgh Street Tramways for the half-year ended Dec. 31 states that a special meeting of the company was held on Dec. 9 last, when it was unanimously agreed to authorise the directors to sign an agreement with the Corporation of Leith for the sale of the tramways for a sum of £60,000. The Corporation of Leith are now promoting a provisional order for the purpose of acquiring and working the tramways, and it is anticipated that the transfer will take effect before October next.

**Paris Metropolitan.**—The working results for 1903 of those sections of the Paris Metropolitan Railway open to traffic have just been published, and show that the company carried 100,107,600 passengers, a gain of 37,984,900 as compared with 1902. The increase has been mainly in second-class travellers. The percentage of gross receipts handed over to the Paris Municipal Corporation in accordance

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with the terms of the concession amounted to £227,700, the company's share being £463,900. The highest monthly receipts were in May and December.

**Hammersmith.**—The Borough Council have decided to oppose in Parliament the London United Tramways (Railways) Bill for powers to construct railways between certain of their existing and authorised tramways and the Hammersmith Station of the Metropolitan District Railway and the Metropolitan Railway Company. They will offer no opposition to the London United Tramways Bill, nor to the Harrow-road and Paddington Tramways Bill, which is being promoted to authorise the sale of the undertaking to the Metropolitan Electric Tramways, Limited.

**Glasgow.**—A proposal was brought before the last meeting of the Town Council to appoint a committee to confer with and obtain information from the tramway or other departments of the Corporation and their officials, and to correspond with other municipalities, as to a portion of the profits of the tramway undertaking being applied to the relief of rates. It was rejected by 36 votes to 2. In view of the opposition which has been shown to the scheme, the Council decided to abandon the proposed tramway extensions to Bearsden and Milngavie and from Spier's Bridge to Barrhead.

**Leith.**—The Corporation Tramways Bill came before the examiner, Mr. Campion, at Westminster this week for proving compliance with the Standing Orders. Opposition was raised on the question whether it was necessary to obtain the consent under the general orders of the Corporation of Edinburgh for the particular parts of the tramways proposed to be constructed so far as these are situated within Edinburgh. After argument, the examiner held that the continuation line should be taken into account in calculating the consent distance, and that it being shown that the two-thirds were already in the promoters' own hands, he would report that the Standing Orders had been complied with.

**West Wales.**—Colonel Boughey and Mr. H. Allan Steward, Light Railway Commissioners, held a public enquiry on Tuesday into an application for an order authorising the construction of a light railway from Lampeter to Aberayron. Colonel Boughey intimated that the Commissioners considered the line from Lampeter to Aberayron was much wanted. The practical question was, how would the promoters raise the money? This appeared to depend on a grant from the Treasury, as well as assistance from the local authorities and local landowners. Under the law as it stood, the Treasury grant depended on arrangements being made with an existing railway company for the construction and working of the line.

**Birmingham.**—Birmingham has scarcely got over her agitation against German-made tramrails before discovering that the trucks of the new tramcars are of American manufacture. All other parts of the new cars, including the wheels and fittings, are of British manufacture. A committee of the City Council is now engaged in enquiring into the general question as to whether the Corporation should restrict their purchases to British-made goods or not. Owing to a fracture in the arm of one of the tramway standards in Steelhouse-lane there was a stoppage of the electric cars on Tuesday for upwards of 1½ hours. The arm suddenly snapped off and hung suspended by the trolley wire. Traffic had to be stopped until the breakdown was repaired, which, however, was confined to this one pole.

**Manchester.**—The poll on the question of the promotion of the Corporation Tramways Bill will be taken to-day (Friday). A meeting of the Manchester Corporation Tramways Committee was held on Tuesday, when the Negotiations Sub-Committee reported that they had had an interview with the Ashton-under-Lyne Corporation, and, with one exception, had cleared up all the outstanding points of difference between the two Corporations. They hoped the agreement would shortly be signed, and that through electric tramcar communication between Manchester and Ashton would be established at an early date. The committee accepted a tender for the supply of 100 new electric tramcars of the bogie type. The Town Council, at a special meeting on Wednesday, approved the promotion of the Tramways Bill.

**Additional Traffic Returns.**—Anglo-Argentine, £1,893 increase; Barcelona Ensanche y Gracia, £60 increase; Barcelona, £80 increase; Brisbane, £42 increase (month of December, £11,915, increase £371), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £369 increase (month of December, £15,057, increase £1,099); Calcutta, £202 increase; Cape Town (month of December), receipts £18,088, expenditure £8 235; Isle of Thanet Electric, £13 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of December), receipts £47,600, expenses £27,400; Perth Electric, £226 increase (for the year 1903: receipts £62,097, expenses £34,871); Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**New Issue.**—The Electric and General Investment Company, Limited, have offered for subscription at par £250,000 4½ per cent. second debenture stock of the British Electric Traction Company, Limited. The company, which was formed in 1896, is interested, as owners, lessees, or shareholders, either solely or with others, in upwards of 60 tramway, light railway, and electrical undertakings in various parts of the United Kingdom and the Colonies. Most of these are in operation and are earning revenue, whilst others are in course of construction or extension, and the present issue is made to provide capital for the general business of the company. The authorised share capital of the company is £4,000,000 in preference and ordinary shares of £10 each, and 156 437 preference and 133,301 ordinary shares have been issued. The subscription list closes to-day (Friday).

**Torquay.**—The town clerk has received a letter from the manager of the Dolter Electric Traction Company (who propose to introduce their surface-contact system of tramways into the town) expressing the surprise of the directors at learning that their Bill in Parliament is to be opposed by the Corporation, the result, it is understood, of opposition to Sunday traffic. Mr. Lancaster claims that the company have endeavoured to meet the views not only of the Corporation, but also of the burgesses, in every possible way, and he thinks that at this late date, after having paid the heavy expenses of engineering fees, plans, parliamentary agents, etc., and also having deposited £5,000 as a guarantee for the completion of the first lines in such a manner as to give satisfaction to the Corporation's engineer and the town, opposition seems unreasonable, more particularly as in the draft agreement submitted, and in the interview with the directors, no question of Sunday traffic was raised.

**Brighton Railway.**—Speaking at the meeting of the London, Brighton, and South-Coast Railway on Wednesday, the Chairman said the introduction of some system of electrical working might possibly prove to be one way of dealing with existing competition, so far, at any rate, as suburban and short-distance traffic was concerned, and the Board was giving careful consideration to it. A very large outlay of capital would necessarily be required if only a short length of line be equipped, and the rapid advance which was being made almost from day to day in electrical science rendered it at least possible that any system adopted might in a short time become out-of-date, and have to be superseded at a further heavy cost. The Board was giving attention to the subject, and the proprietors might rest assured that until a system likely to prove permanent in character and economical in working had been found, the directors would not incur any serious expenditure on this account.

**German Speed Trials.**—Reuter, telegraphing from Berlin on Tuesday, says that in the Budget Committee of the Reichstag that day the question of the fast electric railway travelling was raised. Herr Budde, Minister of Public Works, stated that the matter was still in its preliminary stage, and that in connection with the project the principles of suspension railways and monorail systems came under consideration. As regarded fast travelling of that nature, only the very first experiments had been made, and he could not accept the responsibility of authorising the use of such railways for travellers generally. It was also very far from clear whether the scheme would be practicable for economic purposes. The trials would be continued with due caution. The experiments on the line between Berlin and Grosslichterfelde were giving very favourable results. Soon they would be able to witness practical experiments with the electric city railway in Hamburg. The Prussian Government would at the time take all possible advantage of the results of these trials.

**Great Northern "Tube."**—In view of the approaching opening of the Great Northern and City Railway, the Great Northern Railway Company have announced some important alterations in their suburban traffic arrangements. It was hoped that the negotiations which have been going on for some time past between the authorities of the various companies interested in the conveyance of suburban passengers between the northern suburbs and the City would have resulted ere this in a comprehensive arrangement whereby tickets issued from the suburban stations of the Great Northern would have been made available to all the City stations of the North London, Metropolitan, and Great Northern and City Companies. Up to the present, however, these negotiations have not arrived at a successful conclusion so far as the authorities of the new "tube" line are concerned; but the Metropolitan Railway Company have agreed to extend to Great Northern passengers holding either season or ordinary tickets the privilege of travelling by their trains between King's Cross and Bishopsgate without extra charge, whilst season tickets will also be issued between Great Northern suburban stations and the Metropolitan station at Aldgate. Other concessions are to be made to travellers on the Great Northern Company's system.

**West Bromwich.**—Rumours have been current that a serious difficulty has arisen between the South Staffordshire (Lessee) Company and the West Bromwich Corporation with reference to the working of the electric tramways within the borough. It is now stated on good authority that there are serious points in dispute between the Corporation and the tramway company affecting financial questions and the using of the late Mr. Quin's cut-outs, the construction of the tramways, and other general matters. The tramways within the borough were purchased by the Corporation from the Staffordshire Company, and, after being reconstructed and electrically equipped, were leased to the South Staffordshire (Lessee) Company. The latter, it is understood, agreed to repay by instalments the amount expended by the Corporation in the work of reconstruction, together with rent and interest upon the capital at a fixed rate Further, the lessee company agreed to purchase their supply of electric current from the Corporation electricity generating works. A conference has been arranged to be held shortly, when it is hoped steps will be taken to bring about an amicable settlement. The dispute is causing a good deal of excitement locally, as the undertaking of the Corporation in the purchase, reconstruction, and electrical equipment of the lines involved an expenditure of something like £140,000. The lines extend from the Handsworth boundary of the borough to Wednesbury and Dudley, and it is understood that the whole of the lines have been leased to the company named for 21 years.

**Paris Transit Problems.**—The Paris correspondent of the *Financial Times* says that at its last meeting the extra-Parliamentary Committee formed by Ministerial decree to enquire into the condition of tramway communication in Paris and district went at great length into the financial condition of various electric tramway companies. From the figures submitted to the committee it appears that out of 10 companies dealt with, five do not earn sufficient to cover working expenses. The committee has, therefore, come to the conclusion that an entire reorganisation of the Paris tramway system is absolutely necessary. Since 1898 a large number of companies have been formed to work lines in Paris and the neighbourhood, and some of these are in direct competition with each other, running as they do on almost parallel routes. The ever extending Paris Metropolitan Railway is also taking an increasingly large number of passengers from the

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tramways. Inspector-General Hetier has proposed to the committee that the public transport arrangements of Paris and the suburbs should be divided up into four great sections, parts for the tramways and into a fourth for omnibuses. The lines now in a precarious financial position would be handed over to the three big companies working profitable districts, and in return for certain advantages the three companies in question would also each take over and operate a portion of the unprofitable lines. The omnibus question is one that requires to be dealt with by itself. The outlook meanwhile is scarcely bright for some of the minor tramway concerns, for it is evident the committee is in favour of cancelling the leases or concessions held by all those companies unable to pay their working expenses.

**Great Eastern Railway.**—Speaking at the half-yearly meeting of the company on Wednesday, Lord Claud Hamilton, the chairman, according to the *Times*, said that in their suburban traffic the greatest pressure arose at Walthamstow, where between 7.50 and 7.59 a.m.—nine minutes—they had to move nearly 5,000 passengers to London, and to do this they ran five trains with seating capacity for 4,200 people. He would compare that with two specimens of the electrical system—the Central London and the Manhattan Railway of New York. The former during their busiest time ran five trains at about 2¼ minutes' interval, with seating capacity for 1,620 passengers, whilst the latter ran trains at 1¼ minute's interval, which in 10 minutes would give a seating capacity of 2,016 passengers. It would therefore be seen that they were able in their busiest period to provide about twice as many seats as either of these two electrical railways. Now, the main trouble arose from the fact that the class of passengers carried by these trains would crowd into the latest trains. They had tried to increase the number of trains by obtaining greater acceleration by means of engines of the Decapod type. The experimental Decapod engine built at their works realised anticipations, but they found that, in order to obtain in every respect the speed desired, it was necessary somewhat to add to the weight upon the wheels, and when that came to be fully considered it was found that it would be necessary to expend a much larger sum than was originally contemplated upon strengthening the bridges in the suburban district. They shrank from any very large expenditure in that direction at the present moment, especially having regard to the possibility of electricity in the future, and, therefore, instead of building more engines of the Decapod type, they had for the present, so far as they were able, solved the difficulty in another mode. The Decapod engine would not be in any sense wasted, but would be utilised at reduced weight for other purposes. They had therefore issued instructions for the platforms of the lines most liable to be crowded to be lengthened, so as to enable the trains during the busiest hours to be composed of 17 instead of 15 coaches, increasing the seating accommodation by an average of about 120 per train, or about 15 per cent. If they were to rush into some system of electricity they might obtain the applause of the Press and the electrical engineering world, but in the present transition stage of electrical development, in his opinion, it would be suicidal policy to embark in vast capital expenditure which, after a brief period, might prove to be of little value either to the shareholders or to the users of the line.

**London County Council.**—As will be seen from our "Tenders" columns this week, the Council at their meeting on Tuesday had before them tenders for the supply of three-phase generators for the Greenwich generating station, involving a capital expenditure of £29,600. Reporting on the tenders received, 11 in all, the Highways Committee recommended the acceptance of that of the Electric Construction Company, of London and Wolverhampton, at that figure. This was the tender which had been selected by the chief officer and the electrical engineer after a close examination. The report continues: "The lowest tender, that of Messrs. Siemens Bros. and Co., is for generators which do not comply with the general requirements, as regards dimensions and certain other structural points, specified by the Council. There are, moreover, certain further objections in regard to matters which were left to the discretion of the tenderers. The questions involved are of very great importance in view of the vital part played by this plant in the working of the electricity generating station, and we concur with the officers in thinking that the Council would not be justified in accepting the tender of the firm named. The second lowest tender, that of the Siemens Schuckert Works, Berlin, is for the same type of machine as that above referred to, but the plant would be made at the German works of the firm. The tender is open to the same objections as that of Messrs. Siemens Bros. and Co. The tenders of both the International Electrical Company and the General Electric Company (1900), Limited, are for machines which require an auxiliary flywheel, which would take up considerably more space and result in a less satisfactory design of machine than that suggested in the specification. As regards the fifth tender, that of Messrs. Witting, Eborall, and Co., Limited, the electrical design proposed, while very complete, is not of an entirely satisfactory character for the Council's purposes, and owing to the shape and dimensions of the armature slots proposed, a severe strain would, in the officers' opinion, be likely to be placed, under certain conditions of working, on the high-tension cables. We feel that the objections above specified to the acceptance of either of the five lowest tenders are of a serious character, and in the circumstances we concur in the recommendation of the chief officer and the electrical engineer that the tender of the Electric Construction Company, Limited, should be accepted. The design submitted by this firm is for a complete flywheel alternator built up with steel plates, and is very suitable for high speeds, while the construction proposed is the safest known for withstanding centrifugal strain. The firm have had large experience in the manufacture of the class of machine required by the Council, and we are of opinion that if the work were entrusted to them it would be carried out in a satisfactory manner. In plant of this character it is not possible for the Council to specify more than the general requirements of output, speed, over-all dimensions, strength of materials and efficiencies, and detailed drawings of the design cannot be sent out, as each manufacturer has his own standards and methods of construction. Any consideration of the tenders received is necessarily based to a large extent on the character of the designs submitted in order to ensure that the plant shall work in satisfactorily with the Council's other arrangements. We would add that as the plant required is of an exceptional size few firms have had sufficient experience to be entrusted with work of such magnitude. We understand that the Electric Construction Company propose to sublet certain portions of the work, and we are advised that there is no objection to this course being adopted." The same committee brought up a report in which they recommended that Messrs. Bolckow, Vaughan, and Co., Limited, be allowed to sublet the manufacture of the fishbolts and nuts required in connection with the execution of their contract for the supply of track rails, etc., entered into in pursuance of the resolution of Dec. 22, 1903, to Messrs. Guest, Keen, and Nettlefold, Limited, and to Messrs. Bayliss, Sons, and Bayliss, Limited, or such other firm or firms as may be approved by the engineer under the contract. Following are the conditions on which the Council are to be allowed to lay four 30in. pipes in the river bed at the Greenwich station for taking water for the condensing engines: the Council to pay rent for the pipes, for the first year £190, for the second £380, and for the third and subsequent years £570 per annum, the period of payment to commence from the date on which electrical energy is supplied from the station to trams running for the public service. A special report of the committee again cautioned the Council against entering into an agreement to purchase the London Southern Tramways Company's undertaking, except on condition that the Lambeth Council contribute £40,000 towards the cost of the necessary street widenings in connection with the electrification of the lines. This the Lambeth Council have refused to do, and it was decided not to purchase the undertaking in question.

## LIGHTING AND GENERAL.

**Dulverton (Somerset).**—This place, with a population of only 1,300, is to be lighted by electricity.

**Coventry.**—The question of appointing a canvasser has been referred back to the Electric Light Committee.

**Pontypridd.**—The District Council are borrowing from the Cardiff Corporation £26,000 for the purpose of electric lighting.

**Newport (Mon.).**—An enquiry is to be held to-day into the application of the Corporation to borrow the sum of £60,500 for electrical purposes.

**Weymouth.**—The work in connection with the laying of the cables for the electric light is proceeding swiftly, and the completion of it is in sight.

**Renfrew.**—The Town Council have resolved, in next session of Parliament, to apply to the Board of Trade for a provisional order under the Electric Lighting Acts.

**Swansea Telephones.**—Between Jan. 1 and 20 there have been 40 additional lines connected, and since this time last month 107. The number of lines working was 634, orders in hand 247, making in all 881. The original estimate was 750.

**Chiswick.**—The Aberystwyth and Chiswick Electricity Supply Corporation, Limited, are about to commence the laying of mains in the new roads on the Stamford Brook Estate.

**Heavitree.**—A letter from the National Electric Construction Company offering terms for the supply of electric light in the district is being considered by the Urban District Council.

**New Barnet.**—The East Barnet District Council have decided to enter into a new agreement with Mr. Adams, under which he will be retained as expert electrical adviser to the Council.

**Westminster Electric Supply Co.**—The Westminster Electric Supply Corporation, Limited, recommends a dividend at the rate of 14 per cent. per annum for the half-year ended Dec. 31, 1903, making, with the interim dividend, 13½ per cent. for the year.

**Annfield Plain.**—The Cleveland and Durham County Electric Power Company intend at the expiration of one month to lay electric cables or mains in the urban district of Annfield Plain.

**Shilden.**—The Cleveland and Durham County Electric Power Company propose to lay mains in the Urban Council's district, to which course, it appears, the Council have already consented.

**Wimbledon.**—An enquiry has been held into the application of the District Council for sanction to borrow £11,000 for the purposes of the extension of the Council's electric light system to Merton.

**Huddersfield.**—The increase in the number of consumers on January, 1904, over those in January, 1903, was 178, lamps connected in the same period had increased by 18,661, and units metered 252,745.

**Benfieldside.**—A letter from the Cleveland and Durham County Electric Power Company, stating that they intended to lay mains in the district, will come before a special meeting of the Urban District Council.

**Metropolitan Asylums Board.**—The Works Committee have been instructed to arrange for including the installation of the electric light in the South-Eastern ambulance in the contract for lighting the adjoining hospital.

**York.**—The recent interruption to the street-lighting is said to have been due to some unauthorised person having tampered with the switchboard. A full enquiry is being made with a view of bringing the offender to book.

**Falkirk.**—The Town Council have obtained sanction to the borrowing of a further sum of £10,000 for the execution of capital works

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under the Falkirk Electric Lighting Order, 1901, raising the total sum authorised to be borrowed for that purpose to £35,000.

**Hammersmith.**—Since the last Council meeting 12 additional consumers have been connected, representing a maximum of 122 8-c.p. lamps, and three consumers have been disconnected. The present number of consumers taking current from the mains is 1,390.

**Battersea.**—The charges for the supply of electrical energy through prepayment meters are to be reduced from 5d. to the uniform rate of 4d. per unit. The work in connection with distributing mains for arc lighting at £330, and provision of a feeder at £80, is to be proceeded with.

**Wandsworth.**—The eastern district wharf at the waterside, Wandsworth, and the Sulina-road depôt, Streatham, are to be connected by telephone by the National Telephone Company, the annual charge being £28. The Post Office charge, it is stated, would amount to £42. 5s.

**Sunbury.**—The District Council have consented to an application of the Twickenham and Teddington Electric Supply Company, Limited, as to the supply of electricity in the districity, subject to the terms of the agreement already entered into by the company with the Council.

**Charing Cross and Strand Electricity Supply Co.**—The directors have decided to recommend a dividend on their ordinary share capital for the half-year ended Dec. 31, 1903, at the rate of 12 per cent. per annum, making, with the interim dividend already distributed, 10 per cent. for the year 1903.

**Bridgnorth.**—Both the Town Council and Rural District Council are objecting to the application of the Shropshire and Worcestershire Electric Power Company for an order under the Electric Lighting Acts, 1882 and 1888, in respect of the borough of Bridgnorth and other places, including certain parishes in the rural district of Bridgnorth.

**Sowerby Bridge.**—The District Council have approached the Halifax Corporation as to the terms on which they will supply electricity. The matter has been under the consideration of the Electricity Sub-Committee of the Halifax Tramways and Electricity Committee, and their recommendations will be laid before the full committee at their next meeting.

**Islington.**—At the last Borough Council meeting authority was given for the laying down of low-tension distributing mains for giving supplies of electricity in Mercers-road, at a cost of £60; Holloway-road, £75; Hornsey-road, £30; Wellington-road, £144; and Crinan-street, £130. The supply for the latter premises includes supply to motors aggregating 14 h.p.

**Batley.**—Mr. S. Darwin Jones, A.M.I.E.E., borough electrical engineer, had a "chat" on Monday evening with the members of the Congregational Literary Society about "Electricity," after which the party was conducted to the Batley Corporation electricity works, where they were given practical demonstrations, which proved highly interesting and instructive.

**Ham.**—The District Council have decided to support the application of Edmundson's Electricity Corporation, Limited, with regard to the proposed provisional order for electric lighting, the company having reduced their price to 2d. In their letter they said that they found where the agreements had been made at 2½d. they were very rarely able to charge a higher price than 2¼.

**New Pitaligo.**—Arrangements for the official opening of the Post Office telephone have been completed. The circuit comprises Fraserburgh, Peterhead, and Strichen, but is shortly to be enlarged, and when completed will comprehend the greater part of the Buchan district—viz., a sub trunk line from Peterhead which will include Longside, Mintlaw, Maud, New Deer, and Cruden.

**Bristol.**—The demand for power is greatly on the increase, owing to a great extent to the terms which are given to consumers requiring a regular supply over a number of hours each day. The Corporation have recently entered into a contract to supply one large firm at the low rate of ⅛d. per unit. This is, we believe, a record for the United Kingdom. The firm in question will take 300 h.p. to 400 h.p. for nine hours a day.

**New Branch.**—The Stirling Company, who are the original manufacturers of the Stirling boiler, advise us that they have now opened a London office at 53, Victoria-street, Westminster, S.W., to enable them to deal more efficiently with their London and South of England business. The head office of this company will still be at 53, Deansgate-arcade, Manchester. The London branch will be under the charge of Mr. G. Graham.

**Melksham.**—Mr. Thomas Cutler, distributing engineer to the electric department of Bath, who had been called in to inspect the joints in the electric cables laid by Messrs. Tilke and Smith in consequence of the objection of the Council to the cables being closed in before inspection, has reported that he found that the "Diatrine" compound, with which all the boxes were filled after joints were made, was in a very good and satisfactory condition.

**Dundee.**—It is reported that electric motive power in a large jute works in Lochee has proved so successful, that several Dundee manufacturers are considering the desirableness of introducing a system of the kind from a public source of supply. The recent breakdown is reported to have been due to a defect in a cable near the generating station. The original cables having been laid down nearly a dozen years ago, some of them are getting worn out.

**London Electrical Fittings Co.**—This company, of Roberts Works, Hampstead-road, N.W., have just opened for the convenience of the trade a handsome and spacious showroom at 7A, Soho-square, W., where they exhibit their latest designs in electric light fittings and heaters. Among the novelties is a two-light patent counterweight, which has an adjustable range between the holders of 24in. to 12in., without spoiling the effect of the curves in the fitting.

**Long-Distance Telephones.**—It is reported that notwithstanding the failure of the first efforts to secure a direct telephone line between Paris and Rome, another attempt is to be made. The frequent failure of the voice and indistinctness which has been overcome in Germany by an ingenious use of little bobbins and spools occupies the attention of the mixed commission. They will probably proceed to Germany to study the system with a view to its introduction between Paris and Rome.

**Carnarvon.**—The National Wiring Company have served the Corporation with a writ for an alleged breach of contract. The Corporation have obtained counsel's opinion to the effect that their contention of not having entered into a binding contract was legally unassailable; but a deputation of the Council is to meet representatives of the company and treat with them for the payment, without admitting liability, of out-of-pocket expenses incurred by the company.

**Chester.**—In reply to a report from a committee appointed at a meeting of subscribers to the National Telephone Company, the Council have decided to support a movement having the object to form the present Chester, Wrexham, and Holywell areas into one free area, and the Rhyl, Llandudno, Bangor, and Carnarvon areas into another free area, and to put all the places within these areas into free communication with Chester. The Finance Committee has been empowered to act.

**Brighton.**—The Town Council have agreed that the salaries of the clerks and general office expenses of the telephone department be charged to capital account until the date when telephone rents become payable. They have confirmed the Lighting Committee's recommendation to lay 258 yards of electric mains in D'Aubigny-road at a cost of £110. The Board of Trade have written approving of the prices to be charged by the Corporation for electricity supplied by them within the parishes of Patcham and Preston Rural.

**Bradford-on-Avon.**—Local meetings are being held for the purpose of taking into further consideration the question of assenting to the granting of a provisional order by the Board of Trade to the Western Electric Distributing Corporation, who purpose laying mains in the Council's rural district. We understand that the Rural District Council are in favour of the scheme, but that the parishes of Limpley and Holt desire to be left out of it, as they might use the water power within their district for an independent supply.

**Cardiff.**—The Lighting Committee have adopted a report of Mr. Arthur Ellis on the cost of electrically lighting a number of suburban streets. The capital cost of electrically lighting the streets where mains and cables are already laid by 72 lamps will be £1,561. 12s. 6d., and the maintenance, current, etc., at £14 per lamp £1,610. The estimated capital expenditure on lighting other streets where there are no mains is £7,430. 10s. 8d. The Council will be recommended to light these streets, as suggested in the report.

**Camera Club.**—Dr. Geo. W. Rodman on Monday delivered a highly interesting lecture on "Photography of Some Electrical Phenomena," in the course of which he exhibited pictures showing the *modus operandi* and slides of electrical discharges from points, spheres, and brushes. Other slides illustrating effects of passing single and multiple discharges on coins in contact with emulsion, and the phenomena connected with the various effects on emulsion produced by the discharges on metals under different conditions, attracted particular attention.

**May-Oatway Fire Appliances.**—Several of the large railway companies are now taking steps to instal the above on their lines. The latest converts are the Midland Railway, who have just ordered from the May-Oatway Fire Appliances, Limited, a number of automatically-controlled detectors and indicators for the protection of their new station buildings, goods sheds, etc., at Heysham. The Liverpool Overhead Railway adopted this system after the fatal fire at the Dingle Station, and they were closely followed by the Lancashire and Yorkshire Railway for various buildings.

**Hampstead.**—The Borough Council have decided that mains for the supply of electric current be laid in portions of Willow-road, Johnstreet, and Albion-road. Upon the question of renewing portions of the mains in High-road, Kilburn, the same committee stated that they had received a report from the electrical engineer stating that it was absolutely necessary to renew them, but that if new house service boxes were put in, the risk of another breakdown would be reduced to a minimum. Consequently 48 new house boxes are to be provided in place of the old ones now in use, at a cost of £168.

**Grimsby.**—At a meeting of the Corporation Parliamentary and Electricity Committees on Wednesday the Lincolnshire and Yorkshire Electric Power Bill was discussed. It was pointed out that Grimsby was amongst the towns where the Corporation supply electricity, and that if the company obtained powers to enter the borough they would prove serious competitors to the Corporation's electricity undertaking. After discussion, the town clerk was instructed to see the solicitors to the promoters, and to try and persuade them to remove Grimsby from their proposed list. In the event of their being unable to come to some amicable arrangement, it was decided to recommend the Council to oppose the Bill in Parliament.

**Stock Exchange.**—The Stock Exchange Committee have ordered the Kalgoorlie Electric Power and Lighting Corporation's 150,000 6 per cent. cumulative preferred shares of £1 each, fully paid Nos. 1 to 150,000, to be quoted in the official list. Application has been made to the committee to appoint a special settling day in Callender (George M.) and Co.'s 50,000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 150,000. The committee have also been asked to allow the following securities to be quoted in the official list: the British Columbia Electric Railway Company's further issue of £45,000 Vancouver Power debentures of £100 each; and the Commercial Cable Company's further issue of £21,979 sterling 500-year 4 per cent. debenture stock, redeemable.

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**Call Boxes Rifled.** — The *Daily Chronicle* says perverted ingenuity has relieved 100 telephone call offices of their takings in the past few months in the London district. To prevent a continuance of the inconvenience to the company owning the telephones, alarm bells, which will speak immediately the cash box is tampered with, are to be placed outside the call offices and in communication with the person in charge wherever practicable.

**Littlehampton.**—Three different companies have intimated their willingness to introduce electric lighting, and the schemes are before the Urban District Council. Mr. A. Alwyn proposes to form a private company for the purpose of securing a provisional order and erecting works to supply Littlehampton, Wick, and Arundel with electricity. The National Electric Construction Company and the National Provincial Electricity Corporation are also in the field.

**Saffron Walden.**—The Electric Lighting and Water Undertaking Committees have come to a co operative arrangement by means of which the generating station will be placed on the latter's premises. The two small boilers there will be replaced by the Electric Lighting Committee with two new steam-boilers of much greater pressure. By this plan the Water Committee, while securing two new steam-boilers of greater power, will be saved the capital expenditure on and the maintenance and depreciation of steam-boilers, and the electrical undertaking will have the advantage of labour for the day shift without charge. It is estimated the cost of the installation will be about £8,500, excluding the purchase of some additional property which must be acquired for the purpose. The Council have empowered the committee to employ a consulting engineer to advise.

**Beeston.**—The Urban District Council having obtained a provisional order under the Notts and Derbyshire Electric Power Supply Company, propose to take current from that company in bulk at the rate of 1½d. per unit. They are now circularising the district, and, in order to bring electricity within the reach of all responsible ratepayers, propose to arrange for five lights to be fitted in any premises free of charge to the consumer, and will supply electricity to those lamps at 6d. per unit (5½ hours use of one 8-c.p. lamp per 1d.) by means of slot meters. The ordinary charge of 6d. per unit works out for one hour a day, 5½ hours per 1d.; two hours a day, 8 hours per 1d.; three hours a day, 10 hours per 1d.; four hours a day, 11 hours per 1d. Places of worship will be charged 4d. The Council do not propose to engage in the electric wiring and fittings business, but will make such arrangements as will allow any responsible local firms to do the work to the satisfaction of the Council's consulting engineer.

**Watford.**—The number of consumers connected with the Urban District Council's mains to date amount to 314. The electrical engineer has been instructed to build a sub-station in Clarendon-road at an estimated cost of about £240. Contracts are to be entered into where an order exceeds £50. The engineer has also been asked to give an estimate at the next committee meeting as to the cost of laying the necessary pipeways and mains to connect up the Whippendell-road sub-station. The clerk reported at the last meeting that opposition against the Council's application for the new provisional order would come from the Watford Rural District Council, the Watford Rural Parish Council, the Bushey Rural Parish Council, and the Watford Gas Company, and counsel is to be instructed accordingly. It was stated with regard to the extensions required that, although they would have to apply for a loan of £25,000, the engineer would probably be able to suggest that the greater portion should not be spent immediately.

**Erith.**—Plans prepared by Mr. Hind for the necessary extension of the electric lighting have been approved, and Mr. Hind is to prepare estimates. We understand that the work is to be executed by direct labour. In reference to the proposed scheme of assisted wiring, the following scale has been approved for repayments by quarterly instalments over the periods of three or five years of the cost of electric light installations carried out by the Council: Cost of installation £5, deposit 10s., quarterly instalments for three years 8s. 4d., quarterly instalments for five years 5s. 6d.; £6, 12s., 10s., 6s. 7d.; £7, 14s., 11s. 8d., 7s. 9d.; £8, 16s., 13s. 4d., 8s. 10d.; £9, 18s., 15s., 9s. 11d.; £10, £1, 16s. 8d., 11s.; £11, £1. 2s., 18s. 4d., 12s. 2d.; £12, £1. 4d., £1, 13s. 3d. Intermediate amounts at proportionate rates. At the end of three or five years, the conditions having been fulfilled, the installation becomes the property of the consumer. The cost of the installation under this scheme is limited to £12. The above payments do not, of course, include the supply for current or meter rent.

**Cleethorpes.**—At the last meeting of the Electrical and Lighting Committee attention was again directed to the fact that the current breaker at the Clee Park was attached to a standard in the Cleethorpes district, and that the current from the Grimsby power station was thereby brought for a distance of about 25ft. within the Cleethorpes boundaries. It was resolved to recommend the Council that, if possible, an agreement be entered into with the Grimsby Corporation and the tramways company acknowledging that the fact of the current breaker being fixed in its present position does not in any way give the Grimsby Corporation or the tramways company any power either to supply electrical energy or to establish any rights whatever within the Cleethorpes boundary, and that failing this, notice be given to the tramways company to immediately alter their system and cease carrying power in this district from the Grimsby station. It was also resolved to recommend the Council that Mr. J. F. Wintringham be instructed to prepare a petition against the Lincolnshire and Yorkshire Electric Power Bill, 1904, to safeguard the interests of the Cleethorpes Council, and to take the necessary steps to lay the same before Parliament.

**"Simplex" Steel Conduits.**—Elsewhere appears an announcement referring to an injunction obtained by the Simplex Steel Conduit Company, Limited, against the Metallic Seamless Tube Company, Limited, perpetually restraining the latter from passing off, or enabling or assisting others to pass off, any conduits or other electric fittings or apparatus not of the former's manufacture as or for the former's goods, etc.; and from selling, offering, or exposing or advertising for sale, or procuring to be sold, any such goods as aforesaid under any name of which the word "Simplex" forms a part, without clearly distinguishing such goods from the Simplex Company's goods; and from selling or supplying any such goods as aforesaid as "Simplex" goods in response to orders for "Simplex" goods. On Nov. 17, 1903, a perpetual injunction similar to the above was obtained by consent against Messrs. Julius Sax and Co. Apparently the Simplex Steel Conduit Company has been put to considerable trouble and expense by the unfortunately prevailing practice on the part of some firms who imitate the production of successful manufacturers, and do not trouble themselves to point out that the imitation goods which they make differ from those manufactured by firms who have gained a reputation for the quality of the articles they send out. We are informed that the Simplex Company are determined to maintain their reputation and exclusive right to the use of the word "Simplex" in connection with steel conduit systems.

**London Gazette.**—A receiving order has been made out in the estate of Messrs. Gardner Bros. and Co., electrical engineers, Hornginglow-street, Burton-on-Trent, Staffordshire. A petition for the winding-up of the Electric Tramways Construction and Maintenance Company will be heard on Feb. 2. Any person intending to appear on the hearing of the petition must send notice in writing to Mr. S. G. Warner, Effingham House, Arundel-street, Strand, W.C., not later than 6 p.m. on Feb. 1. A general meeting of members of the English Electric Manufacturing Company will be held at the offices of Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street, London, on March 3, at 12 o'clock noon, for the purpose of receiving the final account of the liquidators. A first and final dividend of 1s. 9¾d. in the £ has been declared in the estate of John Pierrepont Child, electrical engineer, 150, Powis-street, Woolwich, and 109, Piedmont-road, Plumstead, Kent; payable Feb. 5 at the Official Receiver's Office, 24, Railway-approach, London Bridge, S.E. At a general meeting of the South-Western Electrical Company, Limited, held at 14, Copthall-avenue, E.C., on Jan. 18, Mr. Frederick Seymour Salaman, 2, Oxford-court, Cannon-street, London, was appointed liquidator in the place of Charles Edward Peebles (resigned). The P. and R. Storage Battery Company, Limited, is to be wound up voluntarily, and Mr. William Peto, 57B, Hatton-garden, London, E.C., has been appointed liquidator. The partnership between Charles Ross and Wilfred Hubert Price, electrical engineers and contractors, Town Hall-chambers, Leicester-street, Walsall, Stafford, trading as Ross, Price, and Co., has been dissolved by mutual consent.

**Hartlepool.**—The electric lighting is now an established fact. The service has been provided by the Northern Counties Electricity Supply Company, to whom the Corporation, after carefully considering the question of undertaking it themselves, transferred their rights under the parliamentary order obtained three years ago. Negotiations with the West Hartlepool Corporation with the view of extending the latter's service to Hartlepool failed, chiefly owing to the terms asked being considered too high. The public lighting at present consists of 40 large arc lamps made by Crompton and Co., Limited, to be used from dusk till 11 p.m., and 80 incandescent lamps to be used from 11 p.m. to sunrise. The present plant is capable of supplying the equivalent of 4,500 8-c.p. lamps installed, and consists of a gas engine by Crossley Bros., Limited, Manchester, and a dynamo by the British Westinghouse Electric and Manufacturing Company, Limited, Manchester. The switchboard was made by the Electrical Transmission Company, Limited, London, and the storage battery of 250 cells by the Chloride Electrical Storage Company, Limited, of Clifton Junction. A booster and balancer by Crompton and Co., Limited, of Chelmsford, are fixed in the engine-room. The price of supply for lighting is 4½d. per unit, and the price for power is 2½d. per unit, in each case subject to a discount of 5 per cent. for cash. The company do not charge any meter rent. The supply is on the three-wire continuous-current system, with a pressure of 230 volts for lighting and 460 volts for power. There are 1,446 yards of cable feeder, 13,601 yards of distributors, and 5,600 yards of trench.

**Camberwell.**—A conference will be held at the Poplar Council Offices, High-street, Poplar, on Feb. 11, at 3 p.m. The following delegates have been appointed to represent the Borough Council: the Worshipful the Mayor, Councillor F. T. Pexton (chairman, Works and General Purposes Committee), and Councillor J. R. Tomkins, together with the town clerk and borough engineer. A letter has been received from the Board of Trade transmitting copy of letter which has been sent to the undertakers under the Crystal Palace and District Electric Lighting Orders, 1890 and 1894, enclosing a description of the system of supply of electrical energy which has been approved by the Board of Trade for the supply of energy by the Blackheath and Greenwich District Electric Light Company, Limited, for the purposes of the orders, in the event of that company acquiring the whole or a part of the undertaking authorised by the orders under the provisions of Section 6 of the Blackheath and Greenwich District Electric Light Company's Act, 1903. The approval is subject to the regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy imposed by the Department. The Board's formal approval of the connection by the undertakers of certain parts of their electrical circuits with earth has also been given in the form forwarded. As already noted, the system adopted is a high-pressure alternating two-phase supply at a frequency of 50 complete periods per second to transformers placed in some cases on consumers' premises, or in sub-stations, but mainly in street boxes. From the transformers distributing mains will be laid for a two-phase or single-phase alternating-current low-pressure supply on the two-wire system.

**Aberdeen.**—The Town Council have just made the annual inspection of the electric station at Dee Village. In the course of the usual complimentary speeches it was stated that when Cotton-street works were projected in 1891, the expectations of the committee, under the con-

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venership of ex-Bailie M'Kenzie, were that they would cost, to begin with, £21,300 to generate 150 000 units, but at the end of 1894 the result of their first year's working was as follows: capital, £23,000; while the units generated came to 72.000. In 1899 the capital invested in the undertaking was roundly £65,000, or three times greater than in 1894. The units generated had risen to 505,880, or seven times more than in 1894. To-day the capital stood at, roughly, £200 000, or three times greater than in 1899, and 8½ times greater than in 1894. The units generated up to Jan. 19 stood at 2 014,637, with only half the year gone. This was practically four times greater than in 1899, and 28 times greater than in 1894. The response which the committee of 1891 got from the public in their reply to a circular, asking for an indication from the gas consumers in the compulsory area as to whether or not they would take in the electric light if the Corporation would supply was as follows: no reply, 20; doubtful replies, 3; not prepared to take a supply, 119; prepared to take a supply, 7. Notwithstanding this disappointing result, and in face of an extremely doubtful prospect, the committee and the Council went forward with the undertaking, and within five years—viz., in 1899—the number of consumers had risen to 568. To-day they stood at 1,250. Five years ago the motors taking supply were 44 of 159 h.p. To-day there were 362 of 1,535 h.p. In 1889 there were arc lamps, public and private, including harbour, 312; to-day there are 659. Since the date of the last inspection (nine months ago) the units generated had risen 33½ per cent.; the number of consumers have risen 16·3 per cent.; the number of motors have increased 30 per cent.; and in the matter of horse-power connected with these motors 29½ per cent. The number of arc lamps for the nine months had risen 11·5 per cent. At Ferryhill and Cotton-street works the generating plant totalled 4,510 h.p., and over and above that there were in the batteries and balancing plant 1.200 h.p. Only a few days ago the Council decided to increase the plant by £20,000 or £30,000.

**London County Council.**—The Council on Tuesday agreed to lend the Stepney Borough Council £2,883 for electic light installation. Sanction was also given to the borrowing of £3,653 by the Islington Borough Council for electric light installation. Notices under Electric Lighting Acts and Orders were agreed to as follows: Blackheath and Greenwich District Electric Light Company, of intention to lay low-tension mains along a portion of Belmont-grove, Gloucester-place, and The Circus; Charing Cross and Strand Electricity Supply Corporation, various; County of London and Brush Provincial Electric Lighting Company, along Emerald-street; Kensington and Knightsbridge Electric Lighting Company, along a portion of Vicarage-gate; Metropolitan Electric Supply Company, high-tension mains along portions of High-street and Clifton-hill, and low-tension mains along Longacre and across St. Martin's-lane; St. Pancras Metropolitan Borough Council, along portions of Guildford-street and along Guildford-place, along a portion of Hanway-street, and along a portion of Gloucester-road; Westminster Electric Supply Corporation, mains along portions of Buckingham-gate and Buckingham Palace-road; from the Blackheath and Greenwich District Electric Light Company, to lay high and low tension mains along portions of Shooter's Hill-road and Watling-street, and to build transformer boxes at the corner of Shooter's Hill-road and Eastbrook-road, and in Watling-street; from the Charing Cross and Strand Electricity Supply Corporation, mains across and along a portion of Drury-lane, and along a portion of Newton-street, along a portion of Burleigh-street and across the Strand, Little Dean-street, and a portion of Villiers-street, and to build a box at the junction of Shaftesbury-avenue and Broad-street; from the County of London and Brush Provincial Electric Lighting Company, to lay power and low-tension mains along Ely-place; from the City of London Electric Lighting Company, to lay mains along portions of Park-street, Bank-end, and Bankside; from the Kensington and Knightsbridge Electric Lighting Company. to lay mains along a portion of Elvaston-place; from the Notting Hill Electric Lighting Company, to lay mains along a portion of Portobello-road; from the St. Pancras Metropolitan Borough Council, to lay mains along a portion of Kentish Town-road and York-road. The following notices served under orders granted to local authorities were received, under which the Council has no power of approval or disapproval of works: from the Battersea Metropolitan Borough Council, to lay mains along a portion of Wroughton-road, along a portion of St. John's-hill, along Sudbrooke-road and portions of Rusham-road, Thurleigh-road, and Ramsden-road; from the Hampstead Metropolitan Borough Council, to lay mains along portions of John-street, Willow-road, and Albion-road; from the Islington Metropolitan Borough Council, to lay mains along a portion of Mercer's-road, Hargrave-road, Harvest-road, Benwell-road, Mountgrove-road, Blackstock-road, and Packington-street.

## COLONIAL NOTES.

**Tomoana (N.Z.).**—The Canterbury Frozen Meat and Dairy Produce Export Company, Limited, of Christchurch, have received three boilers for their new works at Tomoana from the Stirling Boiler Company. The boilers are each 494 actual horse-power with ordinary small coal, 617 actual horse-power with good steam coal.

**Melbourne.**—The Electric Light Committee are adding to the plant already in use at the station in Spencer-street by increasing the number of boilers, and, at the same time, equipping both the new and old boilers with overhead coal-bunkers and automatic feeders. The installation of the new boilers is the prelude to an extensive increase in machinery, which will before long be necessary in order to cope with the rapidly growing demand made upon the Council to supply electricity, not only for lighting purposes, but also for motor power throughout the city. Tenders were received from Messrs. Babcock and Wilcox, the Stirling, and the Hornsby Companies. The boilers already installed at the works are all of the Babcock type, but on this occasion it was decided to adopt the Stirling boilers on account of the difference in cost, amounting to 20 per cent.

## PROVISIONAL PATENTS, 1904.

JAN. 18.

**1209. Improvements in the recording gear for electricity and other meters.** Harry Webber, Electricity Works, Earl-street, Hastings.

**1222. A method of automatically timing the electrical firing of internal-combustion engines.** Edmund Hawthorne Micklewood and Sydney Currin, 5, St. Michael's-terrace, Plymouth.

**1225. A terminal for making neat and finished ends to electric wires and cables.** Ernest Apted, 41, Blondel-street, Battersea Park-road, London.

**1242. Improvement in party-line telephone systems.** William Warren Dean, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 15, 1903, being date of application in United States.) (Complete specification.)

**1258. Improvements in electric clocks.** George Steele Tiffany and James Van Inwagen, 52, Chancery-lane, London. (Complete specification.)

**1279. Improvements in the manufacture and production of pipes or conduits or other articles for use underground or in other situations where they are subject to electrical or corrosive action.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Lewis Alfred Brown and Dwight Tredway, United States.) (Complete specification.)

**1296. Improvements in electrical ignition apparatus for internal-combustion engines.** Arthur James Postans, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1307. Improvements in electric condensers.** Ignacy Moscicki, 40, Chancery-lane, London. (Complete specification.)

**1308. Improvements in high-tension electric condensers.** Ignacy Moscicki, 40, Chancery-lane, London. (Complete specification.)

**1314. Improvements in electric igniters for explosion motors.** Clément Ropiquet and Alphonse Davelny, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, May 30, 1903, being date of application in France.) (Complete specification.)

JAN. 19.

**1326. Improvements in or relating to electrical switches.** Vernon Hope, Vincent Henry Sugden, and Walter Gardner, 55, Market-street, Manchester.

**1349. Magnetic clutch.** Wallace Fairweather, 65, Chancery-lane, London. (The Arnold Magnetic Clutch Company, United States.) (Complete specification.)

**1363. Improvements in electric bells and pushes, so that either a light can be obtained or a bell made to ring from the same batteries over the ordinary bell wiring.** Edwin Liddle and Guy Emanuel Druiff, 26, High-street, Stockton-on-Tees.

**1364. Improvements in or relating to gas or vapour electric apparatus.** Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper Hewitt Electric Company, United States.)

**1366. Improvements in magnetic brakes.** Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, Incorporated, United States.)

**1374. An improved method of and means for regulating electric motors.** Johan Gustaf Victor Lang, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1414. Telephone relays.** Béla Gáti, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 20.

**1473. Apparatus for indicating leakage in electric circuits.** Henry Harding Kenshole, 8, Quality-court, Chancery-lane, London.

**1481. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**1482. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**1483. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**1484. Improvements in controlling electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**1494. Improvements in alternating-current dynamos.** Marius Latour, 45, Southampton-buildings, Chancery-lane, London. Date applied for under Patents Act, 1901, Jan. 21, 1903, being date of application in France.) (Complete specification.)

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JAN. 21.

**1513. Improved shade carrier holder for bayonet or screw electric lampholders.** Paul Escaré, 129, Wardour-street, London.

**1539. An improved system for limiting the destructive effect of an electric arc accidentally formed within a generating station, and a method for the automatic supply of light during and after a breakdown.** Henry William Clothier, 108, Gilda Brook-road, Eccles, Manchester.

**1542. An improved type of street junction box for the distribution of electrical energy.** Reuben Cohen, 5, Zetland-road, Middlesbrough.

**1549 Improvements connected with electric cable troughs or conduits.** The Seacombe Pressed Brick and Tile Works, Limited, and Frederic Phelp Jones, 15, Water-street, Liverpool.

**1599. Improvements in galvanic batteries.** Johann Heinrich Ryffel, 18, Buckingham-street, Strand, London. (Complete specification.)

JAN. 22.

**1624. A new or improvod device for preventing accidents from overhead trolley wires when broken.** Albert Browne Mudie, 5, Corporation-street, Birmingham.

**1625. Improvements in and connected with electric arc lamps.** Otto Gross, 5, John Dalton-street, Manchester.

**1626. An apparatus to secure the doors of railway carriages or other vehicles by means of an electric or magnetic current.** William Thomas Chapman, Hallwater House, Endon, Staffs.

**1641. Improvements in apparatus for arranging and displaying telephonic addresses and for such like uses.** Arthur Voce Hunt, 55, Chancery-lane, London.

**1642. Improvements in and relating to electric switchboards.** The British Thomson-Houston Company, Limited, Edmund Basil Wedmore, and James Whitcher, 83, Cannon-street, London.

**1676. Improvements in processes for manufacturing electrodes for arc lamps.** André Blondel, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 5, 1903, being date of application in France.) (Complete specification.)

**1711. Improvements in and relating to secondary batteries.** Edward Christopher Ekstromer and the Ekstromer Accumulator Company, Limited, 1, Queen Victoria-street, London.

**1714. Improvements in electrical signalling apparatus.** Adolf Pieper, 18, Buckingham-street, Strand, London. (Complete specification.)

JAN. 23.

**1725. Improvements in electrical transmitting cables.** Frank Walter Hayward and Reginald Charles Fox, 23, King-street, Norwich.

**1727. Improvements in and relating to wireless telegraphy and appliances for use therein.** John Gardner, 51, Deansgate-arcade, Manchester.

**1785. Improvements in connection with conductors for the trolley system of electric traction.** Hugh Godfrey Nicholson, 4, South-street, Finsbury, London.

**1794. Improvements in or relating to electric clocks.** Frank Hope-Jones and Cecil Leslie Sumpter, 322, High Holborn, London.

**1799. Improvements in electricity meters.** William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

**1806. Improvements in electric mining lamps.** Van Raden and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Gulcher-Accumulatoren Fabrik G.m.b.H., Germany.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 11, 1904.*

1903.

**1063. Electric power transmitting mechanism.** Carolan. (General Electric Company.)

**1255. Electrical trolley standards.** Rains.

**2053. Electro-capillary relays and the like.** Armstrong and Orling.

**2574. Electrolytic process for the direct extraction of metals from ores and the like, and for the precipitation of the metals from the solutions, and apparatus therefor.** Mechwart, Coltri, et Cie. (Date applied for under International Convention, Aug. 1, 1902.)

**3509. Electrical lampholders.** Sperryn and Wood.

**3673. Automatic shunting points for overhead trolley wires used on electric railways.** Brecknell, Munro, and Rogers.

**5287. Controlling electric motors.** Carolan. (General Electric Company.)

**5288. Instruments for determining the power factor of alternating-current electric circuits.** Carolan. (General Electric Company.)

**6169. Method of manufacturing letters, numerals, and the like in copper or other metals by electrical deposition.** Elkington and Co., Limited, Lockerbie and Wilkinson, Limited, and Ryder.

**6316. Electric alternating-current generator especially for purposes of ignition in explosion motors.** Herz.

**6342. Safety guard or device for use with electric cars and similar vehicles.** Ward.

**6376. Means for electrically igniting miners' safety lamps.** Best.

**7625. Trolleys for electric tramcars.** Aldworth.

**10697. Watt-hour meters.** Ziegenberg.

**12906. Construction of trolley wheels for collectors for use in connection with overhead trolley wires and electric cars.** Brecknell, Munro, and Rogers.

**13027. Rheostats.** Weston.

**14551. Electric controllers for motors and the like.** Sundh.

**14555. Controlling devices for electric motors.** Lindquist.

**19887. Controlling apparatus for electric motors for electrically-propelled vehicles.** Lamme. (Date applied for under International Convention, Sept. 29, 1902.)

**25012. Systems of electrical regulation.** Adler.

**25222. Protective device for electric circuits.** Hornsby and Anger.

**25255. Means for limiting or preventing the upward movement of trolley booms beyond their normal position.** Carius.

**27830. Electric bell.** Rentsch and Schubert.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manut., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 4¼-4⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 93-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 3 | .. | 1⅜-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-93,261 | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | — | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | — | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | — | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | — | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 13¼-14¼ |
| —— 4½ per cent. Preference | 5 | — | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | — | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | — | 18-19 |
| —— 4 per cent. Debentures | 100 | — | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | — | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | — | 33-36 |
| —— 5 per cent. Bonds | 100 | — | 100-103 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | — | ¾-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | — | 114-117 |
| Bournemouth and Poole, Ordinary | 10 | — | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | — | 9⅝-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | — | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | — | 10-10¼ |
| —— 7 per cent. Preference | 5 | — | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | — | 6-7 |
| —— Nos. 20,001-30,000 | 5 | — | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | — | 14⅜ |
| —— " " " £10 Ord. | 6 | — | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | — | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | — | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. | 5 | — | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | — | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | — | 103-105 |
| Chelsea Electricity Supply | 5 | — | 5¾-6 |
| —— 4½ per cent. Debentures | 100 | — | 105-108 |
| City of London, Ordinary | 10 | — | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref. | 10 | — | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | — | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | — | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | — | 8-9 |
| —— 6 per cent. Cum. Pref. | 10 | — | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | — | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | — | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | — | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | — | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | — | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | — | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | — | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | — | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | — | 11-12 |
| —— per cent. Debenture Stock Red. | 100 | — | 102-105 |

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| Name. | Amount paid. £ | Last price. £ |
|---|---|---|
| Kensington and Knightsbridge and Notting Hill | 100 | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9¾-10¼ |
| London Electric, Ordinary | 3 | 1¾-2¼ |
| —— 6 per cent. Pref. | 5 | 5¼-6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 97-100 |
| Metropolitan Ordinary | 10 | 17-18 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 96-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 93-101 |
| —— Preference | 4 | 100-103 |
| Notting Hill Electric Lighting | 10 | 12½-13½ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | 99-102 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | 5¼-5¾ |
| —— 4 per cent. Debenture Stock | 100 | 97-100 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | 98-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | 3½-3¾ |
| —— 4 per cent. Debenture Stock | 100 | 85-90 |
| South London, Ordinary | | 3¼-3¾ |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | 14½-15½ |
| —— 7 per cent. Pref. | 5 | 8-9 |
| —— 3½ per cent. Deb. | 100 | 98-101 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4¼-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4¾-5¼ |
| Westminster, Ordinary | 5 | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 6-6½ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 91-94 |
| —— 4 per cent. Pref. | 100 | 98-101 |
| —— ,, ,, deferred | 100 | 91-94 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 113-116 |
| City and South London, Consolidated Ordinary | 100 | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 126-129 |
| —— ,, ,, ,, '96 | 100 | 123-126 |
| —— ,, ,, ,, '01 | 100 | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | 4¾-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3¼-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 102-104 p.c. |

| Name. | Amount paid. £ | Last price £ |
|---|---|---|
| British Electric Traction Ord. 1-300,000 & 50,001-80,000 | 10 | 11¼-11⅝ |
| —— 6 per cent. Cm. Pf., 30,001-50,000 | 10 | 11¼-11⅝ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-87,500 | 5 | 4¾-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-107 |
| —— Prov. Cert., all paid | 100 | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-1¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22¾ |
| —— 5 per cent. Cum. Pref. | all | 14½-15¼ |
| —— 4½ per cent. Deb Stock | 100 | 113-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3¼-4 |
| London United Tys. (1901), 5 per cent. Cum. Pref. | 10 | 11¼-11⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | ¼-⅜ |
| New General Traction, Ordinary | 5 | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8¼-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 102-104 |
| —— Deferred Stock | 100 | 78-81 |
| —— 6 per cent. Cum. First Pref. | 10 | 13¼-14¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | 13¼-14¼ |
| —— 5 per cent. Non-Cum. Third Pref. | 5 | 5¼-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 95-97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 100-102 |
| Oriental Telephone and Electric Company | 1 | ¾-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week: Ending | 1904. £ | 1903. £ | Increase or decrease: Week. £ | Current year. £ | Miles of single track open: 1904. | 1903. | Accounts for past year: Ending | Total receipts £ | Passengers carried. | Car miles run. | Receipts per Mile of track: Pas-s'nger d. | Car mile. d. | Mile of track. £ | Cost per car mile. d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aberdeen Corporation | Jan. 23 | 1,082 | 762 | + 320 | + 7,938*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | — | | — | | | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 22 | 728 | 629 | + 99 | + 1,562 | 24 | 24 | March 25*g* | 40,964 | 7,234,105 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 21 | 263 | 254 | + 9 | + 201 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 23 | 190 | 163 | + 27 | − 24 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·52 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 24 | 1,612 | 1,546 | + 66 | + 8,685 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 20 | 840 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 21 | 3,404 | 2,860 | + 544 | +18,525 | 41 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 24 | 659 | 635 | + 3 | + 2,689*h* | 6½ | 6½ | ,, 31 | — | 10,132,508 | 1,031,928 | 1·30 | 10·10 | — | — |
| Bristol Tramways Company | ,, 22 | 4,491 | 4,117 | + 374 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 23 | 822 | 644 | + 178 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 24 | 259 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 23 | 1,779 | 1,485 | + 294 | +21,640 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | — | — | — | — | — | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 23 | 7,100 | 6,776 | + 324 | + 130*h* | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 21 | 3,227 | 3,367 | + 140 | + 936*h* | 6¾ | 6¾ | ,, 31 | 155,003*a* | 19,069,315*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 21 | 393 | 379 | + 19 | + 32 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 22 | 204 | 198 | + 6 | − 245 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 25 | 162 | 169 | + 7 | + 37 | 3 | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 24 | 92 | 84 | + 8 | + 19*h* | — | — | Dec. 31 | 5,795 | 364,736 | 102,037 | 3·81 | 13·62 | 359 | 7·66 |
| Dublin U. T., electric cars | ,, 23 | 3,619 | 3,474 | + 125 | — | 46 | 46 | March 31 | 163,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 23 | 592 | 670 | + 22 | | | | | | | | | | | |
| Dundee City Tramways | ,, 20 | 721 | 717 | + 44 | — | 22 | 22 | May 15 | 35,874 | 9,081,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 23 | 551 | 424 | + 127 | + 7,933 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 23 | 13,374 | 11,628 | +1,745 | +49,423*h* | 124 | 124 | May 31*g* | 666,572 | 177,179,549 | 11,908,750 | 0·88 | 11·25 | 5,489*b* | 7·40*d* |
| Halifax Corporation | ,, 16 | 2,173 | 2,101 | + 72 | + 5,899 | 30½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 23 | 1,099 | 892 | + 207 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 7·32 |
| Hull Corporation, E. S. | ,, 23 | 1,979 | 1,659 | + 319 | + 5,912 | 19 | 19 | ,, 31 | 87,707*h* | 21,965,899 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 23 | 120 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 20 | 173 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 20 | 5,020 | 4,343 | + 677 | +14,818 | 77 | 77 | March 25*g* | 262,655 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,383 | — |
| Liverpool Corporation | ,, 16 | 9,531 | 8,495 | +1,046 | + 1,330 | 101 | 101 | Dec. 31 | 514,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 24 | 1,497 | 1,454 | + 43 | + 334*h* | 15½ | 15½ | June 30 | 79,252 | 10,456,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | — | — | — | — | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 16 | 136 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 16 | 91 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 23 | 3,411 | 2,915 | + 525 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,174,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | — | — | — | — | — | 29 | 29 | Sept. 30 | 47,651 | 9,169,157 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 25 | 103 | 93 | + 10 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 21 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 18 | 3,443 | 2,628 | + 815 | +15,400 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 24 | 4,217 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 55,812,019 | 4,926,083 | 0·904 | 10·428 | 7,510 | 6·70 |
| Southampton Corporation | ,, 21 | 845 | 772 | + 73 | — | 11 | 11 | ,, 31 | 35,274 | 9,054,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 24 | 1,024 | 934 | + 90 | + 2,526 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 17 | 578 | 488 | + 90 | + 3,662 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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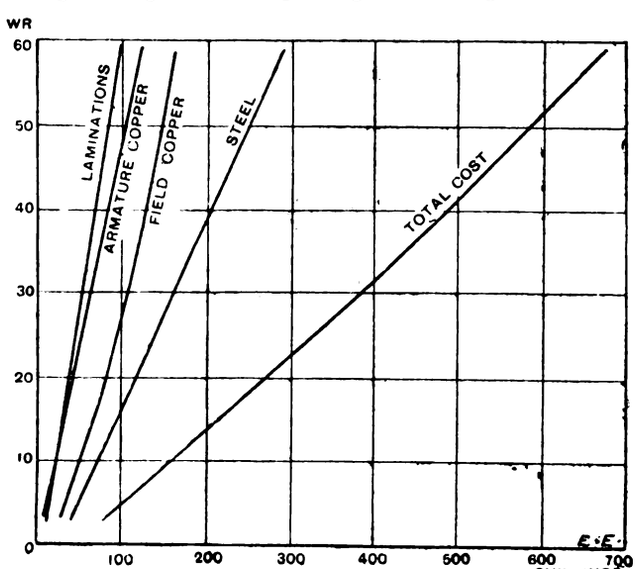
## CONTINUOUS-CURRENT DYNAMOS.

BY J. W. BURLEIGH.

A short time ago the writer proposed a formula for the determination of an output coefficient applicable to continuous-current machines. It is generally recognised that any method of comparison based simply on the dimensions of armature is very misleading. As an example, say we take an armature with a density in gap space of five Kapp lines per square inch. Now, it would not be a difficult matter to design an armature with the same overall dimensions and use a density of, say, 10 lines per square inch in gap; in this latter case it would clearly mean double the watt output, although the dimensions are the same. Any formula, therefore, which does not take into consideration the flux density in gap space is, in the writer's opinion, almost useless, especially is this the case when comparing the cost of machines from armature dimensions. To correctly compare different designs it is absolutely necessary to get at the cost of the active material, of course having due regard to the sparking and heating factors.




Cost Curves of Effective Material for a Line of Dynamos (Four Pole) from 3·21 to 58·6 WR.

The writer has recently designed a line of dynamos on as nearly the possible the same basis, the densities in each part, sparking, heating, and output coefficient being the same for each size. The cost of active material was carefully plotted in terms of watts per revolution ($W_R$) and cost in shillings. An analysis of the cost curve is also given, which shows the prime cost of material used in different portions of the machines. It will be observed that in taking the active material the writer includes only laminations, armature copper, field copper, and steel, as he is of opinion that it is scarcely fair to include the commutator, which, as he believes, is usually done. In the writer's opinion, curves similar to these (combined with the output coefficient proposed) will be found extremely useful in comparing the cost and simplifying the calculations of fresh designs; especially will this apply when a series of machines are to be constructed on similar lines, as in the case of the following machines, the leading particulars of which are given:

$W_R$ = watts per revolution;
$Z_a$ = flux through armature;
$\beta$ = ratio of polar span to polar pitch;
$d_g$ = number of Kapp lines per square inch in gap;
C = output coefficient;
C′ = a factor which × the square root of $W_R$, gives total flux through armature;
D = diameter of armature in inches;
L = length of armature in inches (over laminations);
$D_t$ = lines per square inch at root of teeth;
$D_f$ = lines per square inch in magnets;
$D_y$ = lines per square inch at yoke;
R = revolutions per minute;

$$C = \frac{2\,C'}{d_g \pi \beta} = \frac{D\,L}{\sqrt{W_R}};$$

$$\text{Output in watts} = \left(\frac{D\,L}{C}\right)^2 R.$$

LINE OF FOUR-POLE DYNAMOS FROM 3·21 TO 58·6 WR.

| WR. | Output: Volts. | Amps. | Speed. | Output coefficient: $Z_a$ C′. | $\beta$. | $d_g$. | C. | D L. | Sizes of armature over laminations: D. | L. |
|---|---|---|---|---|---|---|---|---|---|---|
| 3·21 | 110 | 35 | 1,200 | 150 | ·69 | 7·11 | 19·45 | 35 | 8½ | 4½ |
| 10 | 100 | 100 | 1,000 | 151·5 | ,, | 6·98 | 20 | 63·5 | 9¾ | 6½ |
| 14·12 | 220 | 45 | 700 | 148 | ,, | 7·15 | 19·05 | 72 | 11½ | 6½ |
| 19·4 | 220 | 75 | 850 | 146·5 | ,, | 7·02 | 19·2 | 84·3 | 13¼ | 6⅝ |
| 29·4 | 110 | 200 | 750 | 150 | ,, | 7·02 | 19·7 | 106·75 | 15½ | 7 |
| 40·8 | 110 | 260 | 700 | 150 | ,, | 6·98 | 19 9 | 127 | 17½ | 7½ |
| 58·6 | 220 | 160 | 600 | 150·5 | ,, | 7·21 | 19·2 | 147 | 19 | 7¾ |

| WR | Densities: $D_t$. | $D_g$. | $D_f$. | $D_y$. | Heating. Armature. WR | Watts ÷ cooling surface. | Coils. Watts ÷ cooling surface. |
|---|---|---|---|---|---|---|---|
| 3·21 | 21·8 | 7·11 | 15·85 | 13·2 | 3·21 | 1·21 | ·635 |
| 10 | 21·7 | 6·98 | 15·35 | 13·35 | 10 | 1·61 | ·626 |
| 14·12 | 21·2 | 7·15 | 15·4 | 13·25 | 14·12 | 1·41 | ·588 |
| 19·4 | 21·5 | 7·02 | 15·7 | 13·25 | 19·4 | 1·6 | ·602 |
| 29·4 | 21·3 | 7·02 | 15·05 | 13 | 29·4 | 1·54 | ·65 |
| 40·8 | 21·3 | 6·98 | 15·5 | 13 | 40·8 | 1·53 | ·596 |
| 58·6 | 21·7 | 7·21 | 15·85 | 13·05 | 58·6 | 1·65 | ·594 |

| WR | Reactance volts. | Ats. per pole ($a$). | Ats. gap ($b$). | $\frac{b}{a}$ | Ats. in polar angle. | Reversing field. |
|---|---|---|---|---|---|---|
| 3·21 | 2·86 | 835 | 1,258 | 1·5 | 574 | 3·86 |
| 10 | 3·6 | 1,400 | 1,640 | 1·17 | 980 | 2·81 |
| 14·12 | 3·2 | 1,710 | 2,110 | 1·23 | 1,170 | 3·1 |
| 19 4 | 3·08 | 2,020 | 2,480 | 1·18 | 1,390 | 3·09 |
| 29·4 | 2 96 | 2,400 | 2,920 | 1·21 | 1,660 | 3·02 |
| 40·8 | 2·94 | 2,760 | 3,280 | 1·19 | 1,900 | 2·93 |
| 58·6 | 3·06 | 3,360 | 3,820 | 1·14 | 2,310 | 2·84 |

Reversing field is calculated from Kapp's formula

$$d_g \left(\frac{X_a - X_q}{X_a}\right),$$

where $X_a$ = Ats. required for gap;
$X_q$ = Ats. in polar angle;
= number conductors under pole × current in each conductor / 2

## THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.

BY WM. BREW.

*(Concluded from page 106.)*

*Trunk Mains.*—Transmission schemes are considerably handicapped with restrictions regarding high-pressure overhead wires, and the great difference between the cost of the underground high-pressure cable and the overhead line as used abroad.

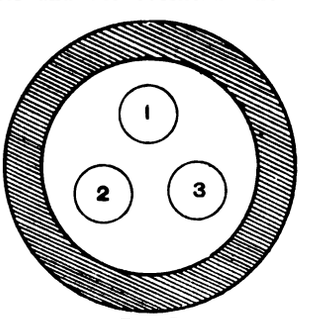



FIG. 5.

Although plenty of data have been published regarding Continental overhead lines, the writer is not aware that tests of the impedance and charging currents, etc., of British power lines are much in evidence. This is probably due to the fact that with short lines and pressures of a few thousand volts the quantities in question do not affect the station instruments. The impedance

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, Jan. 14.

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of cored low-pressure distributor cables is, however, of importance, and should be taken into account in the laying out of a three-phase distributing system.

The writer may perhaps here be pardoned if he briefly reminds you of the elementary principles underlying the impedance of symmetrically-cored polyphase cables.

The value of H, the intensity of magnetic field in C.G.S. units at a point outside the conductor 1 (Fig. 5) and at a distance from it, $l$, is

$$H = \frac{2\,C_1}{l},$$

where $C_1$ = current in conductor 1. If N = total number of lines of force in the space, $d$, between the surface of 1 and the centre of 2,

$$N = \int_r^d \frac{2\,C\,\delta l}{} = C \log_e \frac{d}{r},$$

where $r$ = the radius of conductor 1. Again, considering the interior of conductor 1, it is readily shown that if $N^1$ = the number of lines of force linked by the current itself,

$$C_1 N^1 = \frac{C_1}{2}.$$

The self-induction of the conductor 1 per unit length is therefore

$$L_1 = \left(2 \log_e \frac{d}{r} + \tfrac{1}{2}\right) \times 10^{-9}.$$

Now in the ordinary case of two conductors acting as flow and return, the return conductor will just double this value, L, for the circuit.

In the case of polyphase cables, the number of lines of force, N, linking any conductor will depend upon the resultant field due to the currents, $C_1$, $C_2$, etc., in the conductors and the induction coefficients, $L_1$, $L_{12}$, etc., between them.

For a symmetrical three-phase cable we shall have

$$N = L_1 C_1 + L_{12} (C_2 + C_3) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For a symmetrical five-phase cable it will be evident upon drawing a figure that we shall have

$$N = L_1 C_1 + L_{12} (C_2 + C_5) + L_{13} (C_3 + C_4) \quad . \quad . \quad (2)$$

and so on. Now in the case of the three-phase cable we have

$$C_1 = C \sin \theta\,;$$

$$C_2 = C \sin \left(\theta + \frac{2\pi}{3}\right);$$

$$C_3 = C \sin \left(\theta - \frac{2\pi}{3}\right);$$

and $$(C_2 + C_3) = C \left(2 \sin \theta \cos \frac{2\pi}{3}\right) = -C \sin \theta = -C_1 . \quad (3)$$

It will be evident from expressions (1) and (3) that the currents in conductors 2 and 3 will jointly combine to give a resultant field which is equivalent to an ordinary return to conductor 1.

TABLE I.—Test of Impedance of 6·2 Miles of (Three-Core ·15) Extra High-Tension Feeder at 50 ⌒⌣.

| P.D. between phases at sending end. | | | | Current per core at sending end. | | | Impedance per single core. |
|---|---|---|---|---|---|---|---|
| $V_1$ | $V_2$ | Mean | $\frac{\text{Mean}}{\sqrt{3}}$ | $C_1$ | $C_2$ | Mean | |
| 89 | 88·5 | 88 | 51·2 | 26 | 25 | 25·5 | 2 01 |
| 90 | 90·5 | 90·5 | 52·2 | 26 | 25·5 | 25·75 | 2·03 |
| 99 | 99 | 99·5 | 57·2 | 28·5 | 28 | 28·25 | 2 02 |
| 108 | 108 | 108 | 62·5 | 31·5 | 31 | 31·25 | 2 |
| 116·5 | 116 | 116·5 | 67·2 | 34 | 33·5 | 33·75 | 1·99 |
| 119 | 119 | 118·5 | 68·6 | 34·2 | 34 | 34·1 | 2·01 |
| | | | | | | Mean = | 2·01 |

One phase was disconnected, and the following readings were taken :

| P.D. between phases at sending end. | | Current per core at sending end. | | | Impedance per single core. |
|---|---|---|---|---|---|
| $V_1 - V_2$ | $\frac{V}{2}$ | $C_1$ | $C_2$ | Mean | |
| 92 | 46 | 22 5 | 22 | 22·25 | 2·07 |
| 100 | 50 | 25 | 24 | 24·5 | 2·04 |
| 99·5 | 49·75 | 25·5 | 24 | 24·7 | 2·02 |
| 110·5 | 55·25 | 27·5 | 26·5 | 27 | 2·04 |
| 122 | 61 | 31·2 | 30·5 | 30·8 | 1·98 |
| 123·5 | 61·75 | 31·5 | 30·7 | 31·1 | 1·99 |
| 140 | 70 | 35·7 | 34·5 | 35·1 | 2 |
| 141 | 70·5 | 35·8 | 35 | 35·4 | 1·99 |
| | | | | Mean = | 2·01 |

The test of the impedance of 6·2 miles of ·15 three-core feeder given in Table I. may be of interest. The pressures, $V_1$ and $V_2$, across two phases of the cable and the currents, $C_1$ and $C_2$, in two of the cores were measured at the sending end, whilst all three cores were bunched at the other end. It will be seen from the tests that the impedance of this cable per mile = 0·324. The measured resistance per mile of core = ·282.

Between the generating station at the Pigeon House Fort and the central distributing station at Fleet-street, a distance of 3·1 miles, three trunk mains have been laid. Each of these mains consists of a three-core, lead-covered British Insulated and Helsby Company's paper cable, the section of each core being ·15 square inch. Samples of these and other polyphase cables are before you.

Capacity tests made upon these feeders after they were laid gave the following results :

*High-Tension Feeders. ·15 Square Inch Three-Core Extra High-Tension Paper Cable, Lead Covered.*

| — | Feeder No. 1. | | Feeder No. 2. | |
|---|---|---|---|---|
| | 3·13 miles. | Per mile. | 3·13 miles. | Per mile. |
| One core against two other cores bunched to lead sheath..... | ·95 mfd. | ·303 | ·95 | ·303 |
| Three cores bunched against lead sheath.. | 1·53 mfd. | ·49 | 1·53 | ·49 |

*·04 Square Inch Three-Core Extra High-Tension Paper Cable, Lead Covered.*—The corresponding capacities of these cables per mile are : One core against two other cores bunched to lead sheath, ·25 mfd. ; three cores bunched against lead sheath, ·46 mfd.

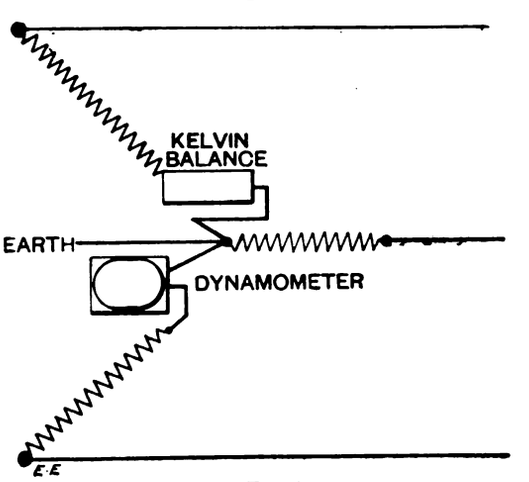


FIG. 6

The above capacities correspond to a Y capacity of ·373 mfd. per mile for the ·15 square inch three-core cable and ·298 mfd. per mile for the ·04 square inch three-core cable. The pressure charging these cable condensers is 2,880 volts, with 5,000 volts between phases. The minimum charging current per mile will, therefore, be for the ·15 square inch three-core = ·337 ampere, and for the ·04 square inch three-core = ·272 ampere. Resonance or deviation from the sine curve of E.M.F. may, however, considerably increase these values. In order to test this point experimentally, two phases of one of the 500-kw. sets were disconnected from the earthed neutral bar, and an electro-dynamometer and Kelvin balance were inserted between these phases and the neutral, as shown in Fig. 6. With the generator coupled to two trunk feeders in series the readings in Table II. were obtained. It will be noticed that the charging current per core considerably exceeds the theoretical minimum value. This current, however, includes leakage from two large switchboards, one at either end of the line, and newly erected.

TABLE II.—Test of Charging Current of Trunk Feeders, Three-Core, ·15 Cable, 6·26 Miles total. ·50 ⌒⌣.

| P.D. between cores. | P.D. to neutral point. | Charging current, amperes— | | Equivalent capacity of one core. |
|---|---|---|---|---|
| | | Elec. dynmtr. | Kelvin balance. | |
| 1,600 | 924 | 2·09 | 2·2 | ·813 |
| 2,100 | 1,212 | 2·88 | 2·74 | ·735 |
| 2,500 | 1,442 | 3·37 | 3·24 | ·745 |
| 3,200 | 1,850 | 4·12 | 4·14 | ·713 |
| 3,700 | 2,135 | 4·47 | 4·5 | ·667 |
| 4,200 | 2,430 | 4·85 | 4·79 | ·637 |
| 4,900 | 2,830 | 5·34 | 5·19 | ·62 |
| 5,180 | 2,990 | 5·6 | 5·48 | ·597 |

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It was considered of interest also to examine the wave-forms by means of an oscillograph under the conditions of this test, and the results of this examination will be found in the appendix.

Before leaving this question of the charging current taken by these feeders, it may be of interest to consider for one moment the relation of the alternator self-induction to it. Taking the alternator E.M.F. wave as being made up of a fundamental wave $e = \sin 2\pi n t$, where $n = 50$ periods per second, and a number of harmonics of frequency $= q$ times $n$, where $q$ has successive integral values, we may express the E.M.F. wave as

$$e = \Sigma E_q \sin ( 2\pi q n t + C_q )$$

$C_q$ being a constant fixing the relative position of any particular harmonic with regard to the fundamental.

Now, if resonance occurs with any particular harmonic, it has been found that the current flowing is exactly that due to the frequency of the harmonic in question. Hence the current, C, charging the cable will be

$$C_K = 2\pi q n K V,$$

and the short-circuit current of the alternator

$$C_L = \frac{V}{2\pi q n L},$$

where K = capacity in farads and L = self-induction in henrys of one leg of the system. When these two currents are equal, we have the well-known condition for resonance.

Applying this condition to the case of a 500-kw. Dublin set coupled to the three trunk mains (9·3 miles of ·15 cable)

$$C_K = \cdot 337 \times 9 \cdot 3 = 3 \cdot 14 \text{ amperes},$$

and $C_e = 145$ amperes, when $q$ is unity.

The value of $q$, therefore, which will make $C_K = C_e$ is

$$q = \sqrt{\frac{145}{3 \cdot 14}} = 6 \cdot 77.$$

We might, therefore, expect to get resonance with the seventh harmonic, or a frequency of about 338.

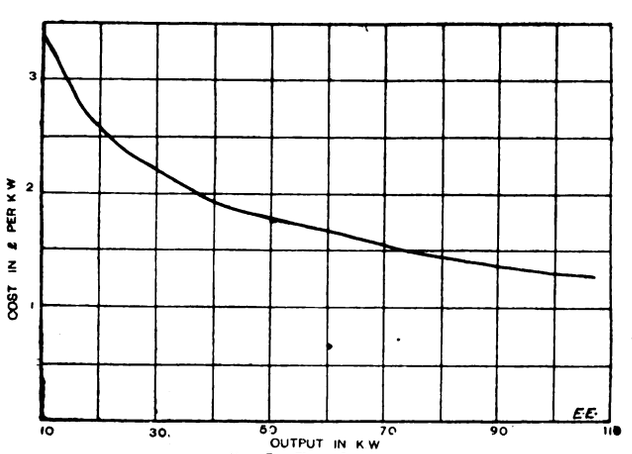


Fig. 7.—Transformers.

*Sub-Stations.*—In the case of three-phase sub-stations we have a variety of combinations of plant open to us. For instance, the transformers may be connected in delta or star on both high-tension and low-tension sides, or delta on one side and star on the other. Then, again, three single-phase transformers may be used one on each phase, or one single three-phase transformer may be used to take the place of the three single-phase transformers. In any particular case the considerations governing the choice of single-phase or three-phase transformers will generally be as follows: (1) capital cost per kilowatt installed; (2) weight per kilowatt installed; (3) efficiency; (4) suitability as regards working conditions.

As regards (1), the average cost of a three-phase transformer appears to be about 20 per cent. less than that of a single-phase transformer of the same output and type. On the other hand, a certain amount of spare plant will always have to be provided, and if three single-phase transformers be used, one spare transformer will act as an efficient spare to all three, whereas if three-phase transformers be used, it would in most cases be as economical to completely duplicate the plant as to multiply the number of transformers by using small ones of less efficiency and greater cost per kilowatt. The curve (Fig. 7) shows how rapidly the cost of transformers per kilowatt installed increases as the output is diminished. For instance, a 90-kw. transformer would cost about 28s. per kilowatt, whereas three 30-kw. transformers installed in place of it would cost 46s. per kilowatt.

As regards (2), where a number of sub-stations are distributed over a large area, the question of weight is of some importance as regards transport and appliances for moving the transformers in the sub-stations. The curves (Fig. 8) show that the three-phase has the advantage of the single-phase transformer in this respect.

As regards (3), the efficiency of the three-phase is usually less than that of the single-phase transformer. In good designs, however, this difference does not usually much exceed 1·5 per cent.

As regards (4), the three-phase transformer possesses the advantage of equalising the pressure upon an unbalanced load. On the other hand, if a fault occurs in a transformer, three or more times the amount of plant is thrown out of use thereby than would be the case with a fault with single-phase transformers.

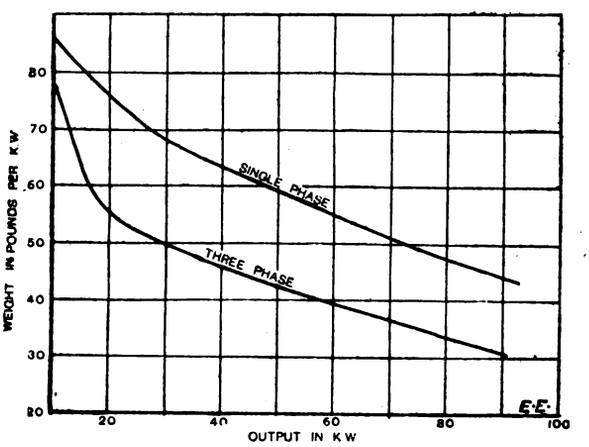


Fig. 8.—Transformers.

I might mention here that in Dublin we have not had the slightest difficulty as regards the banking of single-phase transformers in delta or star connection, transformers of 25 kw. output sharing the load proportionately throughout the range with transformers of 250 kw. output when banked with them, delta and star connected. A general arrangement plan of a Dublin underground sub-station is shown in Fig. 9. The transformers in each of the 21 new three-phase sub-stations are of the oil-cooled type and British Westinghouse Company's manufacture. The results of tests of some of these transformers are given in Table III.

Table III.—Test of Oil Transformers, 50 ⁓, Single Phase.

| Output of transformer in kilowatts | 250 | 50 | 50 | 40 | 30 | 20 |
|---|---|---|---|---|---|---|
| Ratio (volts) | 5,000 / 2,000 | 5,000 / 2,000 | 5,000 / 200 | 5,000 / 200 | 5,000 / 200 | 5,000 / 200 |
| Magnetising watts | 2,100 | 380 | 462 | 438 | 308 | 292 |
| Copper watts | 3,084 | 623 | 660 | 512 | 510 | 265 |
| Total watts | 5,184 | 1,003 | 1,122 | 950 | 818 | 557 |
| Per cent. loss | 2·08 | 2·0 | 2·24 | 2·37 | 2·73 | 2·78 |

The arrangement of the overground sub-station low-tension cables will be seen in Fig. 10. It will be noticed that the neutral wire from each cable-dividing box is joined to a copper earth-bar, which is connected through a recording ammeter to an earth-plate. This earth-bar is situated in a cable trench in front of the low-tension board, where it is joined to three of the tails from the transformers star-connected and forms their neutral point. The remaining three transformer tails are connected through fuses and switches to three 'bus bars indicated by colours, as the red, blue, and green phase respectively.

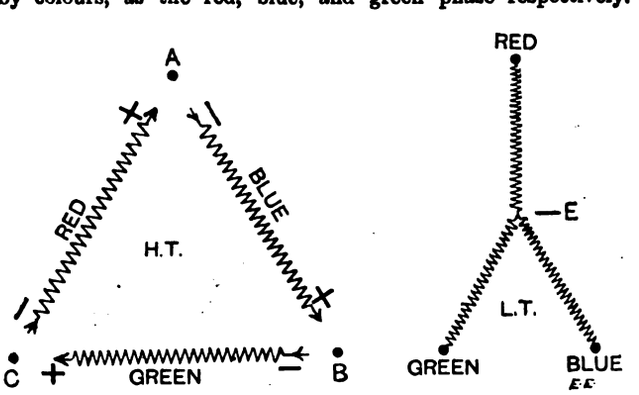


Fig. 11.

Special attention has been paid to the arrangements for switching in a spare transformer with ease and certainty as regards its phase relationship to the other transformers. The conditions to be satisfied will be evident from the diagram (Fig. 11). If A B C represent the high-tension 'bus bars, and + − the spare transformer terminals, the connection must be made in one

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of the three ways shown to correspond to one of the three phases on the low-tension side. The arrangements made for carrying out these connections in practice are shown in Fig. 12. In the centre of both high-tension and low-tension boards are placed plug connections of the well-known split-tube Ferranti type, actuated by a bayonet socket handle. All that is then necessary for the operator to do to replace a transformer, say, on the red low-tension phase is to insert plugs on the high-tension board in the two positions marked red, and the single plug on the low-tension board, making connection with the red phase and then close the switch.

The smaller sizes of Dublin sub-stations are connected with the central distributing station at Fleet-street by a ·04 square inch three-core sub-feeder and spare. This cable, we have seen, possesses a Y capacity of ·298 microfarad per mile. In the case of a sub-station taking a magnetising current of 0·27 ampere per phase, and coupled to a length of one mile of this cable, we have L = 34 henrys and K = ·298 × $10^{-6}$ farads. The natural frequency of oscillation, $f$, of this circuit is, therefore,

$$f = \frac{1}{2\pi}\sqrt{-\frac{1}{LK}} = 50,$$

which corresponds to the frequency of the supply.

The above conditions are very nearly attained with three 66-kw. transformers coupled in delta in one of the Dublin sub-stations. The feeder to this sub-station was switched on and off on several occasions, however, without any visible indication of resonance. It was considered of interest to examine this circuit by means of an oscillograph (see appendix).

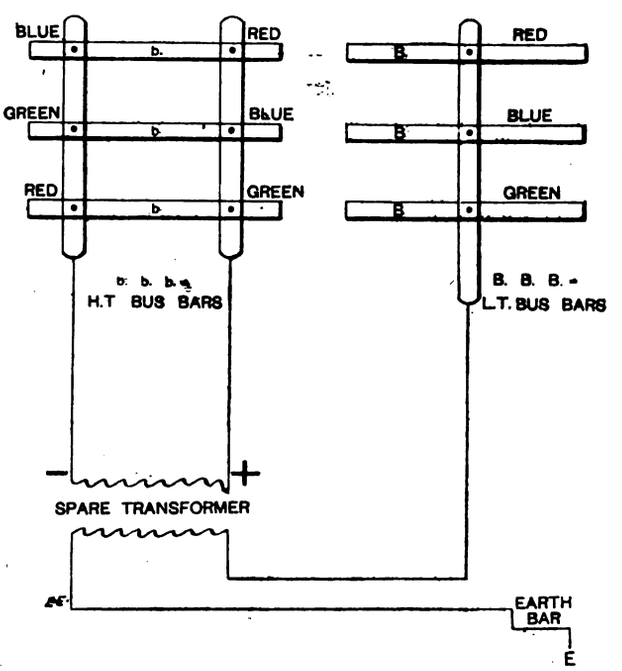


FIG. 12.

*Three-Phase Distribution.*—In considering the relative merits of various classes of distributors we must take into consideration the following points:

(*a*) As regards the consumer: (1) the maximum safe pressure permissible to earth and between the consumers' terminals and wires; (2) the maximum permissible voltage and variation at the consumers' terminals; (3) the minimum number of consumers affected by an interruption on any one conductor.

(*b*) As regards the supply company: (4) the maximum amount of energy capable of being transmitted for a given cost of cable; (5) the maximum pressure between any two conductors which the insulation of the cable and fittings of the street disconnecting boxes will have to withstand; (6) the maximum pressure to earth tending to break down the cable and disconnecting boxes.

As regards conditions (1) and (2), the Board of Trade regulations confine us within the limits of 250 volts between terminals and 4 per cent. variation either side of the declared pressure. It will be evident that conditions (1) and (4) are not the same in the case of three-wire distribution with direct or alternating current, and also in the case of multi-phase distribution, with cored cables, where the insulation of street boxes and that between the conductors of the distribution cables may have to withstand much greater pressures than will exist upon the consumers' premises. As regards condition (3), consideration should be given to the elasticity of any given system of distribution and the minimum number of consumers affected in the case of a temporary interruption of the supply on any one conductor of the distributor, such as would be caused by the blowing of a low-tension fuse or breakdown of a transformer in the case of three-phase distribution with four-core cables and network supplied from independent transformers star-connected. With three-phase distribution we have the choice between three-core or four-core distributors. We are also at liberty to vary the size of the fourth wire of the four core cable.

Table IV. illustrates the principal points by which distribution by three-core and four-core cables would differ in practice. As regards the size of the fourth or neutral wire to be adopted, we might follow the practice of three-wire distribution and reduce the section of this to some extent. There are, however, reasons which probably justify retaining this conductor of the same size. For instance: (*a*) one phase being interrupted, the resultant full load current of the other two phases will combine to form full load current on a neutral of the same section as the other conductors, and one-third only of the consumers will be affected; (*b*) similarly, two phases being interrupted, the neutral will then act as a return for the third phase of equal section, with a slightly increased drop in pressure; (*c*) the increase in the total cost of the cable with the fourth core added of same section as the other three cores only amounts to 20·6 per cent. and 17 per cent. respectively in the case of the ·1 and ·05 distributors considered for 30 per cent. increase in copper.

TABLE IV.—Comparison of Four-Core and Three-Core Distributors with 200 Volts at Consumers' Terminals and C R Drop of 4 per cent. per Quarter Mile.

| Description of Distributor. | | | | | |
|---|---|---|---|---|---|
| Four-core. Consumers connected between each phase and neutral. | | | Three-core. Consumers connected between each phase. | | |
| Section of each conductor in square inches. | | | | | |
| 0·1 | ..... | ·05 | ·1 | ..... | ·08 |
| Effective pressure between conductors in volts. | | | | | |
| 346 | ..... | 346 | 200 | ..... | 200 |
| Maximum instantaneous pressure between conductors. | | | | | |
| 488 | ..... | 488 | 283 | ..... | 283 |
| Effective pressure between conductors and neutral or earth. | | | | | |
| 200 | ..... | 200 | 115·5 | ..... | 115·5 |
| Maximum instantaneous pressure between any conductor and earth. | | | | | |
| 283 | ..... | 283 | 163 | ..... | 163 |
| Drop in volts per core per quarter mile = 4 per cent. of consumers pressure. | | | | | |
| 8 | ..... | 8 | 4·6 | ..... | 4·6 |
| Current density per core in amperes per square inch to give 4 per cent. drop. | | | | | |
| 726 | ..... | 726 | 421 | ..... | 421 |
| Number of kilowatts transmitted, with 4 per cent. drop per quarter mile. | | | | | |
| 43·5 | ..... | 21·7 | 14·6 | ..... | 7·3 |
| Cost of cable in £ per quarter mile laid and jointed in troughing = C. | | | | | |
| £181 | ..... | £124 | £150 | ..... | £106 |
| Capital outlay in £ per kilowatt transmitted quarter mile. | | | | | |
| £4. 17s. | ..... | £5·72 | £10. 3s. | ..... | £14. 5s. |

The principal points in favour of the four-core cable system which has been adopted in Dublin are: (1) greater amount of energy transmitted for given capital cost, the system acting in a manner similar to an ordinary three-wire distribution; (2) less variation in pressure due to want of balance amongst consumers; (3) less inconvenience to consumers in the event of any phases being interrupted—our working experience in Dublin is that considerable weight should be attached to this point. On the other hand, against the four-core cable we have: (1) greater pressure between conductors, tending to break down the insulation of the cable and street boxes; (2) extra expense as regards fittings in house service boxes, disconnecting boxes, etc.

Fig. 13 illustrates a Dublin four-way disconnecting box made by the British Insulated and Helsby Company for use with four-core cable. It will be seen that corresponding to each phase we have an insulated spider, to which connection is made to the corresponding core terminal posts by means of heavy spring links. Fig. 14 shows a house service box suitable for a three-core power service and a concentric lighting service.

*Public Lighting.*—With a three-phase system of supply, as with other systems, special transforming or other generating plant will generally be required to deal with public lighting by means of arc lamps. In those cases where the lamps are coupled to the distributors and switched on in circuits of from four to ten lamps at a time, special generating plant will not be needed, it is true, but this system involves a considerable labour item if a large area containing several hundred lamps has to be dealt with, and, moreover, with single-phase or three-phase systems would necessitate the use of alternate-current lamps, to the exclusion of the more efficient direct-current arcs. Assuming, then, that the area to be dealt with necessitates the use of a number of arc lamps in series, we have then to decide at what pressure the current should be supplied. It is to be noticed in connection with this point that the cost per mile of arc lighting as regards cables and lamps will be more or less independent of the pressure adopted if the circuits radiate from one central point. In other cases arc feeders are necessary—the number of these feeders being greater with lower pressures and fewer lamps in series. On general lines, it would appear, therefore, most economical to have as great a number of arc lamps in series as

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possible. There are, however, considerations of safety and freedom from breakdown which usually prevent these pressures exceeding 1,000-2,000 volts. The pressure of supply having been fixed, the best type of transforming plant—alternating or direct current—to be adopted will depend largely upon local conditions. We have the choice of (*a*) static transformers, chokers, etc.; (*b*) rectifiers; (*c*) motor-generators. If we are dealing with a large area, the cost of a spherical candle-power at the street lamps will usually be least with (*c*)—viz., direct-current open-type arcs under normal working conditions.

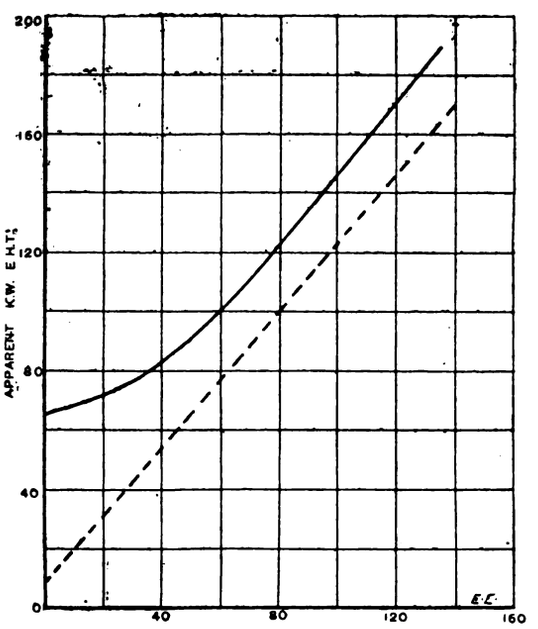



FIG. 15.—Kolben Motor-Generator, 210 B.H.P.

In Dublin the circuits are arranged with 21 lamps in series with a terminal pressure of 1,100 volts. The circuits are supplied by two direct-current generators in series, with their middle point earthed through an indicating device, the two generators being driven from an asynchronous motor on the same shaft. The maximum pressure to earth at any one lamp will, therefore, never exceed 550 volts, and will only reach this figure at two lamps on each circuit. The curves (Figs. 15 and 16) refer to one of these three-phase motor-generators of 210 b.h.p., of which there are three installed, supplying 500 double-carbon open-type arc lamps.

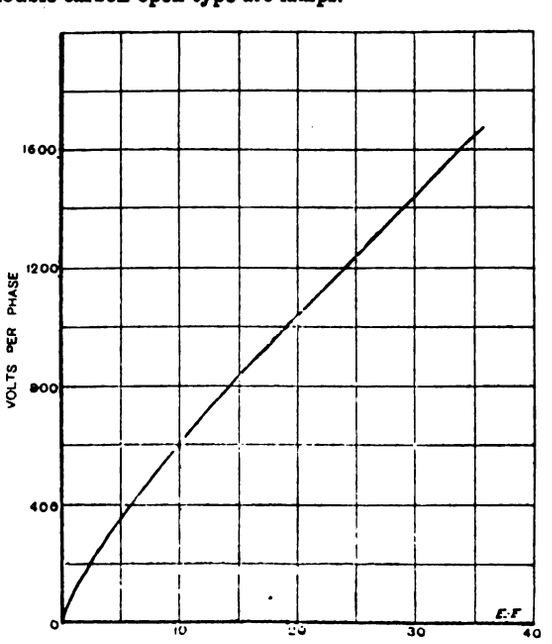
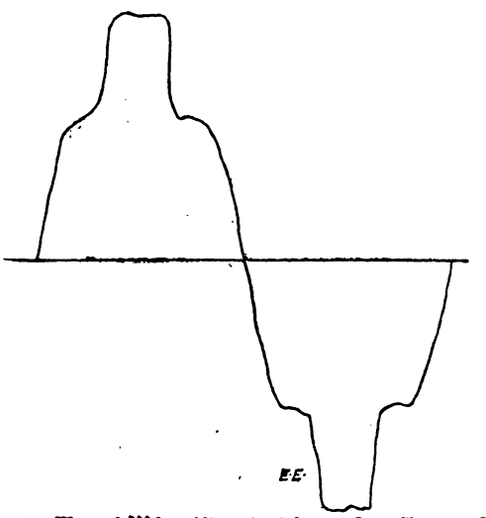
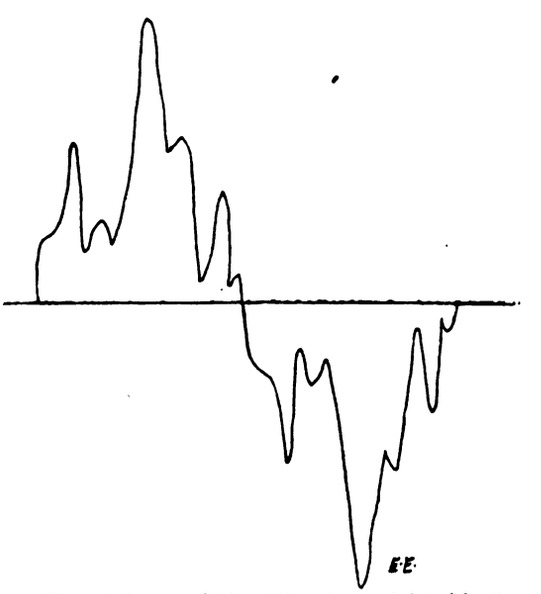



FIG. 16.—Kolben Motor, 210 B.H.P.

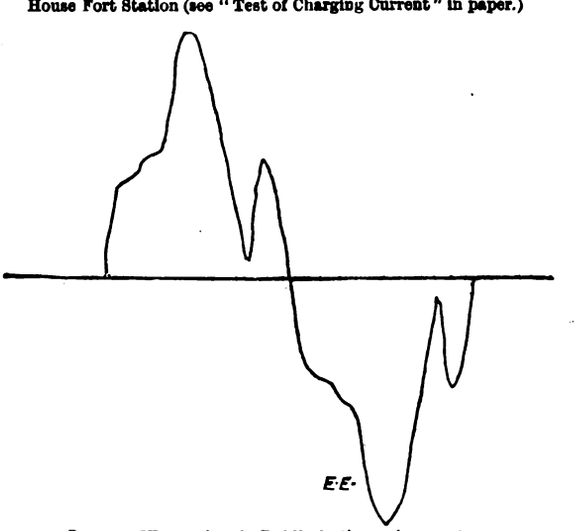
*Three-Phase Motor-Generators.*—The impedance curve for one of these machines is shown in Fig. 16. In making the observations, the motor was held stationary and the slip-rings short-circuited. Observations were then made of the current in each phase of the stator for various applied voltages. It is important to notice that the short-circuit current at 5,000 volts will amount to about five times the full-load current of 20 amperes. With a machine of this class, if copper fuses in oil baths of the Ferranti type be employed on the extra high-tension side, it will be necessary to examine them at frequent intervals, as the copper will have to be run hot at full load if the fuse is really to be of service in the event of a short-circuit on one of the generators. A curious effect has been observed with these




Pressure Wave of 500-kw. Alternator taken on Open Circu a Pigeon House Fort Sta




Pressure Wave of the same 500-kw. Alternator coupled to 6 2 miles of ·15 sq. in. Three-Core Cable. This curve was also taken at the Pigeon House Fort Station (see "Test of Charging Current" in paper.)




Pressure Wave taken in Dublin in the early morning.

machines. With one of the 500-kw. generators coupled to two trunk mains supplying a motor-generator at full load during the daytime with practically no other load on, a slight surge has been observed having a period of about twice that of the engine speed. The same load divided amongst two motor-generators had no effect. Again, with two motor-generators fully loaded the same conditions did not produce any appreciable effect. It would appear, therefore, that the motor-generator must be

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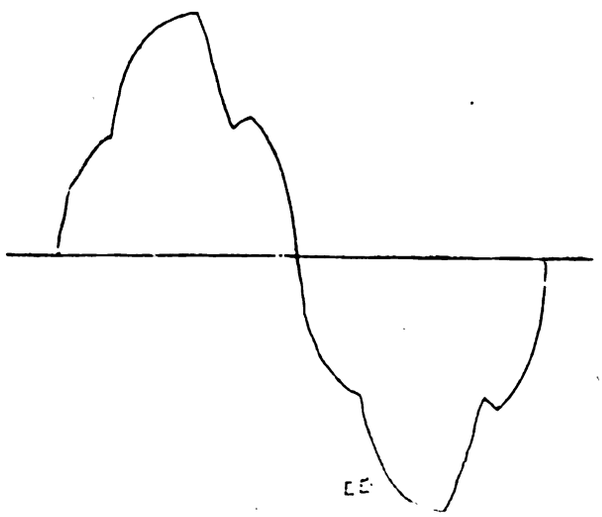
working at a certain power factor to produce this result. The writer is further investigating this matter. These machines were found of considerable value as regards their balancing effect on the pressures on the Dublin network when, on starting the new system of supply, the three phases were unavoidably somewhat out of balance for some days.



Pressure Wave taken in Dublin when a load of 1,000 kw. was being supplied.

In concluding these short notes, the writer desires to express his thanks to Mr. Robert Hammond for permission to bring the subject before you.

ADDENDUM.

The four accompanying curves of wave forms were taken by the author by means of an oscillograph. They are most interesting as showing great variations in the wave forms under different conditions.

## ELECTRICAL TRANSMISSION OF POWER AS AN AID TO GREATER ECONOMY IN WORKS AND FACTORIES.*

BY GEO. HARLAND BOWDEN.

When accepting your invitation to lecture to you on the question of electrical transmission of power, I felt at once that my difficulty would be in arranging a paper which would contain matter solely interesting to this society. The question of electrical transmission of power in workshops and factories is a subject on which I have read many papers and spoken on numerous occasions at various institutes and societies, and I feel that in a general way, unless I read a very advanced paper, which would not be of interest to any society except a body of electrical engineers, I could not attempt to give you what I would call an original paper, or, rather, I could not shake myself free from the points which I have so often described in detail. I also felt that in going minutely into a description of electrical power transmission as applied to engineering works, shipyards, iron and steel works, dockyards, etc., whilst this could not fail to be of interest, it could not exactly fulfil the requirements of this society. I am, therefore, about to lay before you certain facts relating to this question which cannot fail to interest you, and as the question of power transmission is such that, regardless of the class of machinery which has to be driven, and regardless of the nature of the factories, so long as power comes into the question and the efficiency of transmission is an important factor, then we can easily apply to-night's remarks to subjects of more local interest—viz., that of your spinning mills, wool-combing plants, etc. I would, therefore, ask you to allow me to endeavour to interest you in the engineering details of the subject, after which I shall be delighted to hear the remarks of the various members, their criticisms, their doubts as to the desirability or undesirability of this system as applied to your own class of works, and am prepared to discuss this matter with you and, to the best of my ability, answer your questions on the spot.

I have at present in course of construction in Bradford a plant which ought, in the course of a few months, to provide us with some exceedingly useful data. I refer to the electric installation which is now being installed in the works of Messrs. Amblers and Sons, which is being installed for the purpose of driving the whole of the wool-combing plant and all its auxiliary machinery. With the permission of Messrs. Amblers and Sons, I shall be very happy on a future date to give you the actual results which we have obtained in this plant, and which I have not the slightest doubt will more than realise the expectations we have as to the improved working and increased efficiency of this works in comparison with any other method of driving.

Electricity must simply be regarded as a method of transmitting power. In works or factories where boilers are scattered over an area, or the steam is carried from a central boiler plant to several engines, the efficiency is very low indeed. Owing to the possibility of concentrating the power in one or two boilers, and thus generating electricity by means of one or two highly efficient engines, and also owing to the flexibility of electricity, advantage can be taken of the intermittent nature of the work from the various tools or machines to immediately reduce the average load upon the central engines; and, again, owing to the high efficiency of that method of transmission, I have found many cases where this system has been the means of reducing the boiler plant to one or two boilers. These remarks apply to upwards of 100 typical British industries which have come under my special notice. Numerous of these cases have now but a single boiler where previously there were 15 or 20, and possibly two, or at the outside three, highly economical modern steam-engines, in place of a great number of small reciprocating engines scattered about the works. Of course, an engineer does not lay the whole credit to electricity. Electricity is but the means of carrying out more perfect power generation than is possible by any other means. Works' owners are much handicapped under any other system when conveying power long distances in large works With an electric system they are no longer hampered. There is no necessity for them to either divide up their units of power or to crowd up their machinery near to the boilers. Necessarily, under the older system, as works grew from time to time, new boilers and new engines had to be installed, which gradually resulted—particularly in bleaching and dyeing works—in an enormous expenditure of fuel regularly and increasingly taking place, while the attention and upkeep became a most important expensive item. I have had the pleasure of examining several dyeworks in Scotland and in Lancashire, and, speaking from memory, I think the lowest return on the outlay for reconstructing the driving arrangements and utilising electric transmission of power was not less than 30 to 35 per cent. on the first cost.

To return to my remarks as to what I mean as to not giving electricity the whole credit of this increased efficiency, I refer to the possibility of using large units, which is not possible when you desire to divide your power into numerous small engines. This permits you to put down at once a modern economical combined set of engine and dynamo, working at a very high rate of efficiency, consuming less than 15lb. to 18lb. of steam per horse-power hour, with a combined efficiency of, say, 84 to 87 per cent. You can also generate your steam, if possible, in one large boiler, and all the latest appliances can at once be concentrated in one modern engine-house for generating that power as economically as it can be. Thus you have your power provided at the lowest possible cost. Therefore, with such a plant as this it would be the height of folly to waste the power, so economically generated, by an inefficient method of transmission, such as shafting and steam-pipes, and this is where the question of electricity comes in. In the average works there is no reason whatever why any wire or cable installed should not have an efficiency not less than 95 per cent., and the motors for the purpose of driving the various machines, or groups of machines, an efficiency of 87 to 90 per cent. This, in comparison with the very highest class shaft-driven works which it has ever been my pleasure to examine, and which gave, say, 43 per cent.—a figure rarely reached—will, I think, show you at once how the cost of running can be so considerably decreased, as well as how much smaller power you will require in your engine-house than you would have had to provide had your methods of transmission been by any other means.

The efficiencies of a plant driven electrically are so favourable in comparison with any other method of drive, that all new works being constructed should be laid down on these lines; and such has been the progress made during the last few years in this country, that very few of the works and new industries lately started, or now in course of construction, are holding to the old methods, but are at once laying down a modern generating plant, as they see that the first costs compare very favourably in comparison, and the efficiency of the plant is so much higher. Moreover, in designing new works they are no longer handicapped, as in the old and less convenient method. They have no longer to consider how they can squeeze in their machinery and work it in around the power. It is no longer a question of bringing the work to the power. The work and various operations can be carried out in the most convenient and useful situation, a couple of wires being all that is required to run to a certain spot, and there the motor or motors are installed. The engineer will arrive at the powers required in the generating station by giving due consideration, as before mentioned, to any possible future extensions, power required for lighting, and having estimated the powers in his various

*Paper read before the Bradford Textile Association.

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TABLE A.—COMPARATIVE COST OF WORKING HYDRAULIC AND ELECTRIC LIFTS.

| Type of lift. | Load in cwt. | Source of power. | Travel in feet. | Cost of average round trip, up and down, in pence. | Number of trips per 1d. | Remarks. |
|---|---|---|---|---|---|---|
| Electric | 7 | Manchester Corporation. | 50 | ·159 | 6·3 | Observed. Conditions unfavourable. Current at 2½d. |
| Hydraulic suspended, high pressure. | 7 | ,, | 50 | ·29 | 3·45 | Calculated from published scale. |
| Hydraulic suspended, low pressure... | 7 | ,, | 50 | ·445 | 2·2 | Calculated at 6d per 1,000 gallons. Pressure, 50lb. |
| Electric | 9 | Private supply. | 50 | ·16 | 15 | Observed. Conditions ordinary. Current at 2½d. |
| Hydraulic suspended, high pressure. | 9 | London Hydraulic Power Company. | 50 | ·277 | 3 6 | Calculated from published scale. |
| Electric | 9 | Glasgow Corporation. | 50 | 061 | 16·4 | Observed. Current at 2½d. |
| Hydraulic suspended, high pressure. | 9 | ,, | 50 | ·212 | 4 7 | Calculated from published scale |
| ,, | 12 | London Hydraulic Power Company. | 50 | ·35 | 2·86 | Observed. |
| ,, | 9 | ,, | 50 | ·287 | 3·5 | Observed. |
| Hydraulic ram, high pressure | 12 | ,, | 50 | ·42 | 2·4 | Observed. |

TABLE B.

| Nature of work. | Total horse-power. | Per cent. to drive shafting. | State of load. | Horse-power per 100ft. shafting. | Horse-power per 100lb. shafting. | Horse-power per bearing. | Horse-power per belt. |
|---|---|---|---|---|---|---|---|
| Wire drawing and polishing | 400 | 39 | ½ | 14·0 | 58 | ·37 | 1·76 |
| Steel stamping and polishing | 74 | 77 | ⅓ | 9·8 | ·35 | ·84 | 2·4 |
| Boiler and machine work ... | 38 | 65 | ⅔ | 4·77 | ·21 | 55 | ·48 |
| Heavy machine work | 112 | 57 | 1 | 5·7 | ·23 | ·58 | ·45 |
| Light machine work | 74 | 54 | 1 | 8 0 | ·4 | ·69 | ·12 |
| Manufacture of small tools.. | 47 | 52 | 1 | 2 5 | ·23 | ·24 | ·11 |
| Ditto | 190 | 57 | 1 | 4·36 | ·43 | ·39 | ·21 |
| Screw machines and screws... | 241 | 47 | 1 | 6·33 | ·38 | ·63 | ·23 |

motors will thus arrive at the total power required in the generating station. The nature of the work has then to be considered as the means of deciding how this power will be divided. In no case where 500 h.p., or more, is required should the power be put all in one unit, but it should be divided in such a way that at different times in the day, when different loads are required, the powers are so arranged that the plant will be working at as near full load at possible. A good arrangement in an ordinary works taking 700 h.p. to 800 h.p., is to divide the units into sizes of one-third and two-thirds of the total. It might be taken that the large unit in this case would do the work the whole of the day, driving the whole of the machinery, the smaller unit being run in parallel at night, when the lighting would come on, thus giving the total power out of the station. Then at night time, or for overtime, the smaller plant would run by itself. Where the power required is greater than this it is the best modern practice to divide the units into three of equal size, any two of which will together drive and light the works. Thus one plant is always in a state of efficiency, and duplication is obtained at half cost.

I must again repeat that as applied to works electricity must be merely regarded as a method of transmitting the power. Where the power is but small, say below 100 h.p., and given a certain amount of work to do, which can be placed close to the engine, no very great improvement can be made on driving otherwise than direct from the engine. However, where the power in a shaft-driven works is greater than this—and we have several in this town running into nearer 1,000 h.p.—while it is difficult to show a great saving by electric driving, in several works I have been in in this district I know that present engines could be greatly relieved at a very small cost indeed. A curious case to illustrate this fact came under my notice in Leeds. It was one where an engine of some 220 h.p., compound, condensing, driving large engine works, was considered to be overloaded. A dynamo was put down and driven off the same engine, and by this means, cranes, driven by square shafting and ropes, were altered to an electric drive, and one or two isolated cases, bad drives, such as a wood saw and a small department, which were formerly driven by an underground shaft, were then driven by electric motors. Although the cranes were speeded up to do their work at a considerably higher rate of speed, the engine, which was doing all the work, as before, was found to indicate much less power, owing to that desirable portion of the works being driven electrically. In this case a considerable saving was made on a very small outlay, and the engine was able to work under much more favourable circumstances. It is only under such circumstances, however, that a dynamo should be driven from old existing engines.

In arranging motors to drive different departments, different groups of machinery, or separate individual tools, it is advisable to make the plant as nearly as possible interchangeable by means of grouping the lighter machines on to a countershaft, and by allowing the heavier machines to be driven by a single motor. It has been found that for the driving of such machinery shunt-wound motors give the best results. These motors have the field winding and the armature connected directly across the circuit, so that the currents flow in parallel, and the armature current does not go round the field. Thus the shunt-wound motors tend to run at a constant speed, the variation between no load and full load being practically nil. This, however, depends greatly on the design of the motor.

If metallic switches and resistances are used, special care should be taken in the design selected, avoiding all complications. For variable speeds, such as electric cranes, elevators, pumps, and similar machinery, the series-wound motor is best adapted. In the series-wound motor the current passes through the field winding and the armature in series, so that the strength of the field varies according to the current. When the load increases on a series-wound motor the speed falls, and when it decreases the speed rises. It is necessary that a high resistance be first placed in series when starting the motor, which allows only sufficient current to flow requisite to start the load. The resistance is decreased until the desired conditions are attained.

Compound-wound motors have two windings upon the field. One is shunt winding, connected directly across the circuit, the other is a series winding, and carries the armature current. The strength of the field is, therefore, determined by the shunt current, which is constant, and the series current, which varies according to the load. The compound-wound motor is intermediate in its characteristics between the shunt and the series wound motor, the former being practically constant in its speed, the latter varying greatly according to different loads. Where it is likely that heavy overloads will be met with, and where speed regulation is not important, the compound motor is best adapted. The speeds of the shunt-wound motor may be varied by means of a resistance or rheostat placed in circuit with the field circuit; adjustment of this causes variation in the current through the field, which in turn produces a change in the speed of the motor. It is also found necessary to place a resistance in the armature circuit to control the motor speeds and obtain greater variation. This is often found necessary, though the efficiency is reduced in proportion to the throttling done. Still, there are many cases where the avoidance of mechanical complications for the variation of speeds by this means will amply justify the electrical equipment for speed control.

Before departing from these generalities, I think it would be interesting to you if I quote some of the results which have been obtained. I select from a very great number the works of Messrs. Dorman, Long, and Co., Middlesbrough, as a typical case. At these works one by one motors have been installed, until now there are 200 motors at work driving all the outlying machinery. The plant at present consists of three 200-i.h.p. direct-coupled engines and generators and three 500-i.h.p. slow-speed direct-coupled plant. This installation, being the oldest electrical installation of its kind in this country, is the one to

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which we turn for the cost of upkeep, and this has proved to be absurdly small. In fact, after allowing for replacing brushes when worn out and the cost of the necessary oil, etc., there has been practically no further expenditure, and the saving from the first has been enormous. An extract from the directors' report to their shareholders for the year ending Sept. 30, 1895, will thus be interesting. At this time the installation had not reached anything like its present dimensions, and even then the work in hand at the time of this report was not by any means fully completed. The extract from the report reads as follows: "One decidedly encouraging feature in the year s working is the large reduction in the cost of manufacture, due to the improvements of the last few years having come into full operation. This is seen in the fact that nearly the whole of the profit has accrued during the last six months of the financial year, although the prices then realised were lower than for the first six months. The saving effected by the expenditure during 1894 in applying electrical power to the outlying machinery was found to be so satisfactory that your directors felt justified in a further outlay in this direction, and hence the greater part of the capital expenditure this year is for electrical machinery. Up to the present time the total amount spent under this head is about £8,000, and the saving is at the rate of £3,000 to £4,000 a year, in addition to increased efficiencies."

I hope to have an opportunity further during the discussion of explaining how such a very great outlay as would be demanded, say, for the complete equipment of a dyeworks is so quickly returned. Of course, you will readily see that in every case the whole system of the works must be taken into consideration. The question of driving any isolated machine, or single department, unless with the view to extending it to the whole, and at the time of installing it, unless it is a portion of a whole scheme properly designed for the complete equipment of the works, it is rarely worth doing. However, there is no reason whatever where the whole case shows a return on the outlay to justify such a scheme being proceeded with—there is no reason why a small portion, however small, should not be proceeded with, provided it is a portion of the whole, and the whole plan would be maintained and not departed from until the complete installation is carried out. This is most important as preventing complication in the central station. Rarely does the driving of a single machine or tool justify or give sufficient evidence of the desirability of such outlay. I think I have made myself clear on this point—that it is only by consideration of the merits of the entire works, its varying powers, its distance of transmission, the cost of upkeep, the number of men employed, etc., that the desirability can ever be shown on paper. Of course, there are many cases where it is interesting to see the cost of working separate machines, but I do not see that the question could ever be of use to you, as it would be impossible to show a good commercial return in a wool-combing works or a spinning plant by attempting to drive each machine by means of an individual motor. The efficiency would not be so great, owing to the number of small motors, and the first cost would certainly be prohibitive. Hoists, however, are likely to play, or do play, an important part in many of your works, and I am giving you here the comparative cost of working hydraulic and electric lifts. I think the results, which may be relied on, cannot fail to interest you (Table A).

I also give you in tabulated form some particulars of shafting losses in different works, from which it will be seen that the loss varies from 39 to 70 per cent. (Table B). It is obvious that, other things being equal, the greater the average distance of the machine from the driving engine the greater is the loss in shafting. I also show you the possibility of the cost of electricity delivered on the switchboard. In no case where the powers approach 150 h.p. have I ever found a justification for a works' owner to purchase his current from outside sources, even at a cost so low as a penny per unit (Table C).

I have frequently been asked another very obvious and reasonable question—viz., what is the cost of production should we adopt an electrical plant in our works? In answer to this the author has drawn up a number of cases of different kinds and in different parts of the country, showing the rate at which the works' owner can generate his own electricity. The table I give you is a fair example. These figures are taken from actual examples of everyday working, and are not in any way test figures taken for the purpose of this paper. Taking these figures as a basis, it is an easy matter for a works' owner, once having ascertained the total horse-power which will be involved in the driving and lighting of the entire works, to see for himself at what expenditure per annum he can run his works upon the new system.

In placing this paper before the Bradford Textile Society I have endeavoured briefly to show that there are immense possibilities to be derived from carefully considering electrical power schemes in Bradford. The question is a colossal one, and hard to deal with in a brief paper. I have, however, done my best to put the subject forward plainly and in a practical light, and if any of my remarks can be applied to your own industries and raise points on which you would like to have further information I should be very happy to at once join in a discussion on the subject. Also, if the data and information I have had the opportunity of giving you to-night has proved of interest to the members of this important society, then I am amply repaid for any little trouble I may have taken in the preparation of this short paper.

TABLE C.—Cost of Electricity Delivered on Switchboard. Test of 139½ hours, Nov. 17 to 23, 1901.

| | |
|---|---|
| Mean current (amperes) | 3,464 |
| Mean pressure (volts) | 125 |
| Mean power (watts) | 433,000 |
| Mean electric horse-power | 580·42 |
| Board of Trade units | 60,403 |
| Weight of steam per Board of Trade unit (pounds) | 27·52 |
| Weight of coal per Board of Trade unit (pounds) | 3·04 |

| | Cost per Board of Trade unit. | Cost per week. |
|---|---|---|
| Coal 3·04lb. at 11s. 6d. per ton | 0·187d. | £47 4 0 |
| Water, 27·52lb. at 3½d. per 1,000 gallons | 0·00963d. | 2 8 6 |
| Stores | 0·00995d. | 2 10 0 |
| Wages | 0·06625d. | 16 13 3 |
| Repairs | 0·0159d. | 4 0 0 |
| Superintendence | 0·01192d. | 3 0 0 |
| Net cost per Board of Trade unit | 0·30065d. | £75 15 9 |
| Interest and depreciation on £15,000 at 10 per cent. per annum, per unit | 0·099d. | |

Cost per electric horse-power per hour.

| | |
|---|---|
| Coal, 2·27lb. at 11s. 6d. per ton | 0·1395d. |
| Water, 20·53lb. at 3½d. per 1,000 gallons | 0·00718d. |
| Stores | 0·0074d. |
| Wages* | 0·0494d. |
| Repairs | 0·01185d. |
| Superintendence | 0·0069d. |
| | 0·22423d. |

Mean indicated horse-power at 75 per cent. efficiency, 773; coal per indicated horse-power, 1,705lb.; water per indicated horse-power, 15·41b.

* Includes labour of keeping 134 arc lamps in repair.

## ELECTRICITY IN A PRINTING OFFICE.

The new Government printing office at Washington, U.S.A., is said to be the largest of its kind in the world, and is also probably the most notable example of the application of electricity to the various processes of typography that is to be found. Some articles on the subject have been published by our New York contemporary, the *Electrical World*, which show the extent to which electricity is employed in this institution for running motors, for heating, for ventilating, and for lighting. Perhaps the most novel of these applications is heating, and it is believed that the system of heating in question is the largest and most comprehensive in the world. The uses of electric heat in the office fall broadly into two groups. One of these embraces the foundry, and includes matrix-drying tables, wax-stripping tables, wax-melting kettles, case-warming cabinets, "builders' up" tool heaters, case-warming table, wax knife-cutting down machine, "sweating-on" machine, and soldering iron heaters. The other class includes embossing and stamping press heads, glue heater equipments, glue cookers, case-making machines, finishers' tool heaters, and book cover shaping machines. This is a remarkable range, but in addition we find the pamphlet-covering machines, the sealing-wax melters, and some other devices. The extraordinary flexibility and utility of electric heating is here strikingly illustrated, and in these special applications at least it cannot be surpassed or equalled for efficiency and economy. The matrix presses are the first machines of their kind to be electrically heated, and the same may be said of the wax-melting kettles. In these the wax is collected from the stripping table and freed from graphite and dirt and freshened and tempered. A pair of kettles are placed side by side, and electric heaters are arranged to give equal temperatures to the walls of the kettles, and to prevent scorching and unnecessary destruction of the volatile elements in wax. The full article gives many detailed particulars of the other uses to which electric heating is applied, and it is a subject which, from its novelty and its bearing on a still undeveloped branch of the electrical arts and industries, is surrounded with the utmost interest.

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## NOTES.

**Royal Institution.**—A general monthly meeting of the members of this institution was held on Monday afternoon, Sir James Crichton-Browne in the chair. A number of new members were formally elected, and the special thanks of the members were returned to Sir Andrew Noble, Bart., Dr. Frank McClean, Mr. J. B. Broün-Morison, J.P., and Lord Greenock for donations to the fund for the promotion of experimental research at low temperatures.

**Simultaneous Telegraphy and Telephony.**—It is stated that the system of simultaneous telegraphing and telephoning over the same wires by the apparatus invented by Messrs. Turchi and Brune, which has been in operation for several months on a section of line at Bologna, has proved a thoroughly practical success, and that the Italian Government contemplates the installation of the system on other sections. The two inventors are now in Rome negotiating with the Minister of Posts and Telegraphs the details for a working agreement.

**Edison's New Telephone Attachment.**—It is Mr. Edison's sanguine hope that he will soon be able to introduce a camera obscura attachment to the ordinary telephone which will enable users to see each other as they converse. A New York correspondent sends over the news, and adds that Mr. Edison has "been at work on this instrument for a number of years, during which time several announcements have been made that its practicability had been developed, but they have always been followed by further announcements that unexpected difficulties had been encountered."

**Free Wiring in London.**—The agitation of London borough councils who are electric lighting authorities in favour of free wiring of consumers' premises has been revived by the Hackney Borough Council, who are organising a conference to be held on Monday next. The London County Council are to be asked to reintroduce their Bill for powers enabling the borough councils to borrow money for this purpose, although Parliament gave a very emphatic denial to the proposal in the last session. A number of the metropolitan councils have appointed representatives to attend the conference, when the subject will be thoroughly discussed.

**South African "Ring."**—*South African Exports* declares itself to be in a position to state that the "ring" of British manufacturers supplying the South African market, which has once before been mooted, is now almost completely formed. Only one or two details, it is confidently added, require to be settled, and the public will very soon have an opportunity of examining the provisions and terms arranged by this association. The "ring" is exceedingly powerful, including the leading firms in nearly all industries. Roughly speaking, it will take the form of a general council having sub-councils for each trade. Thus, the agricultural machine makers and the electrical engineers are two sections which are at present complete and already commencing to operate. Our contemporary concludes that the "ring" will be one of the most influential and wealthy conceivable.

**The World's Copper Output.**—From the official figures published by the United States Government, it is clear that the supply of copper, taken as a whole, is on the increase. For instance, in 1903 the total output of the world was 589,361 long tons, compared with 551,316 tons in 1902 and 515,992 tons in the previous year. Of these totals the United States contributed 318,861, 303,446, and 272,000 tons respectively—more than six times the supply from Spain and Portugal, which have the next largest output. It is interesting to note that 24 years ago the total annual supply from the United States was only 27,000 tons, which 10 years later increased to 115,916, while by 1900 this figure was more than doubled, the actual total for that year being 269,111 tons. Australasia last year contributed 29,000 tons, and Canada 22,500 tons. Canada has thus already become an important producer, and is expected to show a great advance in the next few years.

**Vacuum-Tube Phenomena.**—In a communication to the *Electrical World* Mr. Wm. J. Hammer gives an account of a curious phenomenon he has noted in connection with a damaged Röntgen-ray tube. The tube, after having for a time been connected in an induction coil circuit, gave forth when disconnected a musical note for a considerable period with apparently no exciting cause exterior to the tube. Since the tube when removed had stored in it a considerable quantity of heat at the anode plate, the first thought was that the cause of the sound could be ascribed to some heat vibratory action, but Mr. Hammer appears inclined to refer the action to a condition of resonance established with respect to some etheric vibration, previous excitation of the tube having rendered it sensitive to such an etheric influence. Mr. Hammer also refers to his observation of the lighting up of a vacuum tube with apparently no exciting cause, which phenomenon has also lately been observed by other experimenters.

**Electrical Engineers Volunteers.**—At headquarters, Regency-street, Westminster, on Saturday evening, the corps gave a very successful Bohemian concert arranged by the Entertainments Committee, of which Captain J. J. F. O'Shaughnessy is president, and Second-Lieutenant E. G. Sheppard the hon. secretary. There was a record attendance, the large drill hall being filled in every part, and there was a fair sprinkling of ladies present. At the head table Major Erskine, the commanding officer, presided, and among the other officers present were Captains the Hon. R. Craven, O'Shaughnessy, Leaf, Pearce, Captain-Surgeon Masters, Lieutenant Levin, Second-Lieutenants Merritt, Sheppard, Leys, and Kaye, and Acting-Adjutant Captain Phillips. An excellent programme was given, including several contributions from members of the corps, and these were naturally specially well received. The Entertainments Committee are to be congratulated on their activity in arranging entertainments of this kind during the winter months. In a week or two the corps gives a grand ball at the Hotel Métropôle.

**Electrical Products in the United States in 1903.**—In accordance with custom, our New York contemporary the *Electrical World* presents an interesting summary of the production of electrical apparatus in America during the year just closed. Taking good years with bad, the usual rate of increase in electrical manufactures each year during the past 20 years has been on an average of 15 to 20 per cent. The total output of electrical machinery and apparatus in America last year was valued at £31,730,000, as compared with £27,990,000 in 1902 This represents an all-round increase of about 10 per cent., although the increase in production of certain manufactures was considerably higher. The output of telephone apparatus, for example, shows an increase of 20 per cent., the respective figures for 1902 and 1903 being £4,200,000 and £5,000,000. Electric motors, on the other hand, represent an increase of only 10 per cent., the respective figures being £5,400,000 and £6,000,000. Insulated wires and cables and submarine cables are set down at a little over £6,000,000, which is a gain of £500,000 on 1902. Altogether our contemporary regards the showing of the year as quite satisfactory.

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**James Watt Memorial.**—The proposal to erect a memorial in Greenock, the city of his birth, to James Watt was broached some time ago, and an influential committee has been formed to further the laudable object. The site of the house in which Watt was born is the property of the Corporation of Greenock, and has been placed unreservedly at the disposal of the committee. It is desired to spread the subscriptions over as wide a range as possible, so that the memorial may be a tribute by the great mass of workers who have benefited by Watt's discoveries. The committee have therefore decided to limit the subscriptions to £100 in the case of subscribing firms for each mill or factory in their control, and to £20 for individual subscribers, and the smallest contributions will be gladly received. When it is possible to estimate within a little what funds are available, the committee will consider and decide upon the form of memorial most suitable worthily to mark the birthplace of the great inventor and the industrial world's appreciation of his services to humanity. Mr. J. Rogers, agent of the Clydesdale Bank, Greenock, is the hon. treasurer to the fund, and Mr. C. C. MacCulloch, town clerk of Greenock, the hon. secretary.

**Electrical Development in Siberia.**—Mechanical power in Siberia has not yet many applications. The railroads and mines are practically the only places where one sees it. More rarely still does one see electric power. The Siberian towns seldom use the electric light, but the town of Tomck is an exception. Even there, however, the supply is limited—a maximum of 2,500,000 watt-hours per day of 24 hours—the Industrial Bureau, which holds the concession, not caring to spend money on additional plant because after 19 years the works pass to the town. In a recent issue of *Power* Mr. L. Lodian gives a few particulars of the existing station, which is the only source of electric supply in the town. The steam-engines, of which there are four, are of the vertical compound type, running at 140 revolutions per minute. They are capable of developing economically 125 h.p. each and 150 h.p. as full maximum working load, and each is belt-connected to a dynamo. Alternating current is generated at 2,000 volts. In the boiler-house are four boilers constructed by Bari, of Moscow. Three of them have a heating surface of 740 square feet each and one of 1,145 square feet, and are run at 150lb. pressure. The engines were constructed by Bromley and Co., of Moscow, while Brown, Boveri, and Co. supplied the dynamos.

**Crystal Palace Automobile Show.**—There is every prospect that the forthcoming motorcar show, which opens at the Crystal Palace on the 12th inst., will be the biggest and probably the most successful of its kind ever held. It will be conducted under the auspices of the Society of Motor Manufacturers and Traders. The Palace is undergoing a regular transformation, as the floor space that is to be occupied by exhibits will be far greater than at any previous show at this place. Some 3,000 to 4,000 square feet has been added to the available space, and a motor boat section, comprising 2,000 square feet, will be quite a novel feature. To provide adequate illumination, a new 750-h.p. generating set has been laid down, and some 10,000 electric lamps are being installed to augment the present lights. It is to be noted that by far the greater proportion of exhibitors will be English firms, though, of course, many will show foreign-made cars. A special feature will be the exhibits of motor agricultural machinery—a section which was not found at the recent Paris show. For the first time in England the Simms Manufacturing Company will exhibit its new high-tension magnetic-ignition car, which is at present a complete novelty. Motor boats will be well represented. Some will be running on the lake in the grounds, and others will be found in the section for heavy vehicles. Altogether the show bids fair to be a big success.

**The Parsons Steam-Turbine.** — The increasing popularity of the steam-turbine as a prime mover has necessitated arrangements being made for the manufacture of these machines on more extensive lines. One of the latest engineering firms to commence the building of steam-turbines under license from the Hon. C. A. Parsons is that of Messrs. Richardsons, Westgarth, and Co., Limited, of the Hartlepool Engine Works. An entirely new department has been created and new plant laid down in order that the manufacture of these engines may be carried out with that extreme accuracy which is so imperative for maximum efficiency. The turbine which this firm is manufacturing not only embodies all the recent improvements by the inventor, but, in addition, the modifications and refinements so successfully introduced by Messrs. Brown, Boveri, and Co., the Continental builders of the Parsons turbine. An idea of the demand for steam-turbines of the Parsons type may be formed from the fact that Messrs. Brown, Boveri, and Co. have constructed and have in course of construction turbines of about 150,000 h.p., including one unit of 10,000 h.p. for the town of Essen, and 35,000 h.p. in units of 8,000 h.p. to 9,000 h.p. for the Paris Metropolitan Railway, whilst the 5,000-h.p. turbo-alternators at Frankfort and Milan have been at work for fully a year with an unsurpassed economy. Messrs. Richardsons and Westgarth, who represent the Continental firm in this country, have exceptional facilities for obtaining the latest improvements in turbine and dynamo design and embodying them in their manufactures.

**Electrical Service at the World's Fair.**—The arrangements for supplying electric light and power to exhibitors in the Palace of Electricity at the World's Fair at St. Louis this year are on very ambitious lines. We are informed that the following service will be available during the run of the exhibition: Alternating current at 104 volts, 25-cycle, three-phase; 104 volts, 60-cycle, two-phase; 6,600 volts, 25-cycle, three-phase; 2,200 volts, 60-cycle, two-phase; and 2,200 volts, 50-cycle, three-phase. Direct current at pressures of 110, 220, and 500 volts respectively. For distribution the following plans have been adopted: Alternating current—104 volts, 25-cycle, 300-kw., and 104 volts, 60-cycle, 100-kw., available and distributed over entire building; and 6,600 volts, 25-cycle, 100-kw., 2,200 volts, 60-cycle, 50-kw., and 2,300 volts, 50-cycle, 50-kw., available at transformer space only. Direct current—110, 220, and 500 volts, 100-kw., available and distributed over entire building. Should any exhibitor require service covered by the last three items of alternating current, it will be necessary for him to wire from his space to the transformer space, located in the north-west corner of the electricity building. In addition to the service mentioned above, there will be at the transformer space a limited quantity of 340-volt, 25-cycle, one and three phase and 400-volt, 25-cycle, one and three phase alternating current. These two items are for supplying current to rotary converters and motor-generators installed in the transformer space. Any further information will be furnished by Prof. W. E Goldsborough, Chief Department of Electricity, World's Fair, St. Louis. We understand that during the exhibition a prize of £600 will be offered for wireless power transmission. The prize will be awarded "for a successful attempt to drive an airship motor by energy transmitted through space, either in the form of electric radiation or in some form of electrical energy, to an actual amount of one-tenth of a horse-power at the point of reception, and at a distance of at least 1,000ft. The test must be made on the exposition grounds by experts satisfactory to the

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jury." The St. Louis Exposition is trying, doubtless, to open up new ways for the electrical industry and to create new fields of application.

**St. Louis Electrical Congress.**—Present indications incline to show that the international electrical congress to be in session at St. Louis Sept. 12-17 this year, will be one of the most successful that has yet been held, both with respect to the number of adhesions and to the value of the transactions. Up to date about 3,550 invitations to join the congress have been issued in North America, and from these 875 acceptances of membership have been received. It is intended to issue in all about 5,000 invitations in American and about 6,000 in foreign countries. A large number of special letters of invitation have been issued to prominent electricians and electrical engineers requesting papers for the congress in the various sections. Of these, 146 have been sent to foreign authors and 134 to American authors. There has not been time to receive replies from more than a few of the former, but 21 acceptences have up to date been received from abroad and 46 acceptances from North America. Sixty-seven papers are thus already promised for the congress, and the number is steadily increasing. The committee of organisation propose to issue a further number of invitations to contribute papers, and it is to be hoped that too much zeal in this direction will not end in disappointment. The object, we think, should be not so much to ensure a large number of papers for reading as to provide for adequate discussion of electrical subjects of common interest. Although there are in all eight separate sections dealing with different branches of electricity, it will be easy to make the mistake of occupying the great part of the proceedings with stereotype papers, and leaving no opportunity for independent criticism and discussion, or for the adoption of definite conclusions by the delegates. The following will indicate the scope of the various sections: (Section A) General Theory; (B) General Applications; (C) Electrochemistry; (D) Electric Power Transmission; (E) Electric Light and Distribution; (F) Electric Transportation; (G) Electric Communication; and (H) Electrotherapeutics. Invitations are being issued to foreign Governments to be represented at the congress, and also to electrical and scientific societies in different parts of the world. All communications should be addressed to the general secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., U.S.A.

**Interurban Electric Traction** —A timely article appears in the Chicago *Railway and Engineering Review* on the encroachment of interurban electric railways upon the traffic of steam roads in the States. We have had a considerable experience of this already in this country, but there is a difference in that the electric roads on this side are mainly street tramways which compete with the local steam lines, whereas the competition in America is on far more ambitious lines, and extends to long distance travel between towns. It seems, moreover, that the steam roads in America are now threatened with an active competition for inter-state traffic as well. As an instance of this it may be stated that in the near future there will be in operation a network of electric lines, extending from Buffalo and Pittsburg on the east to St. Louis on the west, and from Chicago and Detroit on the north to Cincinnati and Louisville on the south. Some of the existing electric roads are providing express services between relatively distant cities, and the latest innovation appears to be the running of sleeping cars on an interurban electric line out of Indianapolis. The construction of this car provides a convertible sleeping and parlour car for night and day use respectively. It has a length over buffers of 56½ft., and a width over side sheathing of 8ft. 10¼in. The car is driven by four Westinghouse motors of 150 h.p. each, making a total horse-power of 600 per car, and geared for 65 to 75 miles per hour. Inside the car are 10 revolving chairs on each side, which can be utilised for making-up a lower berth in each of the five compartments on each side of the centre passage. Thus there are 10 compartments, 6ft. 10in. long by 3ft. 6in. wide, containing one upper and one lower berth, each 27in. wide, and allowing a 15in. dressing space between the berth and the passage partition. The motorman's cab is heated by three electric heaters, and hot and cold water is provided for the toilet rooms, the former being heated by an electric hot-water heater. In minor equipment the car is also very complete. For example, there are electric curling-irons for the use of the women passengers, and electric cigar-lighters for the smoking-room. Electric fans operate during the day to keep the atmosphere clear. The car is made by the Holland Palace Car Company, who, following the practice of the Pullman Company in this country and elsewhere, intend to retain the ownership of the cars and operate them for the railway companys.

**Energy Distribution to Sub-Stations.**—Under this title Mr. C. A. Smith read an informing paper before the Birmingham Local Section of the Institution at the meeting on Wednesday last week. He commenced by remarking that there was no case where the economy claimed for working a large central station of several thousand horse-power by power gas had been tested. Probably no city electrical engineer had seriously considered the subject from a financial point of view, presumably because he was convinced that, for driving large high-tension alternators, gas-engines were not reliable. The idea at once suggested itself that the difficulty would be partially overcome if the size of the unit were reduced, but even then for a city requiring some 40,000 b.h.p. for traction, power, and lighting purposes it would be hardly possible to reduce each set below 1,000 b.h.p. Few city electrical engineers would care to use even this size for running alternators in parallel. To meet this objection it seemed that, if any use was to be made of power gas for producing electricity in bulk, direct currents must be used, and immediately one was confronted with the problem which had prevented the general adoption of direct currents for high-tension work—the troubles of commutation. Consequently it seemed fairly clear that if producer gas were to be used at all for supplying a city with electrical energy it must be used at the sub-stations, where it would only be necessary to have a comparatively small-unit gas-engine to drive a direct-current generator for supplying the line at the customary voltage up to 550. This opened a prospect of what hitherto had been two great rivals, gas and electricity, working together for the benefit of the citizen. In further considering the subject, the author divided the paper into two sections. The first was the transmission of electricity from a gas-engine station, situated under favourable conditions, at a distance of five miles from the centre of the city, and its subsequent distribution by means of electrical sub-stations. The figure to be arrived at was the actual cost per Board of Trade unit at the sub-station switchboard. The second section of the paper assumed the same demand at the direct-current switchboard, and sought to arrive at the actual cost of producing a Board of Trade unit when it was generated under exactly the same local conditions by means of sub-stations containing gas-engines, and supplied with their motive power from a central producer station situated on the same site as the producer and electrical station in the first case.

**The Misuse of Physics.**—A paper has been presented to the American Physical Society by Mr. W. S. Franklin on the misuse of physics by biologists and engineers, in which

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the author arrives at the following concise conclusions. The precise idea of temperature is associated with the notion of thermal equilibrium, and the precise idea of temperature has nothing to do with the sensations of hot and cold. The electric arc, for example, is very hot, but it has no temperature. Not only is the precise idea of temperature limited to substances in thermal equilibrium, but it applies only to a finite portion of a substance. It is meaningless to speak of the temperature of a molecule. There are many cases of steady sweeps, such as thermal conduction in a gas, steady radiation from a hot to a cold region, in which the sweeping substance, be it material or ether, is far from being in thermal equilibrium, although in a permanent or unvarying state. The precise idea of temperature is not applicable to such states. In general, all cases of molecular motion and of ether motion (radiant heat) in which some definite and unvarying function exists expressing the distribution of energy among the various phases of the motion, are to be classed as steady sweeps. In all such cases the precise idea of temperature is inapplicable to the sweeping substance or space. Still, all such processes are amenable to precise and systematic treatment. This systematic treatment always depends upon a knowledge of the function of distribution of energy among the phases, and the characteristics of the sweeping substance or space are properly described in terms of this function, not in terms of temperature and entropy. It is true, however, that a generalised idea of entropy, for example, can be applied to steadily sweeping substances. Entropy always increases in natural phenomena, and the notion of entropy is, perhaps, much more intimately related to the notion of time than any other physical notion whatever. The notion of entropy seems to the author, indeed, to be the very foundation of the notion of time as a physical fact, although the numerical evaluation of time depends, in practice, upon the approximate realisation of some of the precise ideas of mechanics. Heretofore the idea of the increase of entropy associated with a sweeping process has been thought by the ablest writers on thermodynamics to be dependent upon the devising of a reversible process which leads to the same change of state as the given irreversible process. This is, he thinks, true in regard to sweeping processes in general, but it is not true in regard to steady sweeps.

**Power Transmission at High Potentials.**—A meeting of the British Westinghouse Engineering Society was held on the 28th ult., when Mr. J. W. Harris read a paper on the above subject. He prefaced his remarks by the reflection that engineers are always running up against the inexorable laws of Nature, that cannot be bluffed, and must only be challenged on a full hand. He gave details and showed a series of lantern photographs of Oriental scenes met with in his travels, where he foresaw great possibilities in the way of distributing energy, such as, for instance, replacing the crude irrigating methods of men, horses, inclined planes, and skin buckets by pumping motors. He gave some instances of Ferranti effects on long-distance 25,000-volt lines in America, where the pressure rose in one case to about 27,000 volts, and stated that proper regulating was a difficulty in practice, the pressure varying as much as 20 per cent. sometimes. Some experiments with special apparatus to show rise of potential due to capacity on long lines that had been arranged for had been tried on the previous Sunday, and had subsequently broken down. From his experience he considered the following points filled the bill: (1) a wide possible voltage in the generators and transformers both designed for good inductive load regulation; (2) lines designed for a small charging current; (3) the use of inductance coils for balancing the plant capacity of the line; and (4) the use of synchronous motors as a variable capacity for balancing the available inductance of the line and the inductive motor load. For pressures over 20,000 volts he recommended cedar poles, oak cross-arms, and pins, but having had no lengthy experience of steel poles for such high pressures could not give an opinion as to their suitability, although he recognised the fact that English practice would tend towards the more mechanically strong and permanent metal tube if overhead lines came into vogue. The increased inductance and leakage were the principal items against the use of steel poles. The barbed wire earthing screen arrangement is no protection in practice against lightning strokes, and it is an increased risk to guard against as to breakdown. The highest working voltage he had had experience of was a 180-mile run of 45,000 volts, and he believed that in the drier Western States 100,000 volts might be the limit of potential on aerial lines, but 30,000 volts was the highest that would be practicable in such a damp atmosphere as England possessed. Near factory towns the dirt would probably decrease this limit as far as practicable insulating methods were concerned. In America he had seen dry snow 18in. high piled upon a 20,000-volt line. In Manchester he considered that such an amount of snow would break the line down at 500 volts on account of its humidity. A discussion followed, and a vote of thanks was given Mr. Harris.

**St. Marylebone Electric Lighting.**—Until after the poll of the ratepayers, which is to be taken on Monday next, it is, of course, impossible for the Borough Council to decide on any definite course of action, as their future procedure must depend on whether or not they obtain the electors' mandate to proceed with their Bill in Parliament. In any event it would appear that the promotion of this Bill is absolutely necessary, either as a means of obtaining power to raise the amount of the purchase price or as a fiat to conclude agreements with either the Metropolitan Electric Supply Company or any other company. This week a further stage has been reached in the negotiations with that company, who have offered to make very considerable concessions for the right to work the St. Marylebone undertaking for a term of years. The company have expressed their willingness to take bonds bearing interest at 3¾ per cent. in payment of the award and on the new capital expenditure to the end of the year, roughly estimated at £150,000, and to pay as additional rent £7,000 per annum, which would go towards the Council's sinking fund. The company would bear the whole expense of issuing the bonds, and, further, from January, 1913, would give the Council 10 per cent. of their total net profits, after deducting 4½ per cent. on their total capital employed and 1½ per cent. for depreciation. The lease to the company would be for 27 years, but in the event of the Council determining the lease they would be obliged to take current in bulk from the company up to 1931 if it were required to make up a deficiency by the Council's own generating station. These amended terms were placed before a meeting of the Council on Monday, and were generally received with favour. It was recognised that the company have made a very great advance on their previous proposals, but there the matter stopped, the Council neither approving nor rejecting the new offer. There was also before the meeting a report by the Electric Supply Committee which helps to throw a light on the attitude which the Council seem inclined to take up. However keen may have been their desire to acquire this prosperous undertaking of the Metropolitan Company, it is now abundantly clear that they have no such great anxiety to take the responsibility for working the same, at least for the first few years. Failing the successful conclusion of negotiations with that company, the Council mean to lease the under-

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taking to some other company, who would carry on the business for them either temporarily or permanently. This much was agreed to at Monday's meeting on the recommendation of the committee, but to do this, or even to enable the Council to continue negotiations with probable lessees, they must carry their Bill through Parliament, and so obtain the necessary authority. The result of the poll, therefore, is awaited with the keenest anxiety, for if the ratepayers withhold their mandate it is difficult to say what turn events will take. The Council have called a special meeting for Thursday next, when the question of the promotion of the Bill is down for discussion, but if the poll goes against them the Council will be compelled to drop the Bill.

**Electric Coal-Cutting.**—Mr. Percy C. Greaves read a paper before a joint meeting of the Midland Counties Institution of Engineers and of the Midland Institution of Mining, Civil, and Mechanical Engineers at Sheffield on Saturday on the subject of the "Electrical Heading Machine." The author, who is attached to the Denby Grange Colliery, described in his paper how he was led to instal an electrical heading machine at the mines. A straight drive had to be made, and the men refused to do this class of work unless they received higher payment. As electric power was used at the colliery, Mr. Greaves says his thoughts naturally turned to that power, but he found that there was not a single British electrical header on the market. He was, therefore, forced to go to America for a machine, and he decided to make a trial with a Jeffrey header. This machine was started on April 1 last year, and has since been working satisfactorily. It is 21in. high on the runners, and weighs approximately 30cwt. The motor of 15 h.p. runs at a speed of about 900 revolutions per minute. There are 45 tool-holders, and the chain runs at a speed of about 300ft. per minute. The tools are fastened into the holders by means of set screws. After the machine has made three cuts it is lifted by means of an ingenious jack, the runners are inverted, and it is pulled back a few feet from the face by means of a Sylvester chain, fastened to a prop, so as to enable the shots to be fired in safety and the coal to be filled. The depth of the under-cut averages 5ft. 6in., the width is 3ft. 8in., and the thickness of the cut is 4¼in. The cut is made in the dirt lying immediately above the 3in. of coal. It was found inadvisable to cut the holing so fast as the machine was originally speeded to do, as it took too much current. At the present rate of cutting the machine takes 26 amperes at 480 volts, or, say, 16½ h.p. The motor is somewhat overloaded, and in Mr. Greaves's opinion it would be advantageous to adopt a motor of larger size. Of course, as no run exceeds six minutes, the motor has plenty of time to cool. In the three months ending Dec. 31, 1903, the machine made 226 cuts to an average depth of 5ft. 7in., 223 shifts have been worked, and 415 yards have been driven. After the cut has been made, as much as possible of the loose dirt is removed; then the electric drill is fixed so as to make a hole at either side of the heading, and it takes five minutes to set the machine and drill a hole 6ft. long. This drill weighs 170lb., and is driven by a motor of 3 h.p., and when running it takes five amperes at 480 volts. The drill is easily moved by two men, and after the second hole is drilled it is removed a few feet back, so as to be placed out of danger. The shots are then fired, the coal is filled, the coarse coal taken up, and the machine drawn forward for another cut. The coal worked by the machine is of a very much larger size than that produced by hand labour. The machine is moved from one heading to another every 150ft. or 200ft., and during the time that the machine is working in the back heading, ripping is being done in the main heading. The slits are also driven for the machine. The machine is only worked two shifts daily, because a greater distance is driven per shift than when three shifts are worked daily. It has been found that the use of this machine effects a considerable saving in the cost of work. Mr. Greaves puts it at about 4s. 9d. a yard cut.

**Engineering Standards Committee.**—The electrical conference which was held on Tuesday and Wednesday last week under the auspices of the above committee at the Institution of Civil Engineers was of a private nature, but we have received a summary of the proceedings from the secretary, Mr. Leslie S. Robertson. The conference, which was convened by the sub-committee on generators, motors, and transformers to discuss the question of standardisation, was extremely well attended. Amongst those who accepted the committee's invitation to attend were the following: Messrs. A. P. Trotter, G. L. A. Addenbrooke, Charles H. Merz, L. Madgen, R. Robertson, A. A. Campbell Swinton, A. S. Esslemont, Bernard Jenkin, A. M. Sillar, Philip Dawson, Malcom MacLaren (British Westinghouse Company), H. Scholey (Dick, Kerr, and Co.), M. Robinson, E. Parry (representing Mr. H. F. Parshall), J. P. Gregory and J. S. Conover (British Thomson-Houston Company), Hon. C. A. Parsons and Gerald Stoney (C. A. Parsons and Co.), Henry Mavor (Mavor and Coulson), Stuart Russell (India Rubber, Gutta Percha, etc., Company), W. Scott (Laurence, Scott, and Co.), E. S. W. Moore (Electric Construction Company), J. Eck (Union Electric Company), H. St. Hill Mawdsley and H S. Hickley (Newton Electrical Works), A. C. Eborall (Witting and Eborall), J. J. Steinitz (Brush Electrical Engineering Company), H. Fox (Morley Electrical Engineering Company), W. B. Esson (Johnson and Phillips), A. F. Berry (British Electrical Transformer Company), Herbert A. Jones and F. Oelschlager (Phœnix Dynamo Company), H. Northcote (Verity, Limited), S. L. Brunton and K. A. Scott Moncrieff (Crompton and Co.), W. Walter (Clark, Chapman, Limited), C. H. Iles (Thomas Parker, Limited), and F. Hird (Siemens Bros.). A list of questions had, previous to the conference, been drafted and circulated to those gentlemen attending the conference in order that they might be more exactly informed as to the precise matters to be discussed. In his short opening address, the Chairman (Colonel R. E. Crompton, C.B) referred to the opinions which had been expressed on the recommendation of the British Engineering Standards Committee with reference to standard frequencies, and remarked that the committee had for this, and other reasons, decided upon holding this conference. A very animated discussion took place upon the different matters referred to in the list of questions before the meeting, which did not break up till late in the afternoon of the first day. On the second day the several knotty problems arising out of the committee's proposals for standardising motor carcases and speeds were dealt with at length. We understand that the very interesting and instructive discussion which took place, both with regard to the question of standard frequencies and that of motor standardisation, will have great weight in any recommendations which the committee may make in the future with regard to these important matters. The Chairman, after thanking those present, informed the meeting that the committee intended at an early date to carefully consider all the different points raised by the several witnesses present. In conclusion, he added that, with the aid of the valuable information so courteously placed at the disposal of the committee, he felt sure they would be very greatly assisted in the object they had in view—namely, the benefiting of the electrical industry of the British Empire by judicious standardisation.

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## THE ELECTRICAL PLANT AT THE BROADWOOD GRAND PIANOFORTE FACTORY AT OLD FORD.

The new factory of Messrs. John Broadwood and Sons, at Old Ford, near Victoria Park, E, contains work which is of supreme interest to lovers of music. The details of piano manufacture there to be seen are the outcome of

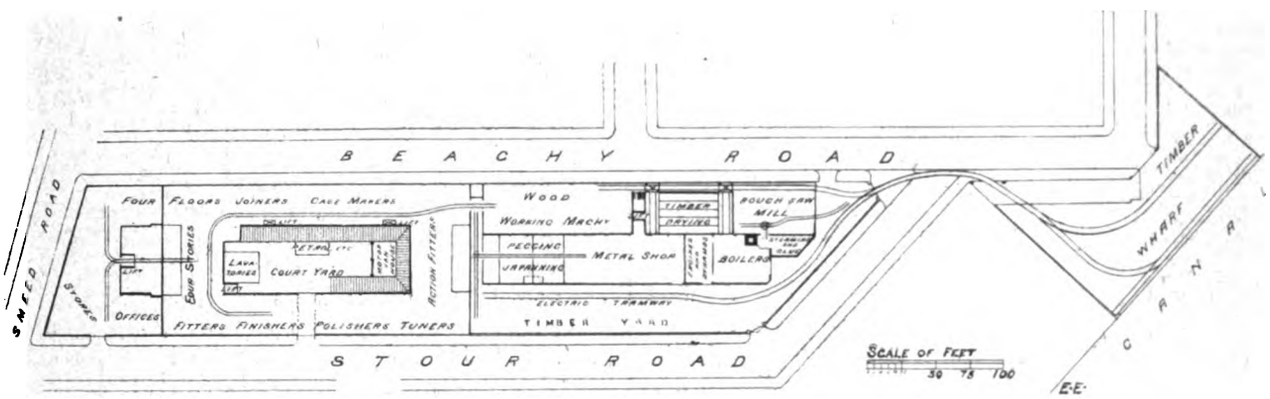


FIG. 1.—Block Plan of Messrs. John Broadwood and Sons' New Factory and Wharf at Old Ford.

experience extending back to 1732, when Burkhard Tschudi, a Swiss harpsicord maker, established himself in Great Pulteney-street, Golden-square. The original John Broadwood found employment in Tschudi's workshops, married his daughter, and was taken into partnership. The first grand pianoforte made in London was constructed by a Dutchman, Americus Backers, with the help of John Broadwood, about 1770; and on the death of Backers, about 11 years later, he left his pianoforte "action" to the Broadwood firm, who, with some modifications, have kept to it ever since. It is universally known as the English action, and has not yet been equalled in all-round excellence by any of the foreign methods.

The history of the development of the grand piano, from an engineering point of view, shows a gradual introduction of iron into the original wooden support for the strings. These struts of iron gave way to complete cast-iron frames, which in time have been superseded by cast-steel frames. The strength gained in this last change has enabled all internal bars to be abandoned, and the free-toned open frame, for which Messrs. Broadwood and Sons are noted, is the result.

The new works of the firm cover the whole plot of ground within a boundary formed by Stour-road, Smeed-road, and Beachy-road, not far from Old Ford Station, and another plot on the Hackney Canal, connected by a private tramway. These have been designed to meet the requirements of the great business established more than a century and a half ago. It is the largest pianoforte factory in the Empire, and every approved modern machine tool or appliance tending to rapidity and improvement in the product has been adopted. The architectural design of the bulk of the buildings was placed in the hands of Mr. Eugene C. Beaumont, M.S.A., who has also superintended the erection of the same.

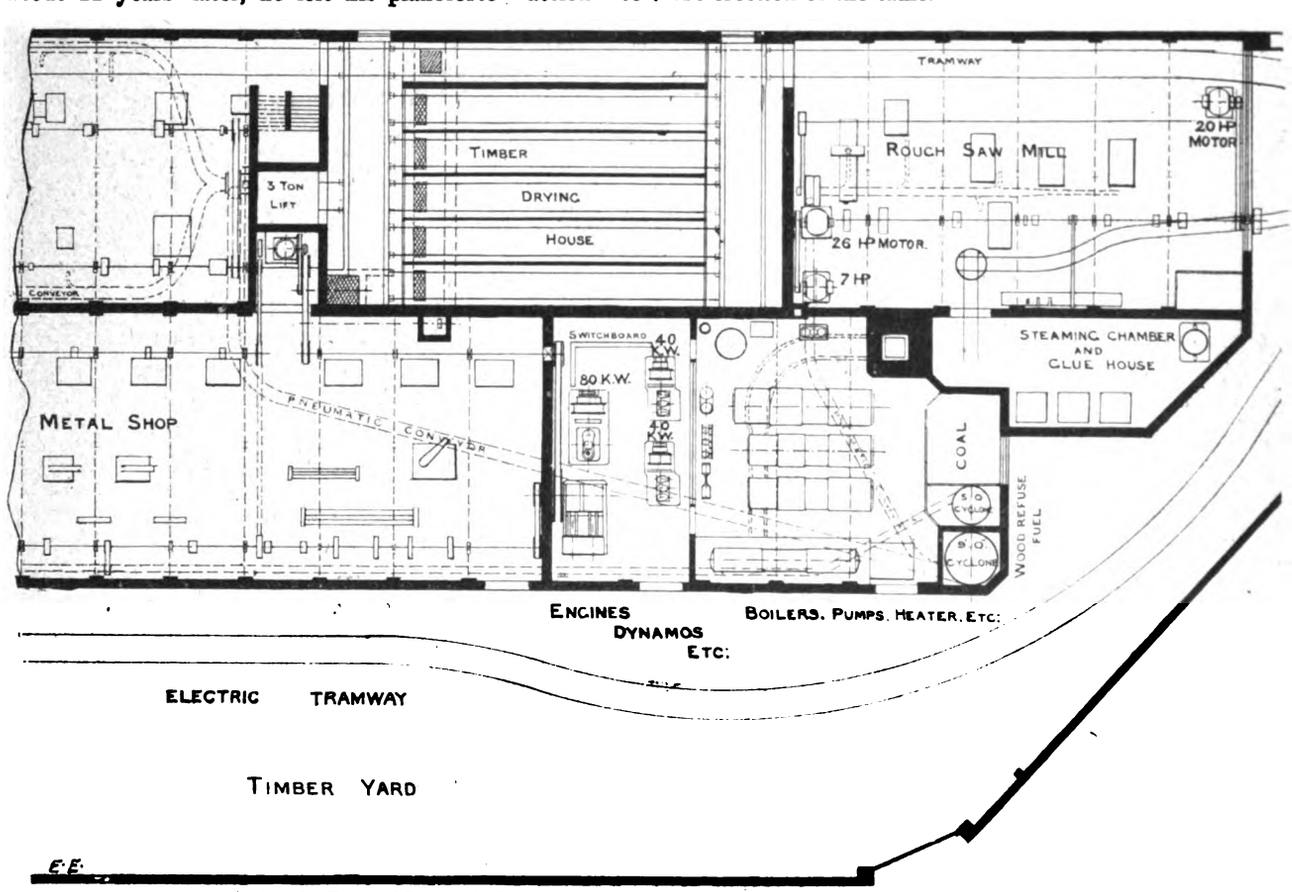


FIG. 2.—Enlarged Plan of the End of the Factory to show the Electric Power and Lighting Plant.

It is with the electrical equipment of the new factory at Old Ford that we have to devote our attention. The block plan (Fig. 1) will give a general idea of the space covered by the works and of the arrangement of the same. They may be said to commence at the timber wharf on the Hackney Canal, at which point the special kinds of wood used in pianoforte manufacture are delivered. From this point the materials are continually moving towards the left-hand side of the plan, where the offices and stores are

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situated. The organisation of the factories and the arrangement of the various departments is such that no part of the path from the timber wharf to the store is traversed by the of a grand piano can be placed on the direct route of the work, which saves a large amount in transport labour.

The boiler-house plant at Old Ford consists of three

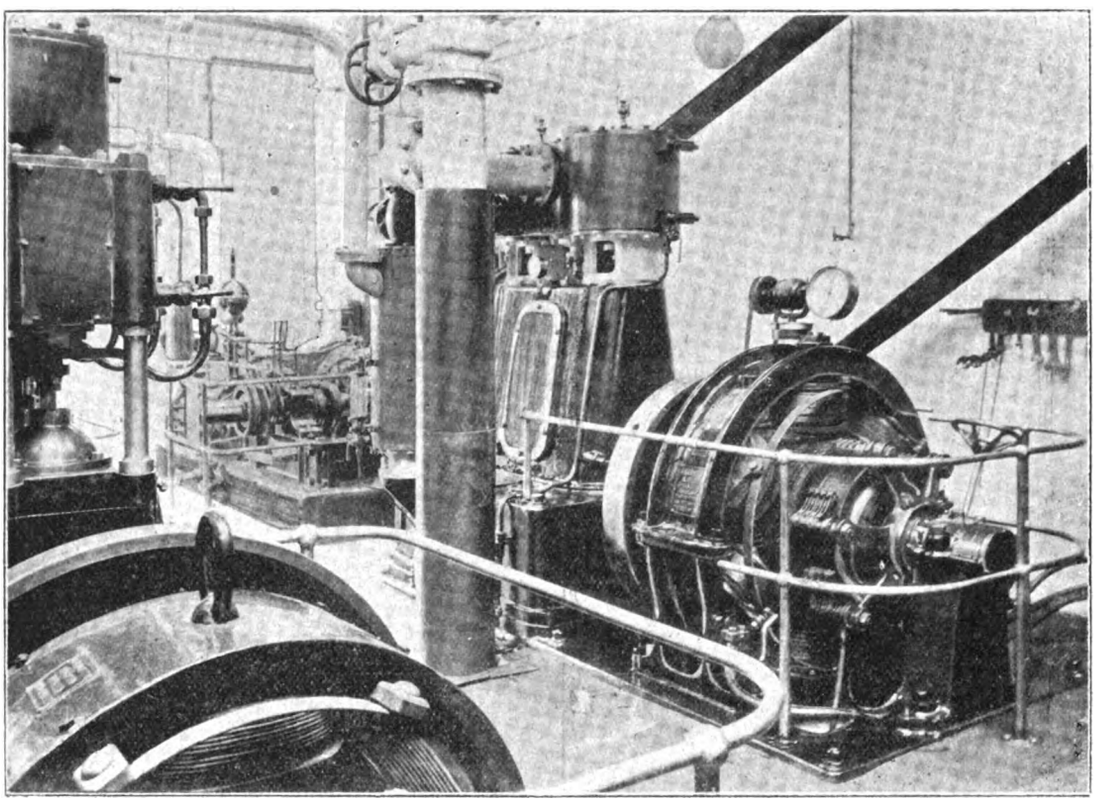

FIG. 3.—View of the Power Station, showing the Belliss-Crompton 80-kw. Set.

materials a second time. In Fig. 2 we give an enlarged plan of that part of the factory in which the whole of the power required is generated, and round which a fairly large portion of it is utilised. The woodworking machine shop locomotive boilers by Messrs. Davey, Paxman, and Co., with an aggregate horse-power of 320, and one Babcock and Wilcox boiler of about 100 h.p. These all work at 120lb. pressure per square inch. The Babcock and Wilcox

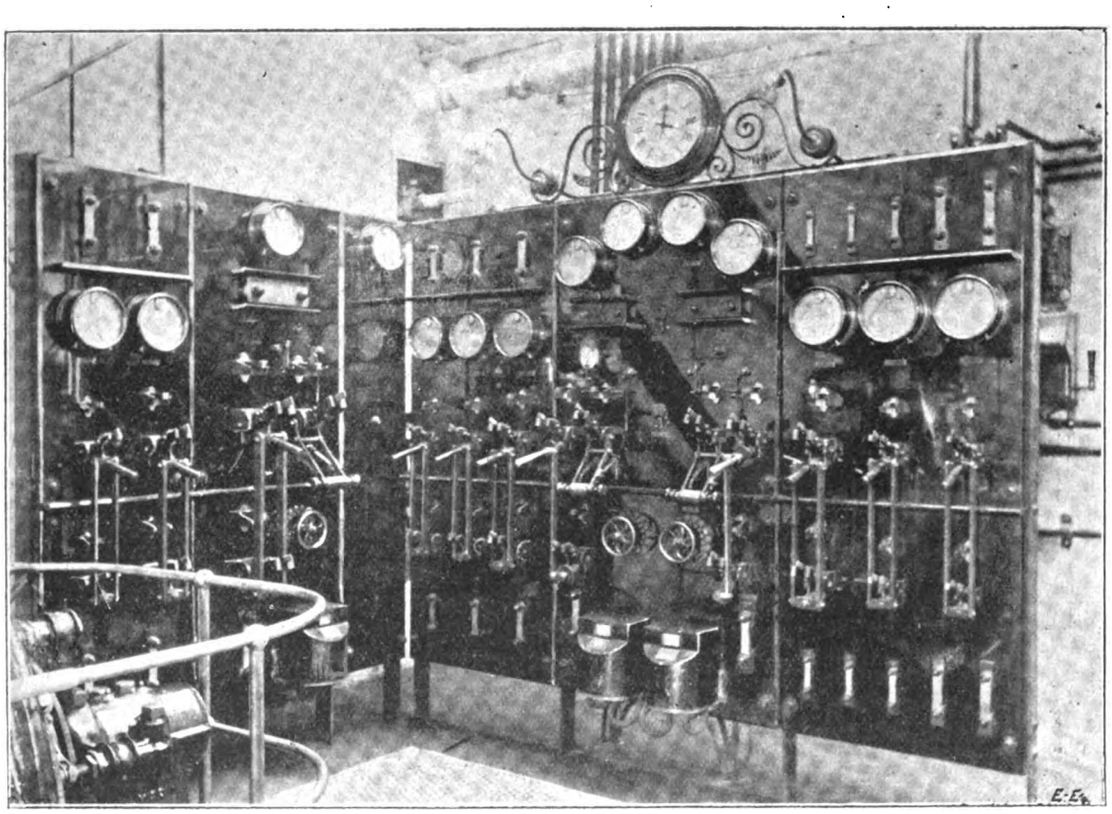

FIG. 4.—The Crompton Switchboard, taken during the dining hour when all Switches are Open.

and the metal shop are driven by means of shafting from an engine in the power-house, but all the other departments requiring power are driven by electric motors. This has greatly facilitated the arrangement of the departments, as the machines required in the various stages of the completion boiler is fired by the waste wood from the various workshops and also with the sawdust and shavings from the woodworking machinery. These latter are transported by a pneumatic conveyor system supplied by the Sturtevant Company. The sawdust and shavings are separated from

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the air by means of the cyclones, which can be seen above the boiler-house roof in Fig. 6. The firebars of the Babcock boilers are arranged on the same level as the boiler-house floor, so that the refuse can be pushed into the fire without any lifting. The feed water for these boilers is heated by a Boby-Chevalet detartariser, which has done good work in softening and removing impurities from the feed water. These are deposited in the heater, which can be cleaned easily and quickly.

In the engine-room there are four main engines, with the first of which we are not concerned, as it drives by belts the shafting mentioned above. The other three are each direct connected on to a Crompton compound-wound dynamo. They consist of two Peache high-speed engines, running at 500 revolutions per minute, each driving a dynamo nominally of 40 kw. capacity, but the engines and dynamos are able to give large overloads. The remaining engine (Fig. 3) is of the Belliss and Morcom type, and it is coupled to an 80-kw. dynamo. The speed of this set is 450 revolutions per minute. The dynamos are compound wound, in order that they may effectually deal with large fluctuations in load. These fluctuations arise from the nature of the motor-driven plant. For instance, in the rough sawmill, where heavy rosewood logs have to be sawn, sudden fluctuations of 25 h.p. are by no means uncommon. The compound winding of these dynamos has been most successfully carried out by Messrs. Crompton and Co. A trial of the 80-kw. and one of the 40-kw. machines showed that they divided the load perfectly. The engines were running on their governors, and the total output was then reduced from the full load of the two machines to practically no load, and they divided the output in the ratio of 2 to 1 throughout the test.

The switchboard (Fig. 4) was also manufactured by Messrs. Crompton and Co. It is arranged to control the three compound-wound dynamos, and has an equalising bar for the same. The positive and negative poles are divided throughout, being kept on independent slate slabs. These are separated by the horizontal slate fillets seen in the illustration. The positive and negative switches in each circuit are connected by insulated links so as to be worked by a single handle. From the switchboard five lighting circuits and three power circuits are supplied, but the whole of the supply is given from common omnibus bars at 230 volts.

The electric lighting of the factory now requires over 1,000 lamps, and these are continually being added to as the various departments are extended. The wiring of the factory has been carried out by Messrs. Ward Bros, of Bevois House, Basinghall-street. The work is done in Simplex tubing in accordance with approved practice; not more than six lights have been allowed on any of the sub-circuits, and there are no joints allowed in any of the cables. Instead of jointing, the conductors are looped into the fittings. All the connections are made in iron boxes, so that the iron covering over the cables is continuous throughout. The large size of the main factory has necessitated the division of the building into four separate fireproof parts, and the wiring has been done in such a way that one-half the lights in any division are on one feeder and the other half on another. The cubic contents of the four floors of the main building is about a million cubic feet, without the mills and metal shops, which are chiefly of one floor only, and make a total of about 1¼ million cubic feet of space in shops to be lighted, the floor space being over 100,000 square feet. This gives some idea of the task of arranging the lamps and circuits to the greatest advantage. By generating their own current, Messrs. Broadwood and Sons have made a great saving as compared with other methods of obtaining their lighting current, or lighting by gas, and great convenience also results in having the electric power transmission facilities entirely under their own control.

The first part of the power plant to be considered is that used for transporting purposes. There is in the timber store round the new factory an electric tramway, on which a travelling jib crane (illustrated in Figs. 5 and 6) is employed. This crane, which was made by Mr. Henry J.

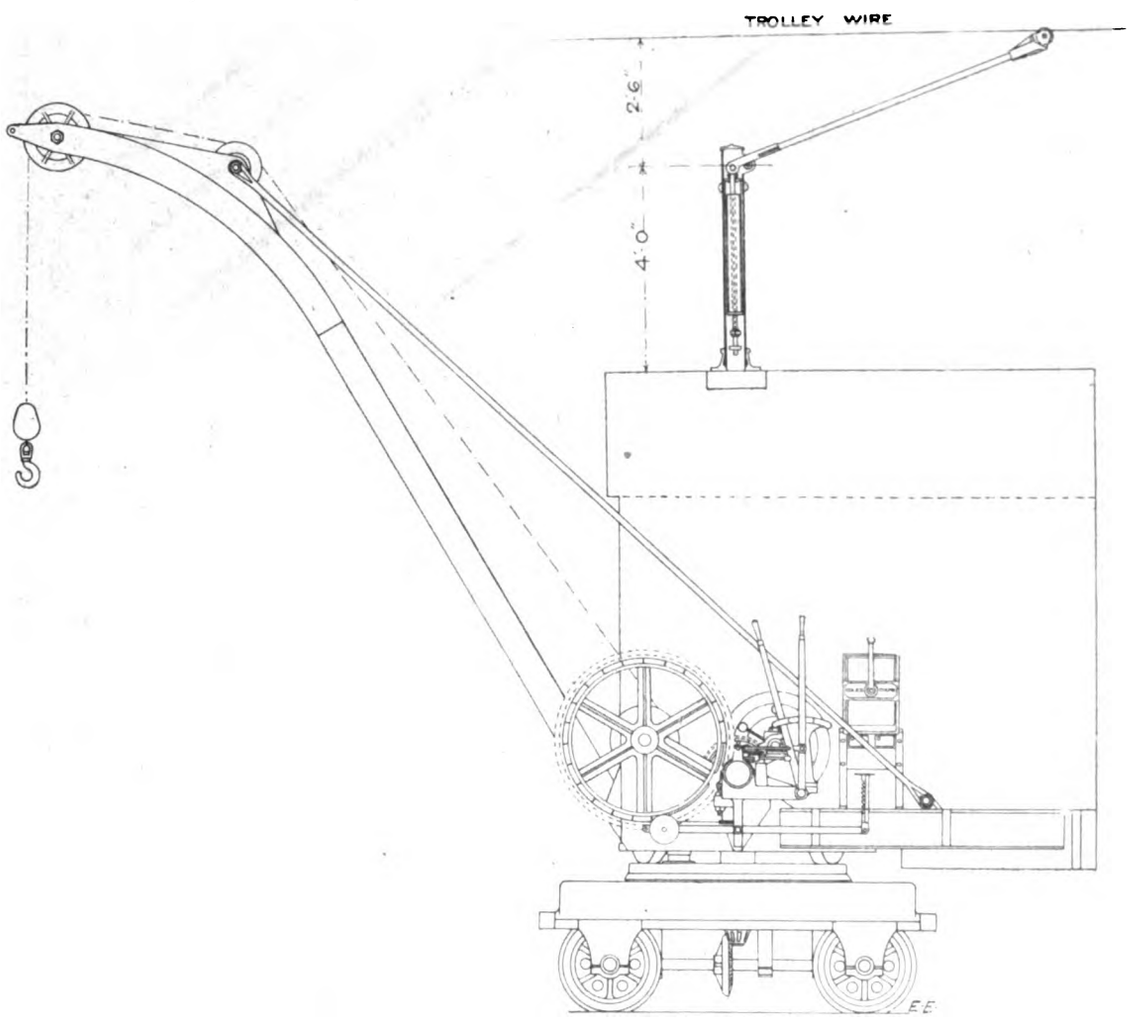


FIG. 5.—Side View of the two-ton Jib Crane, with outline of housing. The trolley wire is 19ft. from the road level.

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Colgs, of Derby, is used for handling wood, either stacking it in piles to one side of the track or lifting it from these piles on to trucks. These trucks can then be pushed by the crane along to the turn-table in front of the rough mill.

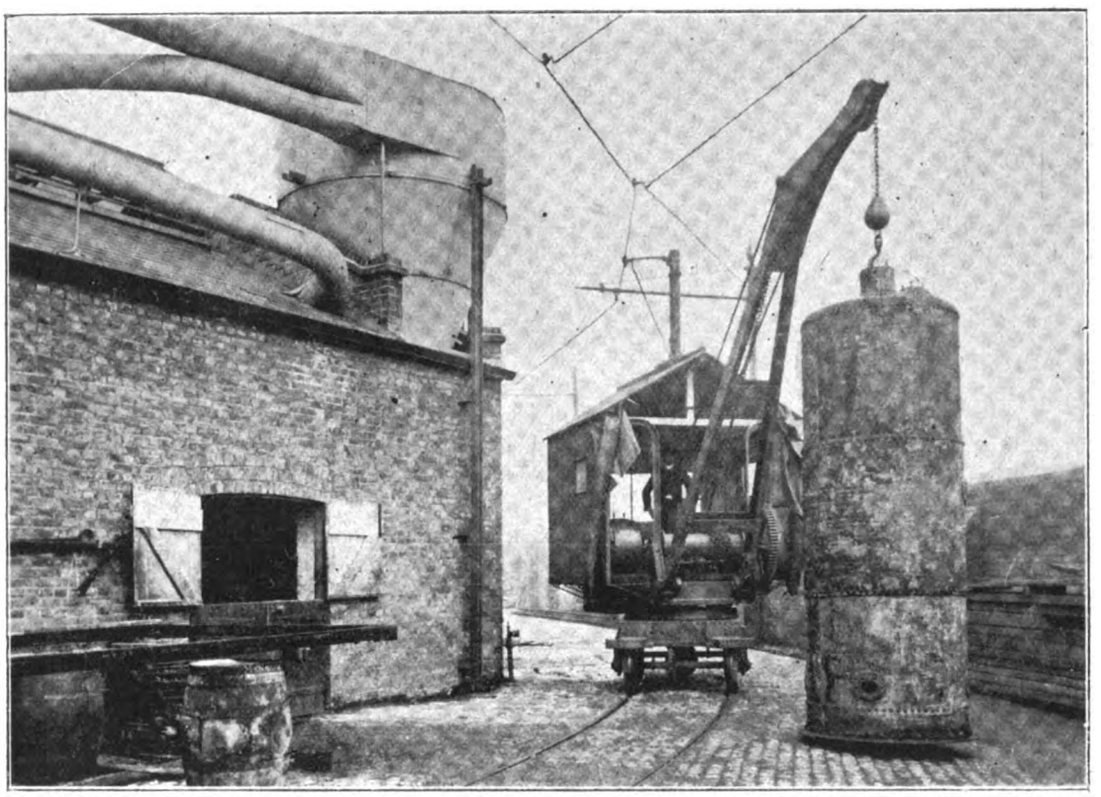

FIG 6.—The Electric Jib Crane and Tractor, showing the Overhead Work.

The crane is designed for a maximum load of two tons, and it will lift this load at the rate of 50ft. per minute. The speed when travelling is about 220ft. per minute. The radius of the jib is 14ft, and it can stack timber up to 12ft. from the ground level. The motor on this crane is a 15-h.p. one and runs at a speed of 500 revolutions per minute. The design of the crane can be seen in Fig. 5. It is made to revolve completely round in either direction by means of double friction clutches fitted on the main shaft. The centre clutch is made to engage with the clutch on either side by means of a pin passing through a hole made along the axis of the crankshaft, and attached to the clutch by a cross cotter. The head of the pin works between gunmetal washers in an oil-box, on which a screw is formed which gives a perfectly central and direct lateral motion to the clutch. The power is transmitted by suitable gearing to a steel pinion, which works into the loose slewing rack placed between the upper and lower portions of the crane. This arrangement of a loose rack effectually prevents breakage of the gearing should the crane be started to turn or stopped too suddenly. The crane revolves on four rollers as can be seen in the illustration. The travelling motion

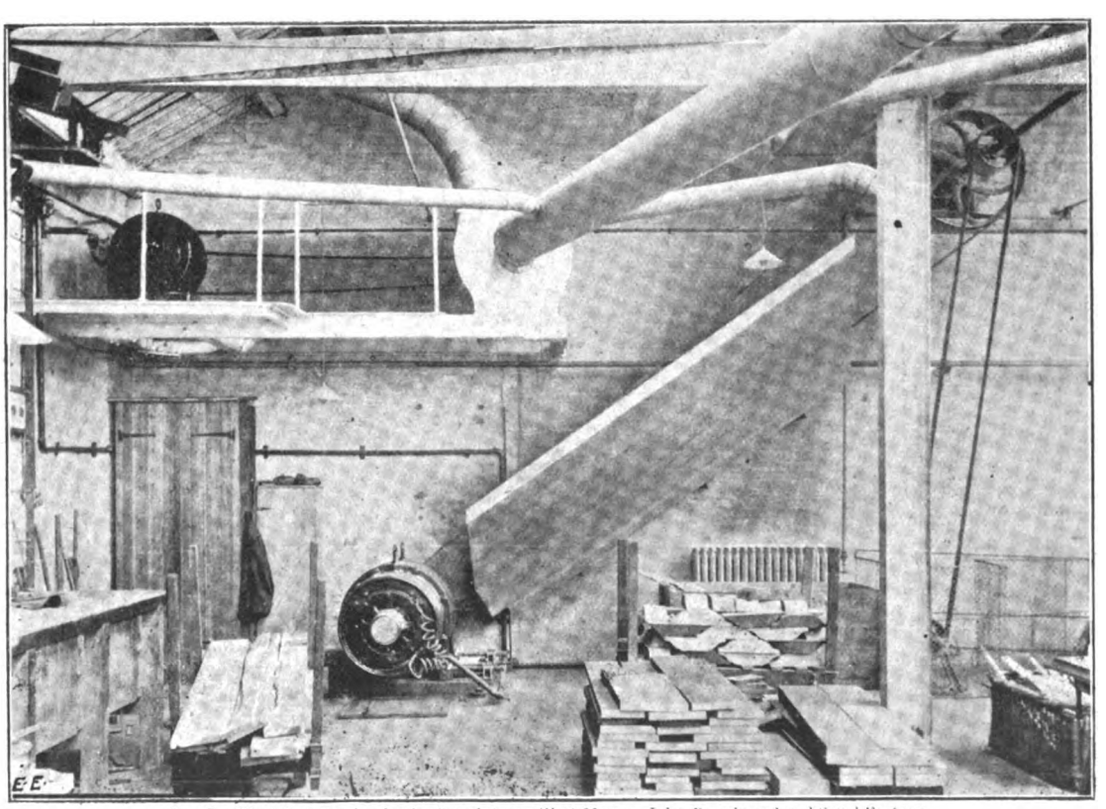

FIG. 7.—Electrical Driving in the Rough Sawmill at Messrs. John Broadwood and Sons' Factory.

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is transmitted from the main shaft by means of a vertical shaft, which passes through a hole bored in the centre pin. Steel bevel gearings under the truck connect this vertical shaft on to both the axles. The lifting motion can be followed from the drawing. When lifting, the load is automatically held by means of a brake if the current is interrupted. This brake is released magnetically when the current is on. A foot brake is provided for lowering. The crane has proved most useful for other work besides timber transporting. In the illustration it is shown handling a boiler. The overhead trolley wire construction and the bonding of the rails was carried out by Messrs. Macartney, McElroy, and Co.

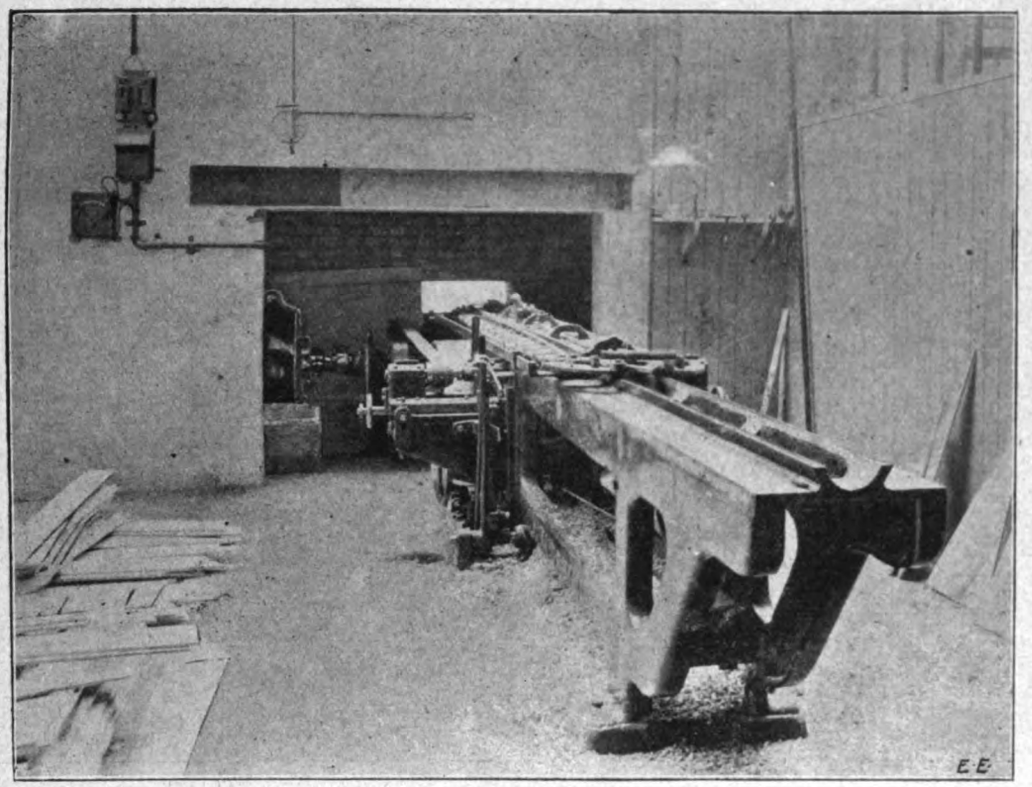

FIG. 8.—Electric Motor direct coupled to a Glue-Jointing Machine.

There are five electric lifts in the factory, of which three are of the Pickering type, and the other two were supplied by Messrs. J. G. Childs and Co. The largest lift is that in the wood-drying department behind the engine-room. The well-seasoned wood used in pianoforte manufacture is subjected by Messrs. Broadwoods to a process of artificial drying before use. The timber, after having cut up to the correct sizes in the rough mill, is stacked on to special trucks and delivered into one of the five air drying chambers. After a period in these chambers it is delivered on to this three-ton electric lift and carried up to the cooling-off floors above. This three-ton lift is supported by two ropes at each corner, and these ropes pass round pulleys at the top of the lift well. The electric motor, which is of 12 h.p., drives the two shafts on which these pulleys are keyed by means of two worm gearings. It is claimed by the makers, J. G. Childs and Co., that this device enables them to balance the thrusts of the two worm gearings. The other four lifts are situated in the main factory, and they are specially

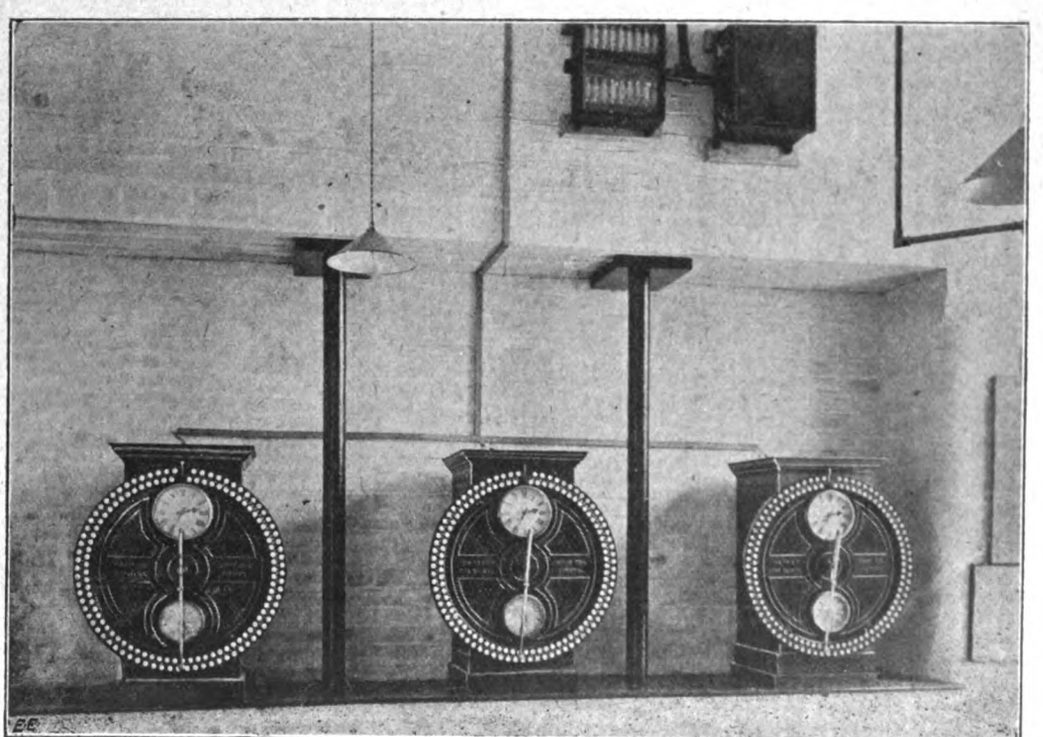

FIG. 9.—Three Dey Time Keepers, which are Electrically Driven. One of the Distributing Fuse Boxes can be seen above.

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designed for taking the largest size grand piano. Two of the electric lifts were previously driven by means of a gas-engine, but Messrs. Pickering, Limited, converted them to electrical driving, saving by the conversion a long length of countershafting.

The electric motors used throughout the factory are 19 in number, and, apart from those mentioned above, they are employed in driving various machine tools. As a rule, the motors operate short lengths of light high-speed shafting to which groups of machines are connected. In other cases the motors drive single machines by means of belts, or are direct-coupled on to the machines themselves. An example of the first arrangement is shown in Fig. 7, which is a photograph of one end of the rough sawmill. The motor seen on the floor level is of 26 b.h.p., and is used to drive about half of the saws in the mill. The other half of the machinery is driven from a 20-h.p. motor not seen in the illustration. These two motors are of the Crompton type, and they are compound-wound so as to give increased torque under heavy load over what would be obtained from a shunt machine. The speed in consequence is not uniform, but the motors are better able to deal with the sudden and varying loads. The other 7-b.h.p. motor placed up on the shelf, as seen in this illustration, is driving the fan which provides the air exhaust to carry away sawdust from the saw benches.

Fig. 8 is a view of an electric motor directly coupled on to a new glue-jointing machine recently installed. This machine gives the absolutely true joints required between the adjacent sections of the soundboard of the Broadwood piano. About one-half of the aggregate horse power of the motors in the factory have been supplied by Messrs. Cromptons, and the other half are of the Electromotors Limited type, supplied by Messrs. Ward Bros. The motor starters are most of the Sturtevant type, provided with no-load releases and in the larger sizes with over-load releases as well. The ease with which small groups of machinery can be quickly put down in a new position and set to work has been fully realised by the firm, and it has helped greatly in the organisation of the factory.

The telephone installation was also installed by Messrs. Ward Bros., and consists of a complete local exchange for 25 subscribers. This system was specified by the engineers in order that the cross talk which is usually found on inter-communication systems might be avoided. The exchange board is in the general office, and the various departments can get connection with each other through this exchange. In order to save the time of the general manager of the works, plug boards have been erected in each of his offices so that he can obtain connection to any department without the delay of going through the local exchange. These telephones are of the General Electric Company's make, and they save a large amount of time in a factory of this size.

The electric clocks which provide uniform time in the various departments are of the Synchronome Company's type. Half-minute impulses are sent through the electric circuit to these clocks from a master pendulum in one of the general manager's offices. A feature in this installation, which includes over 20 clocks, is that the workmen's time-recording apparatus are also electrically driven. There are four of these Dey time recorders in the main entrance, of which we illustrate three in Fig. 9. Each workman as he comes in or leaves the factory moves round the recording arm until it is opposite the hole on which his number appears. He then presses the knob, which records the time indicated by the clock on a sheet opposite his number. In order to prevent the clock being retarded if the workman should be recording his time when the impulse is given by the electromagnet, the Synchronome Company have introduced a certain amount of spring in the connection between the clock and the recording disc. This allows the clock to advance half a minute, even if the disc is locked. The disc then advances when the workman withdraws the plug. This apparatus has given every satisfaction, and the synchronising of the time recorders with the clocks in the various departments prevents dispute over timekeeping.

Mr. G. D. Rose, the experienced managing director of Messrs. John Broadwood and Sons, has arranged the various departments of these new works so that the processes are continuous, and to him every credit is due.

The whole of the engineering work in the new factory has been carried out to the specification and under the superintendence of Mr. W. Worby Beaumont, M.I.C.E., who has for years been the consulting engineer to Messrs. John Broadwood and Sons. Mr. R. W. Weekes, M.I.E.E., has acted with him in the design and superintendence of the electrical portions of the work.

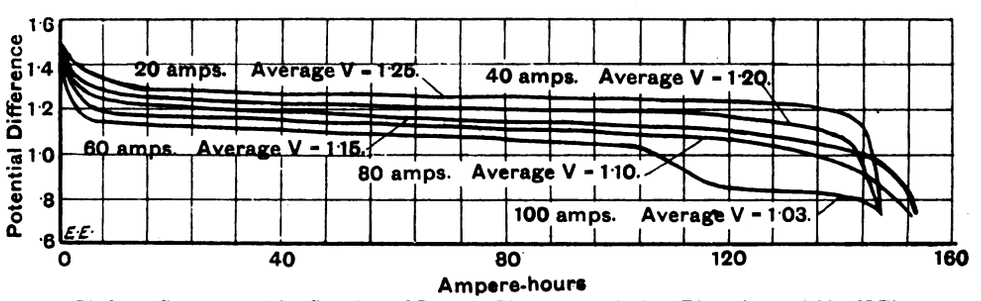
## THE EDISON ACCUMULATOR FOR AUTOMOBILES.

BY W. HIBBERT, A.M.I.E.E

Following is an abstract of the discussion of the above paper, which took place at the meeting of the Institution of Electrical Engineers in London on Thursday, the 28th ult. The paper itself will be found in our issue for Dec. 11 last.

Mr. W. HIBBERT asked leave to make an addition to the paper in view of an improvement which has been effected in the Edison cell. The fact that the former cell, upon which his paper was based, was not balanced—one of the plates having a greater capacity than the other—suggested an obvious improvement. He wrote to Mr. Edison, who informed him that the improvement had already been made, and he had now carried out tests which confirmed the results obtained by Mr. Edison with the new form of cell. It was called a half cell. But it was more than that—it was a rearrangement of the plates, of which there were six negative and twelve positive in the new cell. He exhibited a curve (given herewith) showing the results of Mr. Edison's tests, and he had confidence in saying that for 60-ampere discharges its behaviour was typified by these results and the curves he had received from Mr. Edison. The cell itself was a decided improvement on the original form. It weighed under 13lb.—about 12·7lb.—and had given the following results on test: with a current of 20 amperes it gave a capacity of 146 ampere-hours and 185 watt-hours, or 14·6 watt-hours per pound; at 40 amperes, 146 ampere-hours, 175 watt-hours, or 13·7 watt-hours per pound; at 60 amperes, 150 ampere-hours, 172 watt-hours, or 13·5 watt-hours per pound; at 80 amperes, 150 ampere-hours, 165 watt-hours, or 13 watt-hours per pound; and at 100 amperes it gave 146 ampere-hours and 150 watt-hours, or 11·8 watt-hours per pound. These figures were a good indication of the improvement in the output of the cell per unit of weight, and he should say that the efficiency was not at all unlikely to be higher, but he had made no experiments upon that yet.

Dr. J. A. FLEMING said: It is perhaps a matter for regret that the looked-for discussion on Mr. Edison's automobile cell has been separated by so long a time from the reading of Mr. Hibbert's excellent paper, because by the




Discharge Curves connecting Capacity and Potential Difference for the New Edison Cell, weighing 12·7lb.

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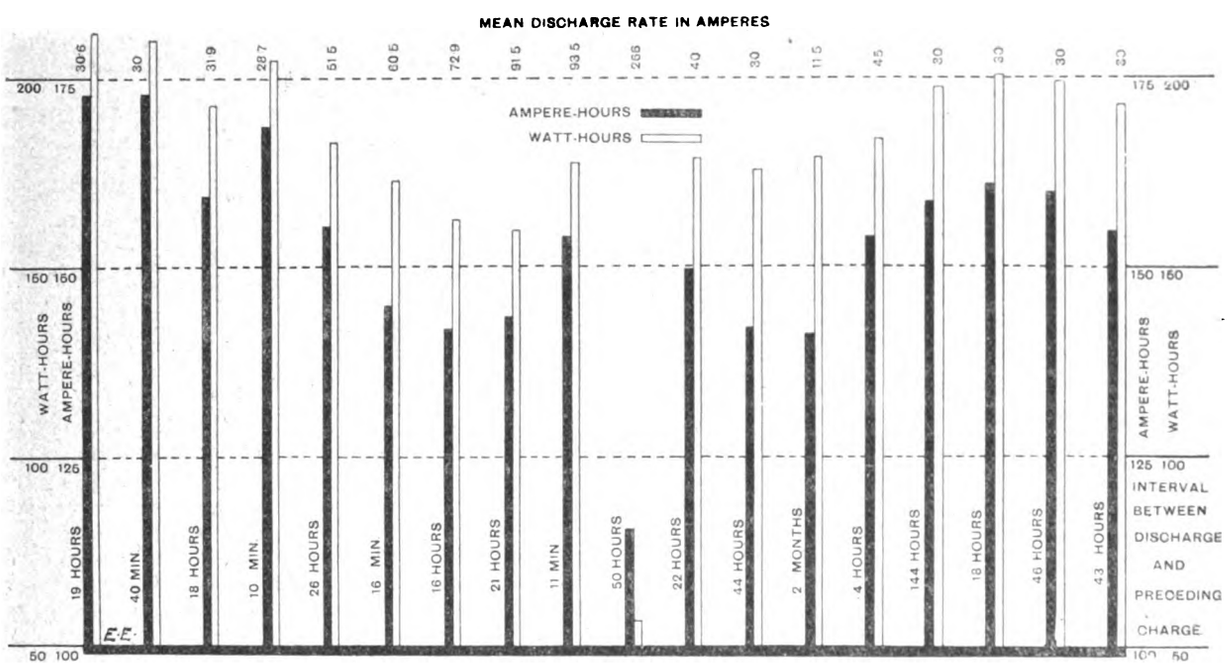
time that we have arrived at the discussion Mr. Edison has arrived at a new cell. Nevertheless, in the remarks I have to make on the subject I will give the results of experiments which we have carried out in the electrical laboratory at University College on the same type of cell as that described by Mr. Hibbert in his paper—*i.e.*, a 28-plate cell, 14 positives and 14 negatives. One of these cells was sent to me at the same time that others were sent to Mr. Hibbert, M. Jouet, Drs. Finzi and Soldati, and others. Although we received the cell as far back as last July, it was not until September that I was able to ask Mr. Clinton, Demonstrator in the Pender Electrical Laboratory, to undertake a series of tests upon the cell, the results of which have been tabulated by him in a series of curves, and the deductions from these curves have been embodied in a chart (which we reproduce herewith). From this chart it will be seen that the results obtained at University College confirm Mr. Hibbert's figures, and are in substantial agreement with the observations of other observers. The cell sent to us weighed 17·8lb., and at an average discharge of 30 amperes was found to give out 212 watt-hours and 173 ampere-hours, which corresponds to about 12 watt-hours per pound of the completely charged cell. The experiments at University College were directed to ascertain, first, the variation of capacity with increasing rate of discharge; second, whether large discharges had any permanent effect in reducing the capacity; and, third, whether heavy discharges had any effect in bringing the active material out of the pockets. With regard to the first point, we went on gradually increasing the discharge rate until on one occasion the cell was discharged at a rate of 375 amperes, falling to 170 amperes, the average current being 266 amperes, the discharge being taken through a constant resistance of one-thousandth of an ohm. Although, as will be seen from the accompanying table of figures, the capacity ampere-hour and watt-hour diminishes with increasing rate of discharge, yet, nevertheless, these immensely heavy discharges have no permanent effect in reducing capacity, because after a few more charges and discharges, on taking a discharge at the normal rate of 30 amperes, the capacity of the cell came back almost to its original value. During this process of charge and discharge the cell was sometimes left standing charged and sometimes completely discharged. There are certain differences in the values for the ampere-hour and watt-hour capacity, as shown in the diagram, which seem to be connected with the time during which the cell stands after being charged and before its discharge. On one occasion the cell was short-circuited for 16 hours after the thirteenth discharge, but such treatment produces absolutely no effect upon the succeeding discharge taken at a normal rate. The cell appears to have a remarkable capacity for taking up current. It can be fully charged with 100 amperes at 2½ hours, or with 200 amperes in about 1½ hours, and yet give its full normal discharge. One point to which I directed attention was to ascertain if these heavy discharges brought the active material out of the pockets. We are well acquainted with the behaviour of the lead secondary cell in this respect. Accordingly, after taking 20 discharges with the Edison cell, it was shaken up, the liquid contents removed, and the cell washed out with distilled water. A small amount of black deposit was found, which was dried and found to weigh 1·4 grm. This deposit was analysed in the chemical laboratory of University College, and found to consist of — carbon, 22 to 25 per cent; iron, estimated as oxide, 27 per cent.; and nickel, estimated as oxide, 51 per cent. We have at University College a lead secondary battery by one of the best makers. After four years' use the cells were cleaned out and 2cwt. of lead oxide mud removed from the 54 cells, corresponding to about 1lb. per cell per annum of deposit. As I have stated, in the case of the Edison cell, after 20 discharges—some of them exceedingly severe—the deposit was only 1·4 grm, showing a remarkable contrast. I was then anxious to ascertain whether any evidence could be found of local

| Number of discharge. | Discharge. Mean current—amperes. | Mean potential difference. | Maximum current—amperes | Minimum current—amperes. | Discharge. In ampere-hours. | In watt-hours. | Previous charge in ampere-hours. | Average charging rate—amperes. |
|---|---|---|---|---|---|---|---|---|
| 1 | 30·5 | 1·224 | 32 | 22·6 | 173 | 212 | 900 | 30 |
| 2 | 30·0 | 1·214 | 32 | 19 | 173 | 210 | 660 | 60 |
| 3 | 31·9 | 1·2·8 | 33 | 20 | 159·5 | 193 | 274 | 60 |
| 4 | 28·7 | 1·216 | 32 | 17 | 168·5 | 205 | 269 | 60 |
| 5 | 51·4 | 1·179 | 57 | 31 | 155·5 | 183 | 262 | 60 |
| 6 | 60·5 | 1·192 | 69 | 36 | 145 | 173 | 225 | 100 |
| 7 | 72·9 | 1·147 | 80 | 41 | 142 | 163 | 225 | 100 |
| 8 | 91·5 | 1·117 | 112 | 62 | 143·5 | 160 | 230 | 100 |
| 9 | 93·5 | 1·161 | 116 | 60 | 154 | 178 | 237 | 1 0 |
| 10 | 266·2 | 0·49 | 375 | 170 | 115·5 | 57 | 245 | 100 |
| 11 | 40 | 1·197 | 42·0 | 24·5 | 150 | 179 | 281 | 97 |
| 12 | 34 | 1·211 | 36 | 21 | 130 | 158 | 184 | 92 |
| 13 | 23 | 1·231 | 24 | 13 | 143 | 176 | 237 | 95 |
| 14 | 29·9 | 1·234 | 30 | 17 | 142 | 175 | 315 | 105 |
| | | | Two months rest charged | | | | | |
| 15 | 11·4 | 1·273 | 11·6 | 8·5 | 141 | 179 | 283 | 105 |
| 16 | 45 | 1·200 | 45 | 45 | 154 | 184 | 390 | 80 |
| 17 | 30 | 1·245 | 30 | 30 | 159 | 198 | 436 | 32 |
| 18 | 30 | 1·249 | 30 | 30 | 161 | 201 | 225 | 60 |
| 19 | 30 | 1·215 | 30 | 30 | 160 | 199 | 336 | 60 |

The cell in each case was discharged down to 0·3 volt on closed circuit, except in discharge No. 10, where initial voltage was 0·7 volt, and final 0·3 volt. Weight of complete cell, 17·8lb. At the end of thirteenth discharge cell was short-circuited for 16 hours.




Record of Tests made on the New Edison Cell at University College, London, from September, 1903, to January, 1904.

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action between the active material and the supports. I tried the following experiment. A number of pieces of bright iron were placed in a 20 per cent. solution of caustic potash, and on the end of one of these was placed a small amount of the black oxide of iron as used by Edison, and on the other a small quantity of the green oxide of nickel as used in the cell. One of the pieces was partly rusted, and the others were left entirely bright. After remaining two months in the potash not the smallest trace of the oxidation of the iron could be seen, nor was there any evidence that the oxide of iron or the oxide of nickel was at all soluble in the caustic potash. Hence there appears evidence that the active material does not react with the iron support to produce local action in the same manner as the peroxide of lead reacts with the lead support in the lead-sulphuric-acid cell. I think that is a very important point. It appears there are only seven common metals, oxides of which are insoluble in a 20 per cent. solution of caustic potash, and these are iron, nickel, cobalt, chromium, manganese, bismuth, and silver. Of these the iron and nickel oxides are almost the only ones which can be commercially used. Hence, in selecting as the elements of his cell active materials that are insoluble in the electrolyte and will not react voltaically with the supports, Mr. Edison has made a great advance. Moreover, the caustic potash solution does not alter in density with charge and discharge. It merely serves to convey oxygen to and fro. The real discovery made by Mr. Edison in connection with this cell is the discovery of a form of iron that can be oxidised and then reduced again by the electrolytic ions of caustic potash solution. And there are many interesting electro-chemical and thermo-chemical points in connection with this reaction. I have not had an opportunity of testing cells in bulk on an automobile as Mr. Hibbert has done, and therefore my opinion is confined to an estimate formed from laboratory experiments. I am well aware, of course, of the caution necessary in forming an opinion of a cell from experiments made with one cell, but as the results obtained have been confirmed by numerous observers, I think it is clear that we can say that the Edison cell has the following points in its favour: first, although the capacity per pound of completely charged cell is not markedly greater than that of many light weight lead cells, yet, nevertheless, there is clear evidence that the plates are less deteriorated by heavy discharges and by time, or by loss of active material and local action; secondly, the cell has a remarkable power of taking up its charge at a high rate, which, of course, is a very important point in connection with automobile work; thirdly, by getting rid of the dilute acid and using alkali as the electrolyte, which can be contained in a light metal vessel unacted upon by it, and, therefore, far more mechanical than the fragile glass or ebonite cells required in the case of dilute sulphuric acid, Mr. Edison has made a notable improvement. Although I have had sent to me one of the later pattern of the Edison cell, containing 12 positive and six negative plates, and having, as Mr. Hibbert has pointed out, a greater capacity per pound of cell than the 28lb. cell, yet our experiments at University College are not sufficiently advanced for me to give you any figures in connection with it. Whilst, no doubt, the arrival of this Edison cell will stimulate invention and improvement in connection with existing forms of secondary cells, there can be no doubt that Mr. Edison has laid the electrical engineering fraternity under a fresh obligation by bringing to such a point of perfection this new alkali cell.

Mr. E. J. WADE remarked that the paper dealt almost entirely with the outside of the cell, and, figuratively speaking, he should have been glad if Mr. Hibbert had got inside the cell and told them a little more about its novel points, which seemed to mark it off so very clearly from the lead battery. He asked the author to explain the causes which determined the discharge potentials as given in Fig. 2 of the paper. Mr. Hibbert, in a paper read before the Institution in 1892, ascribed all these potential changes to variations in the strength of the electrolyte. In the Edison cell there were no variations in the electrolyte, and yet they were getting almost similar curves. He thought it was to be concluded that it was the exhaustion of the electrolyte in the lead cell that brought down the output on the high rate, and that it was maintained in the Edison cell because the electrolyte did not change. While they were all ready to accept Mr. Hibbert's results of actual tests of the Edison cell, he thought that some of the inferences implied in regard to lead cells were not quite justified.

Mr. H. J. JOLY gave some particulars of lead cells used on tramways and for driving automobiles, but to a large section of the meeting his remarks were inaudible. He, however, was understood to say that the best efficiency of the lead cell he described was obtained when charging with 250 amperes, and that the efficiency at varying rates of discharge was practically the same as at constant rates.

Mr. W. R. COOPER remarked that unfortunately the value of the results obtained by Mr. Hibbert on his electric runabout was considerably impaired by the excessive weight and indifferent design of the machine. The author seemed to have proved most of his points, except perhaps that in regard to the heavy discharges of the cell. If one took the weight of the cell as the basis, then certainly the discharges were heavy, but one must take the capacity into consideration as well, and then the discharges were not excessive. An interesting point was made about extra discharge at low voltage, the author stating that he had to rely upon it to get his machine home. He (Mr. Cooper) was not quite sure whether that really was the case, and he should like to ask whether there was a voltmeter on board. Perhaps the author could give them some further information on the point. He joined with Mr. Wade in regretting that the author had not touched upon the theory of the cell. He should like to know, however, whether he had been able to verify the composition of the oxides. Apparently the oxide of iron used was something quite special.

Mr. W. H. PATCHELL, speaking of lead cells, referred to a remark made by Mr. Wade that the electrolyte was subject to considerable exhaustion, and expressed the view that in recent years battery work had improved very much owing mainly to the better class of materials used. He also referred to the spacing of the forks in lead batteries, and to the tendency to increase the distance between them. He thought that in large cells one of the features of success was due to the wide spacing and improved circulation.

Mr. HIBBERT, in replying, said the question of the formation of the cell had been raised. About this he was not in a position to speak in the paper, as the cells came over from the States intact, and he had made it a rule not to put anything in the paper which he had not first confirmed by test. Prof. Fleming had stated that after working for a certain length of time on the cell described in the paper he agitated the liquid, ran it off through a filter, and then had the remains analysed. He himself had done that by breaking up a cell which, in consequence of very violent treatment, had come to grief. He analysed the stuff that was found in the liquid, and the proportion of the active material which was left at the bottom of the cell was one-two thousandth of the whole. This was after the cell had done 3,000 miles. The proportion of graphite was one-fifth of the stuff that had been ejected. Prof. Fleming had also referred to the rusting of iron in alkali, and had conducted an experiment extending over six weeks or two months. Now, he (Mr. Hibbert) had seen the result of an experiment that had been going on for many years—possibly 30. At the Royal Institution Faraday placed in bottles some brightly polished pieces of steel and iron in an alkali. Years afterwards the steel and iron pieces showed no signs whatever of rust, and were as bright as the day on which they were bottled up. He took it that was exceedingly good evidence that even over a very long time they had no reason to expect that an alkali solution would, left to itself, oxidise iron. Therefore, there would be no danger to the Edison cell from the rusting of the materials. Objection had been raised to the testing of a single cell as furnishing reliable results. There were, however, 80 or 90 of these Edison cells distributed about Europe, and they might look upon the results already obtained as being fairly representative, and one ought to accept them without reserve. Mr. Wade had remarked that all the data in the paper referred to the exterior of the cell. That was because he had no data as to the

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interior. Up to the time of writing the paper he had no chance of examining the inside, but as soon as he was in a position to speak with confidence on that matter he would do so. The accepted chemical data were vague, even with reference to oxides of nickel, and he suspected that when the task of examining the electro-chemical oxides had been carried through they should find that there were not one, two, or three, but that there were many more oxides than had been indicated. Mr. Wade had further asked him to explain Fig. 2 in the paper. The chief points about this were embodied in his earlier remarks that night. There was a rapid fall in the potential difference at the beginning of the discharge, followed by a flat form, and succeeded at the last by another rapid fall. He attributed the last of these to changes in the resistance of the oxides in the pockets. Turning to the remarks of Mr. Cooper, the runabout he used was not a bit too heavy for the work it had to do. He could not see the voltmeter at the close, and the figures he had given for the output and the efficiency of the motor were estimated by him afterwards. He, however, had left plenty of margin for error, and the figures might be taken as substantially correct. Mr. Wade had said something about the question of porosity of these cells. Many things could have been stated in the paper, but he found such scepticism in regard to the Edison cell that he put nothing in that he had not already verified. This scepticism seemed to him to be unfair and unjust to the inventor of the cell, because many of the statements that had been made in the non-technical Press, and even in some of the American papers which might be regarded as being tinged with technical knowledge, were typical, not of Mr. Edison's contribution to the electrical engineering world, but typical only of the people who wrote in such papers. For this reason he had left out of his paper many things he had been told but had not yet verified himself. The majority of the cells sent to him from America had been running in London cabs at excessive loads, and five out of the 60 cells had been somewhat injured, so far as capacity was concerned. That afternoon he commenced an experiment on a cell which had been sent to him as having seriously decreased in capacity. It originally had a capacity of 150 ampere-hours, and that had fallen to 78 or 80 ampere-hours. He had succeeded in bringing it back to 122, and he anticipated that when the process of restoration had been applied two or three times more, it would be brought back much nearer to its original capacity. The process was tolerably simple. It consisted very much in giving the cell not only a big discharge, but a reverse current for a considerable time. By a very simple procedure he thought he could avoid the mischief that brought down the capacity. It seemed to him, therefore, that the fact that five out of the 60 cells showed a diminution of capacity ought not to belittle and might possibly increase the value of the results he had described in the paper.

On the motion of the President, the author was accorded a very hearty vote of thanks.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

659. Explain fully and give proof of Scott's method for transforming from a two to three phase system of current.—F. S. Q.

660. Discuss the advantages and disadvantages of putting the equalising bar in a traction and lighting station behind the main switchboard, or in a trench under engine-room floor, beside machines, with equalising and series diverting switches on generators.—R. M.

### ANSWERS.

*Question No.* 651.—Describe some form of transmission dynamometer suitable for measuring the power supplied to a pump.

*Answer to No.* 651 (*awarded* 10*s.*).—Transmission dynamometers may be divided into two classes—viz. (1) those whose action depend on the difference of tension on the two sides of a belt, and (2) those whose action depend on the tension or compression of springs between the pulley and driven shafts.* Obviously, each type has its special uses, the former being suitable when the apparatus is belt-driven, and the latter type when the apparatus is direct-coupled. The general arrangement in the second class is that the pulley or half coupling on the apparatus is not keyed to the shaft, but connected to a plate keyed to the shaft by springs; the relative motion of the pulley and plate (or amount of turning of pulley with respect to shaft) is a measure of the tension or compression of the springs, and therefore of the torque. The spring couplings used by Continental engineers in electric railway work, for transmitting the power from the armature (or rotor in the case of induction motors) to the wheels belong to this class, and also those designed by the late Dr. J. Hopkinson and Profs. Ayrton and Perry. The former are not strictly dynamometers, but they may easily be adapted as such by an arrangement for indicating the relative motion between driving sleeve and driven shaft. Examples of these spring couplings are to be found on the high-speed car built by the A.E.G. of Berlin for the Berlin-Zossen Railway, and the experimental motors of the Belgian State Railways.

The first class is suitable for small powers and will be considered below, while the latter is specially adapted for large powers. The dynamometer shown in diagram by Fig. 1 is very useful for the measurement of small powers.

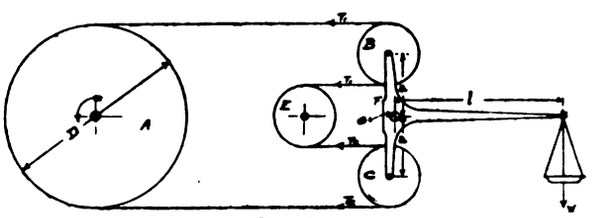


FIG. 1.

The pulley A drives the pulley E by a belt which also passes round the pulleys B and C. These pulleys are on a frame, F, which is pivoted at G. When power is being transmitted by the belt the frame becomes tilted, and weights must be applied to the scale pan in order to keep the frame in the central position, shown in the diagram. In this dynamometer the portions of the belt must be parallel. Let $T_1$ be the tension on the tight side of the belt; $T_2$ that on the slack side; D the diameter of the driving pulley, in feet; W the weight, in pounds, in the scale pan to keep the frame in its central position; and $l$ $a$ the distances, in feet, as shown in Fig. 1. Hence, by taking moments about G, we have $2\,T_1 \,.\, a = 2\,T_2 \,.\, a + W \,.\, l$, whence $(T_1 - T_2) = \frac{W \,.\, l}{2\,a}$. The horse-power can thus be readily calculated, since

$$H.P. = \frac{\pi \,.\, D \,.\, N \,.\, (T_1 - T_2)}{33{,}000} = \cdot 0000476 \frac{W \,.\, l \,.\, D \,.\, N}{a},$$

where N is the number of revolutions per minute of the driving pulley.

A diagram of the Hefner-Alteneck dynamometer is given in Fig. 2. In this form, the belt, which should be long, passes round two guide pulleys, C and D, on a suspended and balanced frame, which can turn about the point, E. The pulley frame carries a pointer, which is adjusted so as to coincide with a datum mark when the line, A B, bisects the distance between the loose pulleys. When the belt is running in the direction of the arrow, the tension on the belt causes the frame to turn about E,

* See the *Electrical Engineer*, vol. xx., No. 25 (Dec. 17, 1897), pp. 776-777, for description and sketches of a transmission dynamometer of this type.

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and the force required to bring the frame into its original position is read on the spring balance, F. The diagram in Fig. 3 will explain the method of calculation. Let $T_1$ be the tension on the tight side of the belt; $T_2$ that on the slack side; $\theta_1$, $\theta_2$ the angles between the two sloping positions of the belt; $W_1$ the reading on spring balance required to bring frame to its standard position when the belt is not running; $W_2$ the reading on balance when an observation is

FIG. 2.

made (the frame being brought to its standard position). Then, since the frame is in equilibrium, we have

$$(W_2 - W_1) + T_2\left(\sin\frac{\theta_1}{2} + \sin\frac{\theta_2}{2}\right) = T_1\left(\sin\frac{\theta_1}{2} + \sin\frac{\theta_2}{2}\right),$$

or
$$(W_2 - W_1) = (T_1 - T_2)\left(\sin\frac{\theta_1}{2} + \sin\frac{\theta_2}{2}\right).$$

If $\theta_1 = \theta_2$ the expression then becomes

$$(W_2 - W_1) = (T_1 - T_2)\, 2 \sin\frac{\theta_1}{2}.$$

When $\theta_1$ is small, $\sin\theta_1$ is very nearly equal to the circular measure of the angle, and thus we may write

$$(W_2 - W_1) = (T_1 - T_2)\,\theta_1.$$

The condition for $\theta_1$ to be equal to $\theta_2$ is (approximately)

$$a\,R_2 + r\,(a - b) = b\,R_1 + d\,(a - b),$$

where $R_1$ is radius of driving pulley, $R_2$ that of driven pulley, and $r$ that of the guide pulleys, the other terms corresponding to the distances in Fig. 3. If N be the

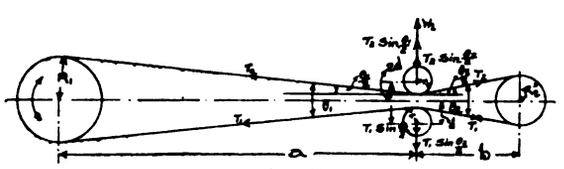

FIG. 3.

revolutions per minute of the driving pulley, then the horse-power that is being transmitted when the spring balance reads $W_2$ is $\text{H.P.} = \dfrac{2\pi R_1 N (W_2 - W_1)}{33{,}000 \times \theta_1}$.

In this expression $R_1$ should be in feet and $\theta_1$ in circular measure (obtained from mathematical tables). Thus, if the diameter of the driving pulley is 2ft., and runs at 150 revolutions per minute, the spring balance readings $(W_2 - W_1)$ being 100lb., and $\theta_1$ being equal to $\theta_2$, which is 11·8deg., the horse-power being transmitted is

$$\text{H.P.} = \frac{\pi \times 2 \times 150 \times 100}{33{,}000 \times 0{\cdot}206} \left(\begin{array}{c}\text{the circular measure of 11·8deg.}\\ \text{being 0·206 radian}\end{array}\right)$$
$$= 14.$$

A modification of this type of dynamometer designed by the late Dr. J. Hopkinson is shown in Fig. 4 In this

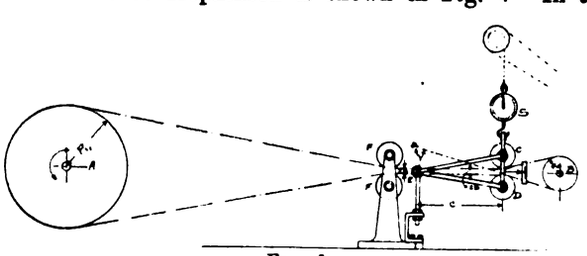

FIG. 4.

arrangement there are two fixed guide pulleys, F F, in addition to the pulleys C and D. The diameter of F, C, and D is the same, and likewise the distance between the centres. The method of observation is exactly similar to that for the type described above, but the calculation differs a little. Let $a$ be the length of the normal from E to the centre line of either portion of the belt between B and the guide pulleys, $b$ the length of the normal from E to the centre line of either of the parallel portions of the belt, and $c$ the distance from E to the centre line of the spring balance, S. Then, by taking moments about E, we obtain

$$(W_2 - W_1) \times c = (T_1 - T_2)(a + b), \text{ or } (T_1 - T_2) = \frac{(W_2 - W_1)\,c}{(a + b)},$$

whence $\text{H.P.} = \dfrac{2\pi R_1 N c (W_2 - W_1)}{33{,}000\,(a + b)}$, where $R_1$ and N have the same meaning as above.

In the calculations for horse-power the value for the diameter of the driving pulley should be taken as (actual diameter of pulley + thickness of belt). The distance between the parallel portions of the belt (2B, Fig. 4) may be 2in., and the distance from E to the centre line of the spring balance, $c$, 3ft. The normal from E to the centre line of either portion of the belt between pulley B and guide pulleys will be 12·5in. ($= a$), assuming pulley B to be 13½in. diameter and the belt to be ⅛in. thick. With these constants the above expression for the horse-power becomes

$$\text{H.P.} = 0{\cdot}0032\ .\ N\ (W_2 - W_1).$$

In the arrangement shown in Fig. 2, the guide pulleys may be spaced at 6in. between centres, the diameter of each being 4½in., while the diameters of pulleys A and B may be respectively 2ft. and 9in. For the angles between the sloping sides of the belt to be equal ($\theta_1$ and $\theta_2$, Fig. 3), the ratio $\dfrac{a}{b} = 3{\cdot}14$. Thus, if the distance between the centres of A and B is 12ft, $a = 9{\cdot}1$ft. and $b = 2{\cdot}9$ft. The length of the frame from E to the centre line of C D may be 2ft. 9in. With these constants, and assuming the belt to be 0·5in. thick, the angle $\dfrac{\theta_1}{2} = 6{\cdot}5$deg., or $\theta_1 = 11$deg. Expressed in circular measure, this angle = 0·192 radian. The expression given above for horse-power thus becomes

$$\text{H.P.} = \frac{\pi \times 2 \times N\ (W_2 - W_1)}{33{,}000 \times 0{\cdot}192} = {\cdot}00099\ .\ N\ (W_2 - W_1).$$

—A. D.

*Answer to No.* 651 (*awarded* 7*s.* 6*d.*).—Fig. 1 shows the arrangement of the transmission dynamometer now being

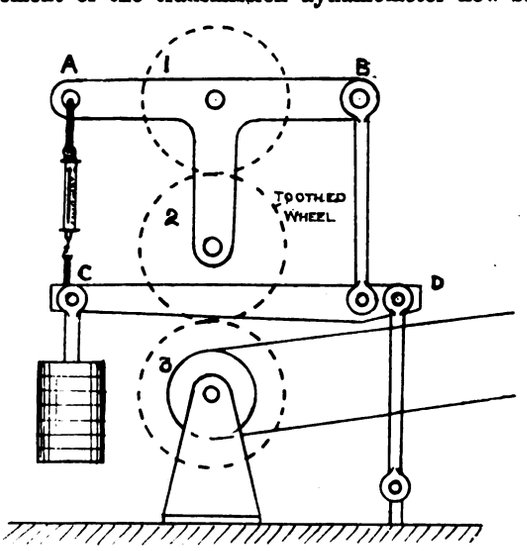


FIG. 1.

fitted to an experimental centrifugal pump at the South-Western Polytechnic. The power is transmitted from the toothed wheel 3, which is connected to the driving pulley, to the toothed wheel 1, which is keyed to the pump spindle, by means of the toothed wheel 2, which is carried on one arm of the lever, A B. Load is applied to the arm B by means of the 10 to 1 lever, C D, thus obviating the use of very heavy weights, and to the arm A directly through the balance.

Fig. 2 is a skeleton diagram showing the direction of the forces in various parts of the arrangement, and the lettering in the following investigation refers to this diagram. Because the lever, C D, is in equilibrium the sum of the moments round the right-hand end equals zero

$$(W - S)\,a - T\,b = 0.$$

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Let R = force exerted on triangle by spindle of second wheel. Then

$$T\,c - S\,c - R\,d = 0$$

$$T = \frac{R\,d + S\,c}{c};$$

$$\therefore (W - S)\,a = \frac{b\,(R\,d + S\,c)}{c}.$$

Let $x$ = force exerted between the teeth of wheels 1 and 2. Then the turning moment round $O = x\,r$. But

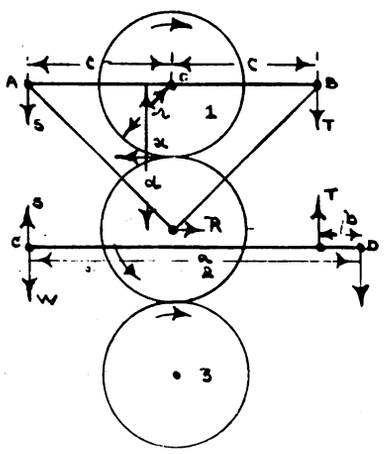


FIG. 2.

H.P. transmitted = moment × angle turned through per minute $= \frac{x\,r \times 2\,\pi\,N}{33{,}000}$, where N = number of revolutions per minute of pump spindle.

Now, force at centre = ½ force at spindle,

$$\therefore x = \frac{R}{2};$$

$$\therefore \text{H.P.} = \frac{R}{2} \times \frac{r\,2\,\pi\,N}{33{,}000}.$$

But $$R = \frac{(W - S)\,\frac{a}{b}\,c - S\,c}{d};$$

$$\therefore \text{H.P.} = \left[(W - S)\,\frac{a\,c}{b\,d} - \frac{S\,c}{d}\right]\frac{r\,\pi\,N}{33{,}000}$$

$$= \left[(W - S)\,\frac{a}{b} - S\right]\frac{c}{d}\,\frac{r\,\pi\,N}{33{,}000}$$

$$= \left[W\frac{a}{b} - S\left(\frac{a}{b} - 1\right)\right]\frac{c}{d}\,\frac{r\,\pi\,N}{33{,}000}.$$

If $\frac{a}{b} = \frac{10}{1}$, then

$$\text{H.P. transmitted} = (10\,W - 11\,S)\,\frac{c}{d}\,\frac{r\,\pi\,N}{33{,}000}.$$

$\frac{c\,r\,\pi}{d \times 33{,}000}$ is a constant $= k$, then

$$\text{H P.} = k\,N\,(10\,W - 11\,S).$$

Fig. 3 shows another arrangement which has been in use on a similar pump. This dynamometer takes up rather more space than the other, and unless provided with a dashpot is liable to be very unsteady. The lever, A B, is balanced at O, and carries two pulley wheels, A and B. The portions of the belt marked 1 and 2 are slack, the tension in each being P; the portions 3 and 4 are taut, the tension being T. The lever is kept in equilibrium by the following forces: (1) the pull of the balance at a distance $a$ in a clockwise direction; (2) the pull of the belt at 1 and 2 = 2 P at the centre of the pulley (anti-clockwise); (3) the pull of the belt at 3 and 4 = 2 T at the centre of the pulley (clockwise). We require the value of T − P, the effective pull on the driven pulley. We have

$$(S \times a) + (2\,P \times b) - (2\,T \times b) = 0$$

$$\frac{S\,a}{2\,b} + P = T, \text{ and } \frac{S\,a}{2\,b} = T - P.$$

Then horse-power transmitted

$$= \frac{\text{Effective force} \times \text{distance moved per minute}}{33{,}000}$$

$$= \frac{T - P \times \pi\,D\,N}{33{,}000};$$

where D = diameter of driven pulley + thickness of belt;
N = number of revolutions per minute of driven pulley.

But $$T - P = \frac{S\,a}{2\,b}\ \therefore \text{H.P.} = \frac{S \times a \times \pi\,O\,N}{2\,b \times 33{,}000}.$$

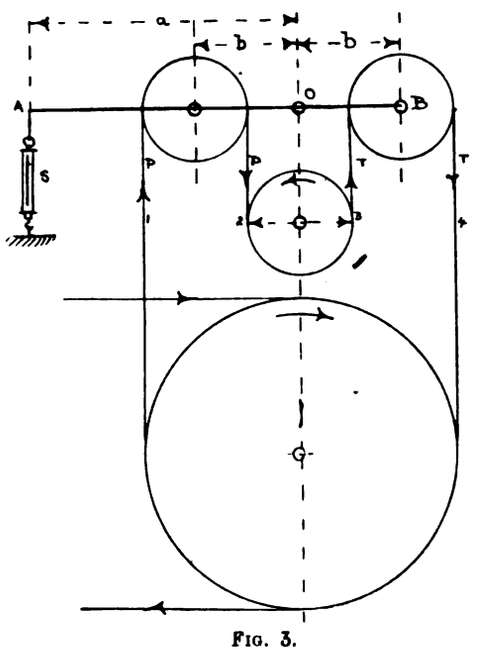
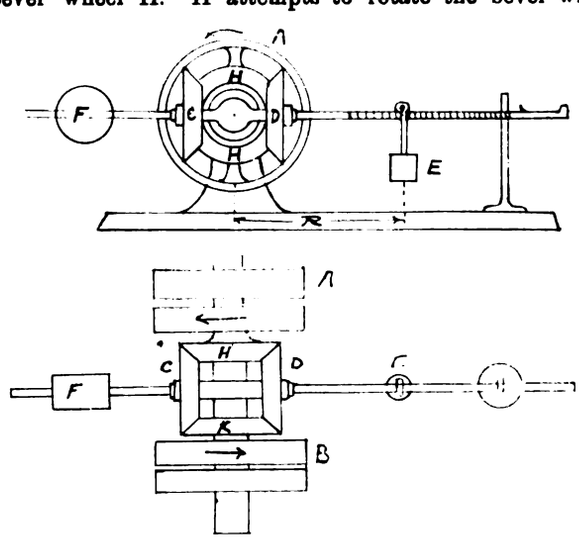


FIG. 3.

If either of the above arrangements cannot be employed owing to the pump spindle being near the floor, White's dynamometer may be useful. A description of this will be found on p. 576 of Lineham's "Text-Book of Mechanical Engineering." If none of these forms are suitable, a number of other forms will be found described on pp. 142 to 160 of Pullen's "Experimental Engineering."—T. S. C.

*Answer to No.* 651 (*awarded* 5*s.*).—The sketch shows diagrammatically the White transmission dynamometer, which would be quite suited for measuring the power supplied to a pump. The apparatus consists of a fast and loose pulley at A, the fast pulley driving the shaft and bevel wheel H. H attempts to rotate the bevel wheels



C and D and the arm, F E, attached to them about its own axis, but is prevented by the weight, E, hung on the arm, F E, at a point determined by the amount of power to be transmitted; H therefore drives shaft, B, in the opposite direction to itself; the power from the engine or main shaft is applied at A, and the pump or other device is driven from the fast pulley at B. This apparatus may be said to be like a wattmeter in an electrical circuit, in that it is

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required to measure the work being used by the machine to be tested, whilst absorbing only an inappreciable amount in frictional loss.

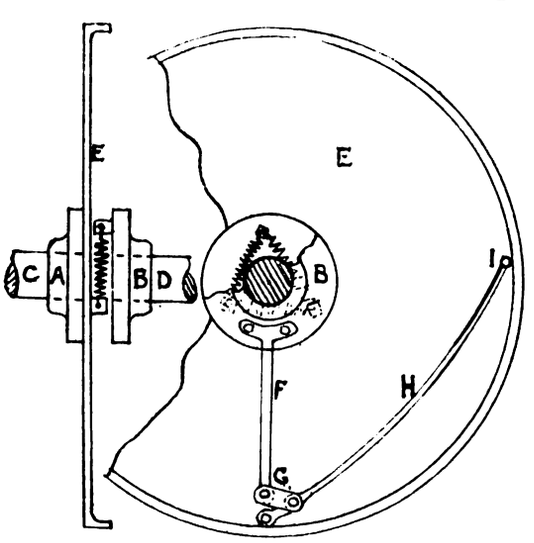
The method of measuring the power supplied to any machine is as follows. If the arm, F E, were carried round the axis of shaft H, no work would be given to B, which would be stationary, whilst E would revolve half as fast as H. The load supported on A would, therefore, be half that on E. When the apparatus is working and the power is taken off at B, the relation of A to E remains the same; therefore work transmitted = load on A × distance travelled on A, and load on A = half that on E.

Therefore work per minute $= \frac{E}{2} \times 2 \pi R N$,

and $$H.P. = \frac{E \pi R N}{33{,}000},$$

where R = distance from centre of shaft to weight E, and N = number of revolutions of A per minute.—W. T. W.

*Answer to No.* 651 (*awarded* 5*s.*).—A form of transmission dynamometer which is suitable for measuring the power supplied to any piece of machinery, is shown in the sketch. This particular type of dynamometer is known as a dynamometer coupling, and takes the place of an ordinary coupling on the shaft transmitting power to the machinery the power for driving which is to be measured. As will be seen by the sketch, this coupling consists of two parts, A and B, A being attached rigidly to shaft C, and B being attached rigidly to shaft D, shaft C being the driving shaft. The part B is attached to A by means of spiral springs, and the stretching of these, when power is being transmitted by the coupling, is therefore a measure of the torque. The disc, E, is attached to part A, and rotates with it. The lever, F, is attached to B, and by means of link, G, is connected to the arm, H, at the end of which is a bright bead, I.




The angular motion of the one part of the coupling to the other when power is being transmitted causes the bead to approach the centre, and radius of the circle of light made by it revolving is a measure of the horse-power transmitted at any particular speed. The arm, H, is slightly flexible, so that when no power is being transmitted the bead is pressed with a certain force against the rim of the disc, E. Hence the bead does not commence to move until a certain prearranged horse-power, at a given speed, is being transmitted, and the whole motion of the bead, I, is completed for any prearranged excess beyond this, thus enabling delicate measurements to be made at powers a little more or less than that normally transmitted.

The dynamometer coupling described has the great advantage over any sort of laboratory dynamometers in that the former has not to be put in position and adjusted each time it is required, but is always indicating the power transmitted at any given speed. If the pump the power taken by which "H. E. H." wishes to measure is driven by a motor, the dynamometer can be fitted, instead of the usual coupling, on the shaft between the motor and the pump; and if driven by a line shaft, the dynamometer can be fitted on the driving shaft. If two such couplings be inserted at two places in the same set of shafting, the difference between the transmitted powers indicated by them is the power utilised by the machinery driven by that portion of shafting that is between them. The smaller the radius of the circle described by the bead as it revolves, the greater the torque, consequently the horse-power transmitted is at once obtained from observing the indicated torque and the speed of rotation.—J. WALKER.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 5.

**Junior Institution of Engineers.**—At 8 p.m., ordinary meeting. Paper: "Producer Gas for Factory Cold Stores and Freezing Works," by Mr. Hal Williams.

SATURDAY, FEB. 6.

**Institution of Electrical Engineers.**—Glasgow Section: Second annual smoking concert. Students' Section: at 10 a.m., visit to inspect the tunnelling of the Baker-street and Waterloo Railway.

**Glasgow Scientific Society.**—Twelfth anniversary dinner.

**Birmingham Mechanical Engineers.**—Ordinary meeting. Paper: "Prime Movers for Electrical Stations," by Mr. C. A. Smith.

MONDAY, FEB. 8.

**Society of Arts.**—At 8 p.m., Cantor lecture: "Oils and Fats," by Mr. J. Lewkowitsch, P.H.D. (Lecture III.).

**Institution of Electrical Engineers** (Newcastle Section).—Ordinary meeting. Paper "The Distribution of Electricity in Shipyards and Engine Works," by Mr J. A Anderson.

**Institution of Mechanical Engineers.**—Graduates' lecture: "The Work of the Alloys Research Committee," by Mr. Wm. H. Merrett.

TUESDAY, FEB 9.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper: "Tonnage Laws and the Assessment of Harbour Dues and Charges," by Mr. Henry H. West.

WEDNESDAY, FEB. 10.

**Society of Arts.**—At 8 p.m., ordinary meeting. Paper: "Thermit—Its Application to Metallurgical Engineering," by Mr. C. V. Boys, F.R.S.

**Liverpool Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "Electric Transmission from Water Powers," by Mr. E. Kilburn Scott.

THURSDAY, FEB. 11.

**Institution of Electrical Engineers**—At 8 p.m., ordinary meeting. Paper: "Transatlantic Engineering Schools and Engineering," by Prof. R. M. Walmsley, D.Sc. Students' Section: at 7.30 p.m. Paper: "On Small Private Installations," by Mr. H. Parle. Dublin Section: at 8 p.m., ordinary meeting.

**Birmingham University Engineering Society.**—Ordinary meeting. Paper "Electric Automobiles," by Mr. F. Bates.

FRIDAY, FEB. 12.

**Institution of Civil Engineers** (Students' Section).—At 8 p.m. Paper: "The Electricity and Destructor Station at Plumstead," by Mr. T. S. Nash.

**Physical Society.**—At 8 p.m., Royal College of Science, annual general meeting. Address by Dr. R. T. Glazebrook, F.R.S., president.

SATURDAY, FEB. 13.

**West Hartlepool Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Balancing of Marine Engines," by Mr. J. V. Robinson.

**Institution of Electrical Engineers** (Glasgow Section).—At Edinburgh, extra meeting. Paper: "Coal-Cutting Machinery," by Mr. Georgi. Visit in the afternoon to new works of Messrs. Bruce Peebles and Co.

## APPOINTMENTS VACANT.

**Borough Electrical Engineer and Tramways Manager,** Doncaster. Salary £300 per annum. The person appointed will be required to devote his whole time to service of Corporation. No one need apply who has not had large experience in working of both an electric light station and tramways. Applications by Feb. 9. See advertisement in last issue.

**Clerk, etc.,** West Ham Borough Council. Applications close to-day. See advertisement in last issue.

**Switchboard Attendant,** Chester. Wages 30s. to 35s. Applications to Electrical Engineer, Chester.

**Tramway Traffic Manager and Engineer,** South Africa. Address R. Z., care of J. W. Vickers, 5, Nicholas-lane, E.C. See advertisement.

**Engineer.** Apply Messrs. Hewitt and Rhodes, Brown-street, Manchester. See advertisement.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## BETWEEN THE DEVIL AND THE DEEP SEA.

In our last issue was a note the moral of which, perhaps, deserves more attention than possibly it might get from being put in that form. It was to the effect that the representatives of borough councils have been and are threatened again to be surcharged their subscription and expenses in attending the meetings of the Municipal Electrical Association. We have always failed to understand the extreme pettiness of municipal and Imperial methods of conducting business. The expenses of a deputation costing hundreds or thousands of pounds are passed without much quibble, while a guinea to twenty guineas for a really much more important work is surcharged. One of the great arguments used against municipalities doing anything in the nature of trade is that the members of the committees or councils are not experts, and know nothing of the details of the business undertaken. When, however, the members try to obtain the latest information available, they are told they can only do it at their own expense. Mr. Jones or Mr. Smith, a member of an electrical committee, does not want to attend a meeting to hear about meters and methods of charging or losses not accounted for or any other detail for his own pleasure—he wants this information for the benefit of the community which he has the honour of serving. This question is not one that has to do with municipalisation or the opposite; it is a mere matter of commonsense to know that the gaining of knowledge of detail will help a man to understand the whole question better, and put him into a more favourable position for the carrying out of his responsible duties. It may be that the councillors are hoist upon their own petard, in that far too few of them realise the necessity of dealing generously with their officials in the matter of gaining experience and information. Engineers are badly paid when their responsibilities are taken into consideration, and many of them have to think twice before incurring liabilities in the shape of purchasing technical journals, books, joining professional societies, going to meetings, paying professional visits to other works, and the like. Every municipality and every company would save money by making its responsible officials an allowance annually for these purposes in addition to salary. Going back to the question of members of committees and councils joining associations expressly organised for giving the very information it is in the interests of the electorate they should know, we think, instead of deprecating it, every effort should be made to extend the system, and to influence men to assist in the deliberations of the association. The Local Government Board has it within its power to allow these expenses, and unless red-tapeism is to ride rough-shod over actions which tend to the better dealing with municipal matters, we think it should take a strong line, and state definitely that it intends to admit these expenses. As we say, the whole question is outside what should or should not be municipalism; it really affects efficiency, and, we contend, economy—results to be praised, not penalised.

## ELECTRIC POWER DISTRIBUTION.

Many papers have been read on the distribution of power throughout factories and large works by means of electricity which have shown both what has been done and what should be attempted in this direction. The subject was most ably summed up by Mr. W. H. Ellis in his presidential address delivered on Monday last before the Sheffield Society of Engineers and Metallurgists. His opinion as a manager of a large and noted steelworks is the more

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valuable because he speaks from his point of view of facts accomplished. Thus Mr. Ellis said: "The engineer of ordinary ability found in electricity a simple means for remedying extravagances in works more readily than by any other method, and consequently welcomed its introduction. In large works the introduction of a central power station had been a means of doing away with miles of steam-pipes connected with the various outlying engines, which caused great loss of economy from condensation. Boilers of high pressure were put down close to the central power station. These, with the electric distribution plant, gave an efficiency of, in many cases, more than 50 per cent. ahead of the old conditions of outlying steam-engines. The wages of engine tenters were to a great extent saved, as the various motors throughout the works merely required periodical visiting, at much less cost than the engine tenters' wages added up to. The old square shaft overhead travelling crane absorbed an enormous amount of power and consumed a large quantity of steam when the crane was only doing light work, much beneath its full load. The substitution of electricity for this purpose had been one of the most useful objects to which it had been applied. The question of how many machines to group for one motor to drive was a very debatable one. It would always depend upon the class of work and the size of the machines. Personally, he had found that grouping of machines to one motor, to a reasonable extent, was advantageous. Hydraulic cranes were also to a great extent giving place to electric cranes." A concrete example of electric power distribution will be found elsewhere in this issue, which shows clearly the many directions in which electric motors can be utilised to advantage.

## OBITUARY.

### The Late W. G. McMillan.

It is with unfeigned regret that we have to announce the death of Mr. W. G. McMillan, late the secretary of the Institution of Electrical Engineers. In the estimation of many close observers, Mr. James Forrest, so long the secretary of the Institution of Civil Engineers, reached almost the highest ideal of what a secretary should be, and few will dispute the suggestion that the late Mr. McMillan came little, if any, below the high standard of his renowned prototype. He possessed to an eminent degree the *suaviter in modo, fortiter in re* so necessary to the successful secretary and manager of men. What the Institution, nay, what the profession, has lost cannot yet be estimated, but the loss will be found to be very real, and the difficulty of replacement very great. Ever courteous to all brought into contact with him, ever obliging to fulfil a request, throwing his whole heart and boundless energy into the work which he thought would lead to the welfare of the Institution, in him the members have lost not only a great official, but a real friend. Only a lengthy history of the progress of the Institution, its increase in membership, the formation of local branches, the visits abroad, the increase in bulk and value of its publications, not to speak of the smoothness of its working, would adequately describe the labours of the late secretary during the seven years he held office. When in 1897 Mr. McMillan succeeded Mr. F. H. Webb in office, we were all charmed with the way he took up his duties and ingratiated himself into the affections of those with whom he had to work. But he has passed away in the prime of life, when ordinarily we could have expected, as we hoped, for many more years of earnest, honest activity. The late Mr. McMillan was born on Jan. 3, 1861, so that at the time of his death he was but little over 43 years of age. His education was obtained at King's College, where he developed a taste for metallurgical pursuits, and ultimately became the private assistant to the professor of metallurgy. A few years' work in India, and afterwards as lecturer at Mason's College, Birmingham, gave him experience not only in secretarial work, but in educational, keeping him fully acquainted with the various developments, of which he made a special study of electro-metallurgy. As an author his works met with considerable success, so that when he left Mason's College to become secretary of the Institution he came fully equipped to perform the arduous duties he had undertaken. His work was made a labour of love, and the Institution will ever remember the impetus he gave to its progress and the successes he achieved in so short a time. Our sympathies go out to those he has left, and it will be a consolation to them that he is sincerely mourned as a kind, considerate, constant friend His death took place on Sunday, Jan. 31, 1904, at his residence at Streatham, after what was considered a slight illness of two weeks' duration—heart failure, however, occurring, he passed away. A short memorial service was held at St. Leonard's Church, Streatham, on Thursday, after which the body was cremated.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### THE BRISTOL FIRE.

SIR,—Reverting to your article in your last week's issue, in which you make some corrections to drawings illustrating the above, I would ask you to turn up my letter enclosing corrected drawings of Jan. 13, from which you will find that the only important alteration made to my original drawings was relating to the position of the outer 'bus bar, which was discovered by myself, and the correction duly sent on, but evidently too late for the alteration to be made in its entirety before the issue of your paper of Jan. 15.

The fact that armoured cables will burn is made evident by your photographs and by the complete destruction of these cables at Bristol, nor is the combustibility surprising when one considers the quantity of yarn which forms the outer covering. This fact also corroborates the gist of my original arguments, but I see no reason why lead-covered cables within a central station should be armoured. I do not think it would be very difficult to cut away the armouring, thus leaving the lead sheathing of the cables exposed.

Later on, when other opinions have been expressed, I hope to be allowed sufficient space in your columns to briefly summarise the many features of the recent discussion, and will then venture to give my views upon the other important points of interest which you are to be thanked for bringing to light.—Yours, etc.,

H. W. CLOTHIER.

[N.B.—The corrections in the drawing referred to by Mr. Clothier reached us as we were going to press, when the blocks could not be remade. We shall be pleased to publish his conclusions on the whole matter, and trust that he will refer to the part played by the oil in spreading the fire. The discussion is one in which the whole industry is concerned, and hence it cannot be too complete.—ED. *E.E.*]

### THE CASCADE CONNECTION OF MOTORS.

SIR,—Please allow me to correct an error in my answer to Question No. 650 in your last issue. The last paragraph should read: ". . . it is on this account that the maximum torque obtainable from a pair of motors in tandem is only about half as great as the maximum torque obtainable from the two motors together when running at approximately full speed."—Yours, etc., Q.

### CASCADE WORKING.

SIR,—I beg to draw the attention of your readers to a slight misprint occurring in my answer to Question No. 650 in the last issue of this journal. In the table on p. 175, giving particulars of the motorcars on the Lecco-Sondrio Railway, line 13 should read:

Diameter of wheels (46in.) . . . . . 3·84ft.

Yours, etc., A. D.

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## A TRAMCAR FOR INSTRUCTION PURPOSES.

In a contribution to the *Elektrotechnische Zeitschrift* Emil Bjökegren describes a car which has been constructed and equipped for observation and instruction purposes on the Berlin tramways. After the conversion of these tramways for electric traction the need was felt, we are told, of some means of accurately determining the energy consumed and the traction conditions on each section of track. A four-axled accumulator car, provided with the necessary measuring instruments, was employed in the first instance. This arrangement rendered good service, and incidentally gave those concerned an opportunity to study traction with accumulators, and to convince themselves of the great difficulties appertaining to the same. The valuable data obtained led to the construction of a special car for observation and instruction service, elaborately equipped for investigating the questions which arise in practice. The car is divided into two main compartments, of which one serves to contain the measuring instruments, while the other is arranged as a waiting-room for the attendants. Outwardly the car does not differ from the ordinary converted four-axled cars used on the Berlin tramways, and the principal dimensions are the same: length of car body, 24ft. 4in.; width, 7ft.; extreme length, including end platforms, 35ft. 9in. It is carried on trucks of the maximum traction type, the distance between the two driving axles being approximately 18ft., and the total weight of the car 14 tons. The electrical equipment, supplied by the Union Elektricitäts-Gesellschaft, consists of two G E 52 series-wound motors, each capable of developing a normal output of 23 h.p., and two B 8 controllers, besides main and automatic cut-outs, lightning arresters, fuses, etc. Any of the different types of motors employed on the Berlin tramways can in turn be mounted on the driving axles of the car and tested. There are three brakes, each quite independent of the others: (*a*) hand brake; (*b*) magnetic brake (Sperry system); (*c*) pneumatic brake (H. H. Böker system). By means of this combination of brakes it is possible to make comparisons between different systems on one and the same car, and so obtain reliable data as to the efficiency, current consumption, etc., of each. The car is provided both with a trolley collector and a plough, and can be worked, therefore, either over the conduit routes or those equipped with overhead wires. In the test room the different measuring instruments are mounted in part on marble panels and partly on a test table. The panel or switchboard instruments serve principally for instructional purposes, and are, therefore, provided with large boldly marked dials, while the standard instruments for accurate measurements are mounted on the test table.

On the switchboard there are: (1) a main and automatic cut-out, besides an ammeter, voltmeter, and speed indicator; (2) two watt-hour meters for registering the energy consumed by the motors, the same being connected in series; (3) a watt-hour meter for registering the energy consumed by the electric radiators heating the car, with switch and fuse; (4) recording ammeter, voltmeter, and speed indicator. With the exception of the last mentioned, these instruments were supplied by Messrs. Siemens and Halske, and register even the quickest variations. The speed indicator by F. Schuchardt, Berlin, is on trial. It indicates the speed per hour direct in kilometres, and is an electrical instrument supplied from a small dynamo mounted on one of the driving axles.

The test table is provided with (1) a combined ammeter and voltmeter for accurate measurements of the main driving current; (2) a standard ammeter for each motor; (3) a standard voltmeter for measuring the difference of potential at the brushes of each of the two motors; (4) a standard ammeter in the circuit of the magnetic brake; (5) a cyclometer, which registers the distance traversed by the car in metres; (6) an incline indicator, which gives the incline of the track through the medium of a pendulum in combination with toothed wheel gearing, a pointer, and a direct-reading scale; (7) a gauge for showing the compression in the pneumatic brake system; (8) a gauge for indicating whether the compressor is running light or is compressing, attached to the pipe connecting to the automatic air-pressure regulator, by means of which the compressor is set in or out of action; (9) a stop-watch. Between the test tables and the two driving platforms telephonic connection is provided, loud-speaking telephones of the Mix and Genest type enabling instructions as to control, braking, etc., to be conveyed to the driver and guard from the test table during the progress of observation. The equipment also includes a draw-bar dynamometer and an insulation-testing set. It is intended to add several special instruments for the following, among other purposes—viz., measuring the resistance of the rail joints, the gauge of the track, the radius of curves in the track, etc. A complete set of maps and drawings of the different routes is provided for reference as to the length of track, positions of the power-houses, feeder points, etc.

The car has been found of great value for instructional purposes, especially in the training of drivers. The speed indicator serves as an aid in estimating speed, while the electrical measurements enable the students to obtain the necessary insight into the working of the car, and to observe the amount of energy consumed by the motors in starting up quickly on a level stretch and on different gradients, as compared with that required for more gradual acceleration; also the consumption of energy corresponding to different speeds in rounding curves and under varying conditions of the track. They see how the watt-hour meter invariably registers every unnecessary and inconsiderate application of current, and how the consumption is increased thereby. The energy used by the application of the magnetic brake is also seen.

The floor of the car is constructed partly in sections, which can be raised for the inspection of the motors when running, or to observe how liable the wheels are to skid when the track is in a greasy state, and how this may be avoided by the proper manipulation of the controller lever. The arrangement of the magnetic brake, air compressor, and the action of the brakes can also be observed.

## STEAM-TURBINES.

The following is a summary of the proceedings of the Manchester Section of the Institution of Electrical Engineers on Tuesday last, Feb. 2, when Mr. W. Chilton's paper on "Steam-Turbines" was discussed.

After the reading of Mr Chilton's paper, at which there were about 250 members present, the **Chairman** (Mr. E. W. Cowan) reported that a local students' section had been decided upon, with over 100 promises of membership, and a committee had been appointed from among them to arrange for the inauguration of this branch. He further regretfully announced Mr. McMillan's death from heart failure, and spoke of the opportunities he had had of discovering the late secretary's uniform great courtesy, patience, and consideration. All the local sections of the Institution owed a great deal to him, and their loss was great. He proposed that the following resolution (which was seconded by **Mr.** C. D. Taite as vice-chairman) be sent to Mrs. McMillan: "That the members of the Manchester Section of the Institution of Electrical Engineers present at this meeting learn with great regret of the death of Mr. McMillan, secretary to the Institution, and, remembering the tact, energy, and unfailing courtesy with which he carried out the negotiations relating to the incorporation of the Manchester Section, they wish to record their sense of the loss which the Institution has suffered by his death, and they wish also to express their deep sympathy with Mrs. McMillan in the loss which she has sustained." This resolution was carried silently, all standing, and the Chairman intimated that a copy of the resolution would be sent to Mrs. McMillan.

The **Chairman**, in opening the discussion upon the paper, considered that the steam-turbine question was second to none in importance to electrical engineers, and suggested that the following headings might be borne in mind by speakers: (1) various turbine designs; (2) the merits of turbines *versus* reciprocating engines, with special reference to the electric generating portion of the plant; and (3) turbines compared with other types of engines. He asked for information concerning reversing turbines, which was especially wanted in relation to marine work, and also regarding the advantages of superheating.

**Mr. London**, of the British Westinghouse Company, in answering the chairman's invitation, referred to the recent discussion in the electrical papers regarding the blades fouling the case, and stated that this was due to either bad design of spindles or cylinders, to sinking foundations, or to failure of the oil supply in the bearings, and thought that if reciprocators received similar treatment, they would develop similar diseases. As regards lack of oil, he had measured an insulation resistance of one megohm between the spindle and bearing of a certain turbine requiring such attention. The Westinghouse turbine was a

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shorter machine than the Parsons, steam being admitted in the centre of the two twin tandem cylinders. The 5,500-kw. machines for the Metropolitan Railway were only 14ft. long. He estimated from the figures given in the paper a saving of £70 per annum on oil, and on coal sufficient in 16 months to pay for a condensing plant if put down.

**Mr. Whysall,** of Manchester Corporation, gave some interesting figures comparing a Parsons turbine set in the Dickinson-street works with a Musgrave engine in the adjoining Bloom-street works. Both machines are of equal power, 1,800 kw., and of about equal efficiency, 19·59lb. per kilowatt-hour at full load and 19·83lb. for turbine and engine respectively. These results were on a six hours' test run, 20lb. being the turbine's guarantee. Capital cost favoured the turbine at £8. 7s. per kilowatt, including condensing plant but minus foundations, against £10 for the reciprocator; and the oil item also, ·0018d. per unit against ·006d. The higher commutator speed 6,000ft. against 2,000ft. per minute, made the turbine's dynamo brushes a formidable item—·0062d. per unit in comparison with ·00005d. The weight of the turbine generator worked out to (85 tons) one-fifth of the Musgrave-Westinghouse set, being only three-quarters the weight of the flywheel alone. Some further details of the turbine showed ·22 square feet of space occupied per kilowatt, and mechanical governing within 3 per cent. between no load and full load. Saturated steam at 125lb. was used, and on account of priming it was proposed to use superheated steam at 100deg. F., but Mr. Whysall desired the opinion of Mr. Chilton on the matter.

**Mr. Barker,** of Cambridge, congratulated himself and the Hon. C. A. Parsons on the fact that his comparatively small station ranked with Leeds as regards fuel consumption. He was persistently asked, "How much does steam cut the blades," but compared the trifling effect with leakage of a boiler at ½lb. of steam. Broken blades, he considered, were due to ignorance of erectors in the attachments of heavy pipes without proper supports to the cylinders, thereby straining the body; also to the use of metal not suitable for superheating. In the early days a nickel-bronze mixture was used, which became brittle at 500deg., and this probaby was the cause of trouble at West Bromwich. Pure copper was best for the blades, and would stand up to 800deg. at the least. He referred to the progress that 20 years had produced in turbines compared with 200 years' reciprocating engine practice. The fact that brushes sparked badly on continuous-current turbine sets was not due to the designers or the engineers, but was due to the current. He hated continuous current, and prophesied the universal use of alternating currents in time. He thought that Mr. Whysall's turbines might safely be used at the 100deg. extra superheat.

**Mr. Giles,** of Blackburn, thought the steam consumption figures given should be reversed—25lb. reciprocating, 22·5lb. turbine.

**Mr. Leonard Andrews** gave some reminiscences of Hastings, where turbines were put in as an experiment owing to lack of room, but this was not regretted. He thought it was no fault of the engineers when blades ripped out, but of a too (steam) efficient a design. The fact that blades were ripped out was only discovered at Hastings when the steam consumption rose abnormally, and on one occasion, finding through this warning 1,000 blades gone, he wired the makers on a Saturday, their fitter came down on Monday, and the whole job was as good as ever within 36 hours. Like the Manchester Corporation turbines, he got a better result on test than was guaranteed, and the efficiency was maintained. In some cases reciprocating engines were more suitable, such as when condensing was impracticable. He instanced at Hastings, when a slight scale formed upon the condenser, this affected the fuel consumption by 25 per cent., and when the scale was taken off normal consumption resulted. When the vacuum failed the loss of power result was likely to be serious. He knew a man who had a reversing turbine, but wanted £50,000 for the English patent.

**Mr. Wells** commented on the absence of the reciprocating engine partisan from the discussion. The various devices for improving economy of working were all right to a certain point but one could pay too much for a good thing. He considered the reasons for Mr. Willans being so successful were (1) because he wanted to make money on his engines, and (2) wanted his customers to make money with them also. A Willans engine he had inspected was so little worn that it was estimated it would run 30 or 40 years before going back for repairs. He drew attention to the discrepancy between Mr. Chilton's statement as to turbines dating back to the Conqueror and Mr. Barker's 20 years' estimate of existence. As regards the latter, it was to be remembered that most of the knowledge possessed by turbine engineers was gained on reciprocating engines. He ridiculed the way in which the recent Press discussion had been carried on, when opinions as to the efficiency of the two types of engines were expected to be formed upon the combined working of them with all kinds of boilers and accessory plant. The tests should be based upon the direct working efficiencies of the machines themselves.

**Mr. Cooper,** of Colne, said the Siemens's made turbine continuous-current machines with satisfactory carbon brushes. He did not think that it would be safe to run the Manchester turbines with an extra 100deg. of superheat, as he had a breakdown when working with less than 100deg. extra superheat to the extent of 18 rows of rotor blades and 18 rows of stators. He could recommend the use of cheap oil, however, from experience.

**Mr. Neilson** and **Mr. Wood** also spoke.

**Mr. Chilton,** in reply, said it should be remembered that superheated steam had to be paid for in cost of coal, and that turbines had to be specially designed for this, similarly to other engines. Blades usually fouled in the middle expansion cylinder. He thought that electrical engineers would be able to get over the commutator troubles without mechanical men dabbling in the matter. The reciprocating engines mentioned on the diagrams were *not* Raworth type, and he considered that the Brush Company made turbines equal to any on the market.

A vote of thanks to Mr. Chilton concluded the proceedings.

## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion sat again on Thursday and Friday last week at the Westminster Palace Hotel, under the presidency of Sir David Barbour.

**Mr. W. G. Shadrake,** chairman of the Leyton Urban District Council, said that the tramways in his district, except the North Metropolitan from Leytonstone, did not afford intercommunication with other districts, and for that reason the Council had given notice under the Tramways Act to purchase certain portions of the tramway lines. The object was to communicate with the tramways of the West Ham Corporation and those about to be constructed by the Walthamstow Council.

**Mr. R. H. Scotter, C.E.,** said he was deputed by the eleventh International Tramway Congress, held in Paris in 1900, to collect information and prepare a report upon legislation in all countries relative to tramways and light railways. In the course of his enquiries he had been brought in touch with various governmental and other officials who had the regulation of light railways in various Continental and American cities. In Continental countries the official was nearly always an expert. Large reforms affecting large areas where many divergent interests were included must be carried out by some higher authority than any one of the local elements could furnish. As examples of work carried out in a national spirit, he referred especially to the light railway system of Belgium, the underground railway system of Paris, the abolition of accumulator traction in Germany, and the experiments upon the military railway at Zossen. Although the idea of municipal control was rapidly spreading on the Continent, it must not be confounded with what seemed to be the ideal of the ordinary English local authority—namely, to construct and work the tramways and light railways within its limited area without any reference to the rest of the world. Continental municipalities were, as a rule, content to construct the permanent way and to grant a long lease to a private company or companies to equip and work the line. Further, it was the universal practice to grant the greatest possible facilities to light railway companies to bring passengers and goods from the country into the towns, and *vice versâ*. He had noted many points of theoretical similarity between English practice and that on the Continent; but one feature relating to the authority for granting powers to construct and work light railways and tramways he had not found elsewhere than in England—namely, the local enquiry held in open court by the Light Railway Commissioners under the Act of 1896. From the success which had attended that departure he suggested the advisability of constituting a similar tribunal for reference in all secondary lines in London, and at the same time of strengthening and enlarging such a commission by the addition of expert engineers of world-wide experience, able to advise upon the various traffic problems both theoretically and practically. The new tribunal should be an enlarged light railway commission, answerable only to Parliament, and should consist of experts. One of their first duties should be to formulate a scheme, and to endeavour to step in advance of public opinion. As to goods traffic, some might be conveyed by night by tramway. The new tribunal might prohibit goods traffic in certain streets during the day. The tribunal should attempt to secure co-ordination and subordination between railways, tubes, trams, and light railways. There would then be no competition between those, but each class would develop its own class of traffic. The local veto did not exist on the Continent. The local authority had the fullest deference paid to its wishes by every promoter or company seeking a concession within its area, and it could make suggestions which were considered, but it could not prevent any scheme from going forward. It many States it was the duty of the municipal or provincial council itself to submit the scheme to the Government department.

**Mr. H. L. Cripps,** parliamentary agent, said that during the 25 years 1878 to 1902 his firm was concerned for the promoters in 851 private Bills and 3,413 petitions. No more satisfactory tribunal for the conduct of business of that class than committees of Parliament was possible. He could scarcely recollect more than one or two cases in which real injustice had been done. Generally speaking, the decisions of committees of Parliament were very certain and regular, and in 90 per cent. of the cases submitted to him he could confidently advise clients as to their chances of success. He believed all those interested in the actual conduct of the business and most competent to judge were satisfied with the decisions and procedure. As to the alleged cost of parliamentary procedure, where the work was in the hands of those who knew their business it was small considering the magnitude of the interest involved. He believed that the public interest demanded a hearing before two committees of Parliament. He had had to consider the question of underground railways in London, and also tramways. He did not think that the provision of necessary railways and tramways was more difficult now than 20 years ago. He agreed that when promoters brought forward their own schemes there was a difficulty in making them form part of a comprehensive plan.

The **Chairman:** Do you think the difficulty would have been removed if there had been a permanent competent authority to consider the whole question of locomotion and put forward certain regulations? I do not mean to judge it.

With certain qualifications I should agree with you. I think it would be a drawback to any fair decision of Parliament to have any sort of propositions for dealing with the matters you refer to excluded from its consideration. If the Board were considering two or three different schemes, and were going to recommend one to Parliament, with the result that the other two would be shut out altogether, that would be a misfortune, because Parliament, which must be the supreme authority in these matters, would be deprived of the material which it would otherwise have on which to decide.

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What you say is that Parliament should always have the final decision?—Yes, and it should have all the necessary material before it on which to decide.

The witness said that the provisional order system was, in his opinion, convenient in cases where new powers were required which did not involve any controversy and were unopposed, but was quite unsuitable for cases in which decisions had to be given between conflicting interests. In the latter cases the ultimate decision was rightly reserved to Parliament. Continuing, the witness said in 1892 he had strongly recommended that the whole question of London railway communication should be considered.

And that is the opinion which you still hold, though you think that, owing to so many railways having been authorised since the City and South London Railway, there is not now the full advantage to be reaped from it?—In one or two cases there may be room at present for more of these underground railways, and in the future the conditions of London may justify it.

The witness, in reply to further questions, said that the question of London Tramway Bills had been under his consideration, especially with reference to the operation of Standing Order 22. He had submitted to some members of the Committee on Private Bill Legislation last year some suggestions on the matter, including the appointment of a general standing committee in the House of Commons on unopposed or practically unopposed business, to which might be referred the preliminary question as to whether or not a local body had a sufficient reason for imposing a veto upon the introduction of a Tramway Bill. The occasional consideration of matters of complication, such as that now existing with regard to the London underground and other railway schemes, was one which might be usefully considered by a Royal Commission, whose report would be useful in enabling committees of Parliament to deal with the particular cases. On the whole, he thought no new or special tribunal was required, but the whole matter might be best dealt with by committees of Parliament acting upon the report of a Royal Commission.

At any rate, you are not opposed to the idea of a Board which will consider these matters and prepare them for Parliament, supposing it were found practicable to arrange the details?—I reserve my opinion. It is desirable that Parliament should have every possible information.

Would you do away with the Light Railway Commissioners?—I think the original idea of the Light Railway Act, which was to give facilities for the construction of railways of an economical character in agricultural districts or in districts where otherwise the powers would not have been obtained, was a good one, but when it is extended so that it interferes with existing railways and important railway interests I am not in favour of it.

The Commission adjourned.

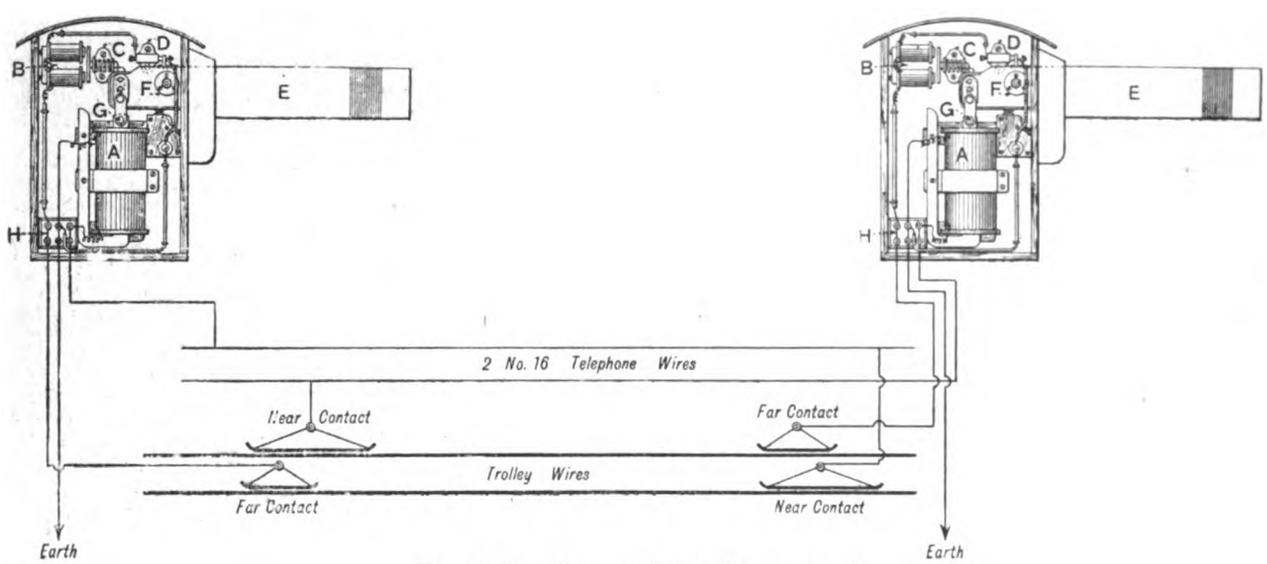
## TRADE NOTICES AND NOVELTIES.

### The Royal Ediswan Motorvan.

We are informed that, owing to the continually increasing demand for the Royal Ediswan electric lamp, and the difficulties experienced in getting stocks delivered quickly enough by the now antiquated method of horse traction, the Edison and Swan United Electric Light Company, Limited, decided to adopt motor traction for this purpose, and the first of their motorvans recently commenced its duties. These comprise a daily trip from the works at Ponder's End with a stock of lamps for head office in Queen-street, City; thence supplies are taken to the various contractors in other parts of London. On its return in the evening, the van carries a load of empties and raw material. The vehicle is rated as a 9½-h.p. two-ton lorry, and is 16ft. 11in. long by 5ft. 5in. wide over all. The body is finished in dark blue, picked out in white letters, with a large Royal Ediswan lamp in natural colours on the back. It should be stated that this motorvan does not supersede but is additional to the many horse vans employed by the Ediswan Company for similar purposes.

### Signal Apparatus.

We have recently received from Messrs. Estler Bros., 25, Laurence Pountney-lane, Cannon-street, E.C., a pamphlet dealing with Harvey's patent automatic electric tramway signal. This apparatus, we are told, is especially serviceable on sharp curves, at street corners, on single track where the turn-outs are far apart, and generally in a variety of cases where it is necessary to give a driver information as to whether he can safely proceed or not. It consists of a main solenoid, A (see the accompanying diagram), which receives current direct from the trolley wire by means of special contact plates suitably suspended above the trolley wire. The solenoid is wound with thin wire having a total resistance of about 750 ohms, consequently takes only a very small current. In the core of the solenoid is a soft iron plunger, G, which is connected to the semaphore arm, E, by means of links. This arm is free to swing about the pin, F. Its normal position is down, indicating that the line is clear. But as soon as a car passes the contact-plate connection is made, and current flows through the solenoid, which pulls the signal to the horizontal or danger position. It is held in this position by means of a catch, C, until the car passes the far contact plate, when current is conducted to the solenoids, B, which releases the catch, C, allowing the signal arm to fall. As soon as the signal arm falls the circuit breaker, D, is opened, so that current only flows through the solenoids, B, for a short period. All the necessary electrical connections are made from a small terminal block, H. The example illustrated is that of a single line of track having turn-outs which are invisible from each other, but provided with double trolley wires, consequently two signals are necessary and four contact plates. A car approaching from, say, left to right would proceed if the signal on the left were down, and would on passing the near contact plates set the signal on the right to danger. Passing the far contact it would release the signal on the right, indicating that the line was clear again. In practical use the apparatus has given complete satisfaction we understand.




Harvey's Patent Automatic Electric Tramway Signal.

### Transformers.

Messrs. Crompton and Co., Limited, Arc Works, Chelmsford, have sent us a copy of their new price list of single-phase transformers. In designing these transformers, Messrs. Crompton and Co. tell us they have borne in mind that a good transformer must have thorough insulation of a permanent nature capable of withstanding damp, a high all round efficiency, good regulation, no ageing, small magnetising watts and current, sound and simple mechanical construction. They are of the core type, the windings being outside the iron. Reduction of the light load losses has been made the first consideration. The totally enclosed transformers will give their rated outputs without oil or other artificial cooling. For further particulars we must refer the reader to the list in question.

### High-Conductivity Copper Castings.

Messrs. J. Tylor and Sons, Limited, 2, Newgate-street, London, E.C., inform us that they recently submitted to the Westminster Testing Laboratory some samples of copper castings to be tested for copper resistivity. The results of these tests were most satisfactory, especially as regards the high conductivity registered viz., 90·08 and 90·01 per cent. Messrs. Tylor and Sons believe they have now mastered the many difficulties with which manufacturers of this description of metal

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have to contend—a fact which should be of considerable interest to our readers.

### Tachometers.

A booklet which we have received from Messrs. Thos. Thompson and Co., 35, New Broad-street, London, E.C., gives a very clear description of Thompson's (new system) standard tachometers or speed indicators. We understand that these instruments are now in use in many of the most important electric generating stations in this country, and are being adopted by some of the leading firms of engine builders, who express themselves very highly as to their sensitiveness and efficient working. The booklet in question is well illustrated.

### Accessories.

From Messrs. Plutte, Scheele, and Co., 18-19, Queenhithe, London, E.C., sole agents in this country for Schmahl and Schulz, manufacturers, Barmen, we have a catalogue of electric light accessories. These include lampholders, tumbler switches, cut-outs, ceiling roses, counter-weight sets, fuse-boards, ball and spider fittings, main switches, portable hand lamps, brass brackets, and ornaments for ceiling roses or reflectors on holders.

### Separate Driving.

The advantages of the separate driving of metal-working machines by means of electric motors are dealt with in Pamphlet No. 8 just issued by the Lahmeyer Electrical Company, Limited, 109-111, New Oxford-street, London, W.C. This pamphlet is profusely illustrated, and cannot fail to interest those who have this method of driving under consideration.

## PERSONAL.

The Newcastle Tramways Committee have increased the salaries of the superintendent mechanical engineer, Mr. G. Claughton, and the superintendent electrical engineer, Mr. W. Dalton, both of the Manors power station, Newcastle, from £200 to £250 per annum.

Mr. G. F. Metzger, A.M.I.C.E., M.I.E.E., having been appointed consulting engineer to the Manchester Corporation for the completion of the work initiated by him as their city electrical engineer, has started practice as consultant in electrical and mechanical engineering at 3, York-street, Manchester.

Mr. A. R. Fearnley, the Birkenhead tramways manager, who has accepted a similar position under the Sheffield Corporation, was on Sunday presented by the employés of the Birkenhead Corporation tramways department with a handsome solid silver table lamp. Mr. R. Chadwick presided, and he, along with representatives of the different branches under Mr. Fearnley's control, spoke of the high esteem in which Mr. Fearnley had been held by the whole of the employés. Mr. J. Swale acted as hon. secretary for the presentation.

The Right Hon. Sir Alfred C. Lyall, G.C.I.E., K.C.B., K.C.S.I., has joined the Board of W. T. Henley's Telegraph Works Company, Limited.

Mr. A. E. Aspinall is leaving the service of the British Westinghouse Electric and Manufacturing Company, Limited, for that of the De Beers Consolidated Mines, Limited, Kimberley, and will act in the capacity of manager of the costs department. He leaves for Africa on the 11th inst.

## LEGAL INTELLIGENCE.

### SNOWDON ELECTRIC RAILWAY.

Before Mr. Justice Swinfen Eady in the Chancery Division on Thursday last week, **Mr. Eve, K.C.**, moved in the matter of Sir Richard Henry Williams-Bulkeley *v.* the Portmadoc, Beddgelert, and South Snowdon Railway Company for an injunction to restrain the defendants from further proceeding under a notice to treat. The defendants had powers to construct an electric railway in Carnarvonshire and Merionethshire, and to erect stations and necessary appliances, and to compulsorily acquire land for the purposes of the railway. They had served plaintiff with notice to treat in respect of land on which they proposed to construct a generating station, and to lay pipes to carry water from the lakes. The plaintiff contended that these did not come within the purposes for which defendants were entitled to take land compulsorily.

After hearing the arguments, **His Lordship** said the plaintiff was not entitled to the injunction. The defendants' Act contemplated that the railway would be electric. A generating station and a supply of water would consequently be necessary, and the defendants were entitled to acquire land compulsorily for these purposes.

The motion was accordingly dismissed with costs.

### BRIGHT'S LIGHT AND POWER.

A motion by debenture-holders for the appointment of Mr. Harry Seymour Foster as receiver and manager of Bright's Light and Power Company, Limited, came before Mr. Justice Swinden Eady in the Chancery Division on Friday. Mr. Bennett appeared in support of the motion, and Mr. Eve, K.C., M.P., for the River Plate Electric Company, Limited, which had a prior encumbrance, and had obtained judgment which it was proceeding to execute in the Argentine, where the property charged was situate.

**His Lordship** said that, if a receiver was appointed, there would be nothing for him to receive. A person in the Argentine had taken possession of the property. The Court was asked to appoint another person receiver and manager to enable some money to be borrowed for the purpose of commencing further proceedings in competition with the River Plate Company. He refused the motion.

### TRAM AND 'BUS COLLISION.

In the Court of Appeal, before Lords Justices Romer and Cozens-Hardy, the case of Phillips and wife *v.* the London General Omnibus Company, Limited, and the London United Tramways (1901), Limited, was mentioned. As stated in our last issue, the plaintiffs were awarded £2,500 and £430 special damage against the defendants for personal injuries sustained in a collision between a 'bus and an electric tram owned by the defendants respectively. The defendants had given notice of motion for a new trial, and now applied for a stay of execution.

The defendants having offered to pay the plaintiffs the £430, not to be returned under any circumstances,

The Court granted a stay of execution as to the £2,500.

### ST. PANCRAS ELECTRIC LIGHT WORKS.

In the Chancery Division of the High Court on Wednesday and yesterday Mr. Justice Joyce was engaged in hearing evidence in the case of Colwell and others *v.* the St. Pancras Borough Council, which was an action brought to restrain the defendants from causing a nuisance to the plaintiffs in the working of the combined generating station and dust destructor of the St. Pancras Borough Council. The case had not concluded when we went to press, and we propose to deal more fully with it in our next issue.

### APPOINTMENT OF RECEIVER.

In a debenture-holders' action of Grant *v.* Venner James and Co, Mr. Justice Swinfen Eady appointed a receiver and manager of the defendant company, who carried on the business of manufacturers of electric accumulators. The appointment of manager was, however, limited to one month without further application to the Court.

## COMPANIES' MEETINGS AND REPORTS.

### BLACKPOOL AND FLEETWOOD TRAMROAD.

The report of the directors for the past half-year shows that, with the amount brought forward from last year, the balance of profit, after providing for debenture interest, is £10,677. 10s. 8d., and the directors recommend a dividend at the rate of 9 per cent. per annum—1 per cent. of an increase—which will absorb £6,750, writing off £1,500 to depreciation, and putting £500 to a special reserve. This leaves a balance of £1,927. 10s. 8d. to be carried to the current half-year. The number of passengers carried during the half-year was 1,469,964, and the total receipts amounted to £21,404. 8s. 5d. The total expenditure was £9,982. 1s. 9d., as against £9,843. 15s. 5d. for the corresponding half of last year, and the total income was £21,393. 14s. 3d., against £21,033. 11s. 3d. The income has increased in spite of disadvantageous weather, and there is also a decrease in expenditure. The car mileage run during the half-year was 375,065, against 366,947.

### GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The directors report that the capital expenditure during the half-year to Dec. 31 last amounted to £1,175,504. The estimate for the current half-year is £900,000. The progress of the works during the past half-year has been satisfactory. The Bill promoted by the Company in the last session of Parliament received the Royal assent on Aug 11, 1903. Under this Act further capital powers to the extent of £250,000 in shares, with £83,000 borrowing powers, are authorised. The rent due from the Underground Electric Railways Company of London, Limited, under the terms of the agreement for lease dated Jan. 13, 1903, up to Dec 31, 1903, permits of a dividend at the rate of 4 per cent. per annum, and a resolution declaring a dividend will be submitted to the meeting. The dividend declared at the last half-yearly meeting covered the period ended Aug. 1, 1903. The proposed dividend will therefore be for the balance of the year (five months) to Dec. 31, 1903.

### NORTH METROPOLITAN TRAMWAYS.

The report of the directors for the half-year ended Dec. 31 last states that gross receipts amount to £330,821, and the total expenditure amounts to £311,817, leaving as net profit £19,003. Adding £407 brought forward from the last account, and the £2,625 received from the Metropolitan Electric Tramways, Limited, for debenture interest, there is a balance of £22,035. The sum available for division, after providing for debenture interest, is £19,410. It is proposed to appropriate £17,747 to the payment of a dividend at the rate of 4 per cent. per annum on the ordinary shares. The balance of £1,662 will be carried forward. The number of passengers carried was 68,454,670, a decrease of 11,255,759. Traffic receipts amounted to £321,777, a decrease of £56,948. The average number of cars running was 485·46, a decrease of 95·81. The sum of £20,904 has been charged against revenue for maintenance of permanent way.

### WATERLOO AND CITY RAILWAY.

The report of the Waterloo and City Railway Company for the half-year ended Dec. 31 last, to be submitted at the meeting on the 11th inst., shows a total outlay of £606,500 on capital account to Dec. 31

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last, being the same as at June 30, 1903. Gross receipts, less Government duty, amounted to £17,296, and working expenses to £8,032, being at the rate of 46·44 per cent., as compared with 44·45 per cent. for the corresponding period of 1902. The balance available for dividend, after providing for interest on debenture stock, is £8,455, and a dividend at the rate of 3 per cent. per annum on the ordinary shares will absorb £8,100, leaving £354 to be carried forward. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2,240,864, showing a decrease of 66,277. The season-ticket holders on Dec. 31 last numbered 1,434, as against 1,243 at the end of December, 1902.

## MARCONI INTERNATIONAL MARINE COMMUNICATION.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at 18, Finch-lane, Major S. Flood Page presiding.

The **Chairman,** in moving the adoption of the report (*vide* last issue) stated that the efforts of the Board during the past year had been directed mainly towards obtaining a permanent basis for profitable business in the future, and a considerable further extension of the Company's operations had been the result. A year ago 25 ships were fitted with the Marconi system, as compared with 54 to-day, and if only a few more land stations could be secured in some of the countries on the Continent of Europe the number would be still larger. Wireless telegraphy was even yet apparently something mysterious and intangible to the public, in spite of what Mr. Marconi had done, and in spite of its practicability and utility, as evidenced by the many connections which were being regularly and commercially operated. It was, therefore, important that, when largely by their own efforts an almost universal demand should arise for this new system of communication, they should find themselves in the position of meeting such a demand upon terms that would tend to exclude the competition of the so-called other inventions. They had established at great expense a world-wide organisation of shore stations for ship telegraphy, extended through agreements with Lloyd's and with the Governments of Great Britain, Canada, Italy, Newfoundland, and others, which offered the shipping companies taking their apparatus a large choice of posts with which to communicate, and it was only fair that this advantage, which had been gained through the merits of the invention which their companies had been formed to work, and by their commercial enterprise, should not be artificially taken away by legislation. To do so would entail great commercial injustice so far as they were concerned, and it would have the further disadvantage of rendering their system liable to disorganisation by the bad working of other systems over which they had no control. They protested against any Government being permitted to deprive them of the fruits of their labour, but he was glad to say that there was no reason to suppose that the British Government would support any such measure of confiscation. Nearly all the big shipping lines now were fitted with the Marconi system, and when this Company had stations in Spain and Portugal they would doubtless get all the companies whose ships traded to the East or to South Africa. Since the issue of the report the Board had learned from the manager of the Canadian Company that an Order in Council had been passed instructing the Minister of Marine in the Canadian Government to contract with the Marconi Company for the equipment of all the wireless telegraphic stations which the Government proposed to establish on the St. Lawrence. This river was credited with being dangerous in respect of navigation, and it had long been under contemplation that something of the kind now decided on should be done, and he was sure that owners of vessels using the St. Lawrence would be glad to hear of the intention of the Canadian Government. As a company they were extremely indebted to that Government for the assistance afforded by them to Mr. Marconi about two years ago in carrying out certain experiments.

**Mr. H. J. Davis** seconded the motion, which was agreed to unanimously.

## METROPOLITAN RAILWAY.

The half-yearly general meeting of the proprietors of this railway was held on Friday at the Cannon-street Hotel, Mr. John J. Mellor presiding.

The **Chairman,** in moving the adoption of the report (which we gave last week), expressed the satisfaction of the directors at being able to point on that occasion to an increase in receipts in practically every department, with, at the same time, a diminution in the expenses. The largest business ever done by the railway was in 1899, in which year 96,000,000 passengers were carried. In 1900 the Central London Railway was opened, and in 1901 this Company felt the full effects of the competition. In that year their passenger traffic dropped to 87,821,000, and they touched the low-water mark of their business in recent years. Their efforts to regain it had been so successful that in the year just closed they carried 94,000,150 passengers, or only 2·18 per cent. less than in 1899. To put in another way, of the 8,000,000 passengers who forsook them in 1901, 6,000,000 had already come back to them, no fewer than 4,250,000 returning to them last year. The new Harrow and Uxbridge line, which was expected to be a feeder to their system, would, it was hoped, be open for traffic during the course of the present half year. Alluding to the progress of the work of electrification on the Company's system, he stated that the power-house at Neasden was practically completed, and was ready for receiving the main machinery for generating the electric current which was to revolutionise the traffic on the railway. There was every reason to be satisfied with the work at Neasden so far as it had gone. On the 8th inst. he visited the Westinghouse works, accompanied by the general manager and the electrical engineer, and they had every reason to be satisfied with the quality of the work, so far as they could judge of it in its incomplete state. He believed that the contractors were anxious to turn out a thoroughly good installation, and they had every inducement to do so, for the whole contract was in their hands, and they were solely responsible for it. The centre of the great dynamos, or field magnets, as they were called, was a ponderous mass of solid steel weighing about 16 tons; and this great mass of metal, after it was wound with the necessary coils of copper to maintain it at a high state of magnetism, had to make unceasingly, day and night, 1,000 revolutions a minute, and would produce, each one of them, 5,000 h.p. of electric energy at 11,000 volts, three-phase. If any flaw existed in the casting there would be a danger of this great mass of metal flying in pieces. To make assurance doubly sure, however, the contractors went to Messrs. Armstrong, Whitworth, and Co., at whose works these centres were being made by what was known as their compressed fluid steel process. It was a costly process—about £60 per ton—but it secured absolute homogeneity of material. Mr. Parker had reported to him that the main high-tension cables were being delivered to time, and about 12 miles had been laid. This work was progressing at a rapid rate. The conductor rails, from which the current was picked up by the trains, were being placed in position upon the insulators on the road, and about 22 miles of this work had been completed. The question of obtaining the sites necessary for the substations on the Circle had proved a difficulty, but this had at last been surmounted and the buildings were in progress. The first portion of the rolling-stock was being delivered at their works at Neasden preparatory to receiving the electrical equipment which would be put upon them by the Westinghouse Company ready for operating the railway traffic. The directors expected that some portion of the Metropolitan system would be running electrically by Midsummer, but they were largely dependent on the preparedness of the District Company—so far, at least, as a portion of their system was concerned. They and the District Company were acting together—at any rate, so far as regarded this work—through the medium of the joint consultative committee. Difficulties in so large and complicated an undertaking might possibly present themselves, but they hoped, by mutual and conciliatory action, to move forward without friction to the speedy and successful completion of an undertaking which was so essential to the interests of both companies. The directors had already appointed the officers for running the generating station and superintending the electric working generally, and by the aid of this staff a good deal of their own work of installation was being carried out. The directors had lately entered into negotiations with the Great Central Company for the settlement, or rather adjustment, of certain claims which they had upon that company, and which that company, in turn, had upon them. They had already had one or two conferences, and they had met in a thoroughly frank and friendly spirit. Having warmly recognised the services of the general manager and staff, he observed that when the system was "electrified," the service accelerated, and travelling on the Circle made as pleasant as it was now unpleasant, it was not unreasonable to anticipate that their traffic on that portion of their system might be increased by 50 per cent.

**Sir C. McLaren, K.C., M.P.,** seconded the motion, which was adopted unanimously.

A special general meeting was held subsequently, when a resolution was adopted authorising the Company to promote a Bill in Parliament to convert and consolidate their existing capital, to raise additional capital, "and for other purposes."

A further resolution was afterwards passed approving a Bill conferring further powers on the District Company as regarded Clause 17 of that company's Bill relating to the powers of the two companies as to lands and buildings on the City lines.

## CHARING CROSS AND STRAND ELECTRICITY.

The ordinary general meeting of the shareholders in this Corporation was held on Wednesday at the offices, 60, St. Martin's-lane, W.C., Mr. William Francis Fladgate presiding.

The **Chairman,** in moving the adoption of the report (which appeared in our last issue), said the shareholders might consider that the Corporation's progress for the past year had been, on the whole, most satisfactory. In the two districts, the West-end and the City, altogether 146,700 8-c.p. lamps had been added. In no other metropolitan area had so large an increase in lamps been made in any one year. Regarding the City, there was £200,000 of capital at present unproductive. In the West-end there was a capital of £923,000, 20 per cent. of which was at present unproductive, in the sense that the Company had stations at Lambeth, Maiden-lane, and St. Martin's-lane, in each of which there were possibilities of further developments. The Company had, at very great expense, laid down a trunk main from Bow to the West-end. That main was the most important feature of the Company's existence. It had been laid with very great provision, and at present it was only being used at half its capacity. With regard to the progress in the West end, lamps had increased to the extent of 55,326. The directors were not wholly satisfied with the increase in revenue shown, but the cause of the disappointment had been an absence of fog. The local consumption had been exceedingly satisfactory. The Company had earned sufficient to pay the dividend recommended—viz., 10 per cent. for the year. The Board, however, had come to the conclusion that in the solid interests of the shareholders it would be better to hold a certain amount of the dividend in hand for the moment. The carry-forward, as recommended, was £3,140, which was a respectable figure, but not a large one. Under the circumstances the Board had decided to move an amendment to its own report, reducing the dividend by 2 per cent. The result was that £10,140 would be carried forward to the revenue account.

The report and accounts were adopted, and a motion that a dividend of 4½ per cent. on the cumulative preference shares be duly paid, and that a dividend at the rate of 8 per cent. for the year ended Dec 31, 1903, on £350,000 of the ordinary share capital of the West-end undertaking be declared and paid, was carried.

An extraordinary meeting followed for the purpose of passing a resolution to the effect that the capital of the Company be increased by £500,000 by the creation of 100,000 shares of £5 each, of which 50,000 shall be issued as ordinary and 50,000 as preference shares.

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## GREAT NORTHERN AND CITY RAILWAY.

The half-yearly general meeting of the proprietors of this railway was held at River Plate House, Finsbury-circus, on Tuesday, Sir Charles Scotter presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), congratulated the proprietors on the completion of the line, which had taken about four years to construct Considering the nature of the undertaking, and the many difficulties which had had to be faced, he considered that the engineers and the contractors might be proud of their achievement. He explained the nature of the railway, which has been described in this journal, and stated that the extension to the Bank, which was regarded as an important factor in connection with the success of the undertaking, had not yet been commenced. It was hoped that within a short time the money market would be in such a state as to enable the capital to be got on reasonable terms, in which case there would be no further delay. He had told the shareholders over and over again at the different half-yearly meetings that the proposed fare from end to end of the line would be 2d., and that policy would be adhered to. The line would be opened for public traffic between Moorgate-street and Finsbury Park so soon as the necessary certificate had been granted by the Board of Trade. The inspectors of that department had already made a careful inspection of the entire undertaking, and had expressed their opinion to the engineers that it was much in advance of any of the other "tube" railways. Owing, however, to a few minor details in reference to the signalling, Colonel Yorke had arranged to make a final inspection next Saturday, when it was expected that permission would be at once given for the opening of the line. He desired to make a few remarks to try and remove the impression that people had as to there being an element of danger in riding on "tube" railways. A scare was undoubtedly created in consequence of the deplorable disaster on the Paris Metropolitan line, but he had been told on authority that few, if any, lives would have been lost in that accident had the lights not gone out, and so created a panic among the passengers. The reports published in the newspapers on that terrible event had an immediate effect on the receipts of the electric railways in London. Those of the Central London at once declined, and even the Waterloo and City line traffic was adversely affected. In his opinion the Great Northern and City Railway would be one of the safest places to be in in London. The electric lighting on the railway would be quite distinct from the motive power, so that if the latter failed, the stations would not be thrown into darkness. The two systems would be quite independent of each other. In addition, provision had been made for at once illuminating the stations by gas, in the event of both electric systems failing simultaneously. Should the trains come to a standstill, passengers would be able to get out on either side and proceed on a concrete footpath to the nearest station. All the material used in the construction of the stations and elsewhere was fireproof, and, in fact, every known precaution had been taken to render an outbreak of fire impossible. The carriages would be roomy and lofty, and fitted with comfortable seats. It was proposed to run trains every three minutes, and the time occupied on the journey from Finsbury Park to Moorgate-street would be about 13 or 14 minutes. The line served a densely-populated district, and the Board believed that, with cheap fares and good accommodation, it would become the popular means of travelling between the North of London and the City, and that, ultimately, it would prove a great financial success. In conclusion, he moved the adoption of the report.

The **Earl of Lauderdale** seconded the motion, which was agreed to unanimously.

A special general meeting was afterwards held, at which the Company's Bill in Parliament, seeking for an extension of time for the completion of a small portion of the line at the south end of Moorgate-street Station, was approved.

After the meeting a number of the shareholders were afforded the opportunity of travelling over the railway, a special train being held in readiness at Moorgate-street Station for the purpose.

## CITY AND SOUTH LONDON RAILWAY.

The ordinary general meeting of the proprietors of this railway was held at the offices, Finsbury-pavement, on Tuesday, Mr. Charles G. Mott presiding.

In moving the adoption of the report (which appeared in our last issue) the **Chairman** referred with great regret to the diminution in the dividend, which, however, he pointed out had been caused by exceptional circumstances. During the process of conversion of the London County Council tramways the ordinary traffic of the tramways was very much interrupted, and a great deal of traffic was thus thrown on their railway in the corresponding period of 1902, and up to the middle of February, 1903. The electric tramways were opened in May last, and the Company had since had to compete with this new and improved system, which had taken a good deal of traffic from their railway. The minimum fare charged on the tramways also was ½d., while the Company's own minimum fare was 1d. Their position, however, was not by any means so hopeless as it appeared. They were steadily recovering the traffic they had lost, and the receipts of the first five weeks this year showed an increase of £1,000 on those for the corresponding period of 1902, when the horse tramways were working, and the circumstances of the Company were the same as they were at the present time, except that they now had to compete with the tramways worked by electricity. He then dealt with the details of the revenue account, pointing out that the decrease in the number of passengers carried in the half-year had been 1,166,137, as compared with the numbers carried in the December half of 1902, and that the receipts had been £10,957 less. From season tickets they had received £1,112 more. There had been various decreases in the working expenses. The ratio of working expenses rose from 44·04 per cent. in the December half of 1902 to 47·86 per cent. in the past half-year consequent on the diminution in the traffic. The ratio was still very low, at 47 per cent., but he hoped to see it much lower in the future. Everything was done during the past half-year to see in what way an improvement could be brought about in the position of the Company and with a view to making the line more attractive. They, in the first place, reduced the fare over a portion of the system—the section between the City and the Angel—but while there had been a large increase in the number of their passengers from this reduction, there had been no improvement in the receipts. They had, therefore, not introduced any further reductions on the rest of the line, but the charges for season tickets for six months and three months had been reduced to the same rate as those for 12 months; and monthly season tickets had also been issued. The result had been largely to increase the number of their season-ticket holders. It was hoped that the Great Northern and City Railway would be opened next week, and arrangements had been made with that company for through bookings, and they were also going to arrange with them for through season tickets. There were further to be through bookings over a portion of the South-Eastern Railway, and it was hoped shortly to introduce through bookings over the Metropolitan. There would be a joint station at Old-street with the Great Northern and City Railway, with whom there would also be a connection by means of a short staircase at the Moorgate-street Station. The Board attached great importance to the proposed extension to Euston. They believed that the cost of working it would be very small, that the capital expenditure would not be excessive, and that the Company would obtain a very large traffic—apart from local traffic—from the five railway companies they would be brought into connection with at King's Cross, St Pancras, and Euston, by this extension. They felt that its construction should, therefore, be proceeded with as soon as it could be prudently undertaken. The negotiations with the five other companies would take a long time, and until the plans were settled, contracts could not be entered into. When the time arrived he hoped that the position of the money market and of the Company's own finances would enable the Board to raise the necessary capital on terms which they would consider satisfactory.

**Mr. C. Seymour Grenfell** seconded the motion.

In reply to questions, the **Chairman** stated that the suggestion to extend the Company's system to Tooting was an important one. It would, however, be very imprudent at the present time to endeavour to raise the large capital which would be required to construct this extension. What they proposed to take in hand first was the Euston extension, because it would only involve the outlay of a very moderate amount—£400,000 odd—and they felt quite certain that it would pay handsomely.

The motion was then unanimously adopted.

## CENTRAL LONDON RAILWAY.

The half-yearly meeting of the proprietors of this railway was held on Wednesday at the Holborn Restaurant, Sir Henry Oakley presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), observed that nothing of any material consequence in the working of the Company had taken place during the past six months. At first blush the revenue account did not look so bright as usual. Compared with the corresponding half-year of 1902 a decrease was shown in the receipts of £6,545. owing to 650,000 fewer passengers having been carried. The traffic of the previous year, however, was abnormally swollen by the multitudes of people who flocked to London for the Coronation and its attendant festivities and attractions. The result was that the Company's receipts for that year showed an advance of 10 per cent. against a decline of 1½ per cent. last year. Taking 1902 and 1903 together they had an improvement of 8½ per cent. The accounts, as a whole, presented no discouraging features. The net result of the six months' working was that the Board were enabled to pay dividends on all classes of stock at the rate of 4 per cent. per annum, to add £10,000 to the reserve fund, raising it to £30,000, and to carry forward £36,000, or £9,000 more than was brought into the accounts at the beginning of the year from 1902. About 12 months ago it became necessary to consider the question of making a radical change in the system of working, and he was pleased to state that the new system of working had answered admirably. The motor-carriages were more economical and quite as reliable as the engines. The sub-station at Bond-street was now practically completed. This station was for the purpose of separating the lighting and the power required for the lifts from the motive power for running the trains, so that, in the event of any accident or stoppage, the tunnels could be lighted from end to end and passengers taken up or down the lifts. The large fan at Shepherd's Bush was in regular working order, and it had effected a great improvement in the ventilation of the tunnels. It was only right to say, however, that the ventilation was not yet perfect, but it was hoped still further to improve it as time went on. Some time ago considerable complaints were made with regard to overcrowding on the line during the busy hours of the day. The manager went thoroughly into the matter, and, as a result, the number of trains run between 8 and 10.30 in the morning had been increased. This had naturally added to the costs of working, but, on the whole, the expenses remained practically the same. A final settlement with the Electric Traction Company had at last been arrived at. As was usual in the case of large contracts, certain questions arose on which there were differences of opinion. These were referred to Sir Benjamin Baker, who acted as arbitrator, and upon his decision the Board had agreed to hand over the securities, amounting to £58,000, which they had kept in hand, until the points in dispute were finally disposed of. He desired to say that, after three years' experience, the works had been found to be substantial, and did credit to the contractors. Dealing with the capital account, he tated that the expenditure of the half-year was about

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£44,000, mainly on works already commenced. The estimate of further capital expenditure was given as £160 000, but there was nothing to lead the Board to suppose that such a sum would be required for the present. In fact, no serious addition to the capital was contemplated.

**Lord Knollys** seconded the motion, which was carried unanimously.

## HARROW AND UXBRIDGE RAILWAY.

The half-yearly meeting of the proprietors of this railway was held at Cannon-street Hotel.

**Colonel J. J. Mellor,** who presided, in moving the adoption of the report, stated that the Metropolitan Company had now contributed the whole of the amount authorised to be subscribed by them to the undertaking. Although the completion of the railway had been delayed, owing to the heavy rainfall last year, the works were in a very forward state, and it was expected would be ready for opening in April next. The line, when opened, would be worked by the Metropolitan Company. It was not proposed to work the line electrically at first, but to use steam traction for a time. The electrification of the line was well in hand, and would be ready by the time the Metropolitan Railway introduced electric traction on their own line.

The motion was adopted.

## SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report of the directors for the year 1903 states that the gross profit amounts to £6,691, an increase of £625, while the gross receipts have increased by £750. After providing for interest and other charges amounting to £2,530, placing a further sum of £2,000 to reserve fund and £1,500 to depreciation account, there remains a balance of £3,662. 13s. 11d., including £1,350. 18s. 7d. brought into the accounts from last year. This balance the directors propose to deal with as follows: by the payment of a dividend at the rate of 4 per cent. for the year, £2,400; and to carry forward, £1,262. 13s. 11d. It was considered expedient to adopt a uniform price for the current supplied to the shops in the markets, and this was done in the spring of 1903. This reduction to the consumers has proved advantageous to the Company, the receipts from the sale of current having substantially increased notwithstanding the lower average price obtained. It is also satisfactory to note that the cost of production has been again reduced. The new generating set referred to in the last report was installed in October last, and is working satisfactorily. The entire cost of this engine and dynamo has been met without raising further capital. Capital account has been credited with the cost of the set replaced. The plant and machinery throughout are in good condition, having been fully maintained out of revenue.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 7,364 | 17 | 5 |
| Distribution and maintenance | 2,341 | 15 | 10 |
| Rents, rates, and taxes | 1,053 | 6 | 3 |
| Management expenses | 2,148 | 0 | 7 |
| Legal charges and insurance | 175 | 2 | 7 |
| Auditor's fees | 36 | 15 | 0 |
| Total expenditure | 13,119 | 17 | 8 |
| Balance carried to net revenue account | 6,691 | 3 | 5 |
| | £19,811 | 1 | 1 |
| Cr. | £ | s. | d. |
| Sale of current, less bad debts | 18,706 | 9 | 4 |
| Meter rents | 185 | 4 | 4 |
| Installation charges | 807 | 1 | 6 |
| Sundry receipts, discounts, etc. | 112 | 5 | 11 |
| | £19,811 | 1 | 1 |

| Dr. ABSTRACT OF BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Capital account | 118,000 | 0 | 0 |
| Debenture interest accrued | 1.000 | 0 | 0 |
| Sundry creditors and deposits | 2,495 | 15 | 6 |
| Reserve account for premium on redemption of debentures | 400 | 0 | 0 |
| Depreciation account | 2,965 | 0 | 0 |
| General reserve fund account | 4,080 | 0 | 0 |
| Net revenue account | 3,662 | 13 | 11 |
| | £132,603 | 9 | 5 |
| Cr. | £ | s. | d. |
| Capital account | 120,847 | 18 | 6 |
| Deposits and interest | 4,118 | 14 | 7 |
| Sundry debtors for current | 5,634 | 14 | 5 |
| Other debtors | 488 | 1 | 5 |
| Rates, taxes, insurance, etc., paid in advance | 153 | 5 | 6 |
| Stock on hand | 737 | 0 | 10 |
| Cash at bank and in hand | 623 | 14 | 2 |
| | £132,603 | 9 | 5 |

## DUBLIN UNITED TRAMWAYS.

On Tuesday the ordinary half-yearly meeting of the shareholders in this Company was held at Dublin, Mr. W. M. Murphy presiding.

The **Chairman,** in moving the adoption of the report, said that the statement of accounts was the most satisfactory that they had yet been able to present to the shareholders. The net result might be summed up in a few words—viz., an increase in receipts of £8,346, with increase in working expenses of only £216, so that nearly the whole of their increased receipts represented increased profits. The sum of £48,950. 0s. 2d. was at their disposal for distribution amongst the shareholders, which included £2,857 brought in from the June account. This enabled them, after paying the usual rates of 6 per cent. on the preference and 6 per cent. on the ordinary shares, to place £4,000 to reserve, £2,000 towards maintenance in the current half-year, £1,000 to an accident insurance fund, and to carry forward £6,775. 0s. 2d. The receipts from parcels delivery, which had proved such a great convenience to the citizens, continued to increase, and they reached in the last six months the substantial sum of £2,873. There was no other city in the kingdom with such a tramway parcel delivery as Dublin possessed, and they were constantly receiving visits from the tramway authorities of large cities in Great Britain to see how their parcel business was organised and conducted. The actual cost to the Company for electric energy per car per mile was only ·438d. This they certainly could not hope to beat in the future unless they largely increased their output, which now reached over 7½ million units per annum. The Company were being constantly applied to by would-be consumers for a supply of electric current, which, owing to the agreement with the Corporation, they were unable to give, though in many cases the demand was for direct current, which the Corporation had made no provision for supplying, their generating and distributing system being designed exclusively for alternating current. During the half-year the Company completed and opened for traffic an extension of the Drumcondra line, a little more than half a mile in length. This extension was already developing building in the district. Five years ago they got powers for many extensions of the system, all of which had been since completed, except the lines to Upper Rathmines, and to the Rialto Bridge, Dolphin's Barn, and a line through Lower Baggott-street to Merrion-row. As the time was expiring within which these lines had to be completed, they applied to the Privy Council for an extension of time for two years more, which was duly sanctioned.

**Alderman Cotton** seconded the motion, which was adopted.

## ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The report of the directors for the year ending Dec. 31 last states that the supply has been distributed from the Carnaby-street and Mason's-yard stations of this Company on a total of 254,463 8-c.p. lamps, being an increase of 21,783 in the past 12 months. For this purpose 6,662,228 units were generated at these stations, and 1,118,082 units were purchased from the Central Electric Supply Company, Limited. An agreed price, high enough to cover the abnormal cost of production during the initial stages of working, has been paid to the Central Company for current supplied. To meet this extra charge on the year's working a sum of £2,500 has been transferred to the net revenue account from the contingency fund specially provided last year for this purpose. The net profits applicable to dividend on shares for the year 1903 were £35,952. 5s. 3d. The balance brought forward from 1902 amounted to £2,792. 11s. 8d., giving a total of £38,744. 16s. 11d. After deducting dividends on preference shares and ordinary shares amounting to £13,500, there remains to be dealt with a sum of £25,244. 16s. 11d. The directors propose to divide this amount as follows: (*a*) by payment of a dividend at the rate of 7 per cent. on the preference shares for the second half-year, £3,500; (*b*) by payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year, £19 000; (*c*) amount to be carried forward, £2,744. 16s. 11d.—total, £25,244. 16s. 11d.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation and distribution of electricity | 33,690 | 16 | 9 |
| Purchase of current | 14,176 | 0 | 6 |
| Rents, rates, and taxes | 8,493 | 18 | 3 |
| Management expenses | 8,134 | 0 | 10 |
| Legal expenses | 169 | 11 | 11 |
| Special charges | 656 | 5 | 4 |
| Depreciation on buildings, plant, etc. | 14,494 | 15 | 10 |
| | 79.815 | 9 | 5 |
| Balance carried to net revenue account | 37,291 | 11 | 8 |
| | £117,107 | 1 | 1 |
| Cr. | £ | s. | d. |
| Sale of current, less rebates and bad debts | 113,425 | 16 | 2 |
| Rental of meters | 3,055 | 19 | 7 |
| Rents receivable | 289 | 13 | 9 |
| Transfer fees | 29 | 12 | 6 |
| Discounts on purchases | 140 | 12 | 11 |
| Sale of old materials, etc. | 32 | 10 | 1 |
| Sundry fees, etc. | 136 | 16 | 1 |
| | £117,107 | 1 | 1 |

| Dr. GENERAL BALANCE SHEET. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 452,000 | 0 | 0 |
| Capital reserve fund | 66,529 | 5 | 3 |
| Contingency fund | 2,500 | 0 | 0 |
| Sundry tradesmen and others, due on construction of plant, etc. | 4,442 | 10 | 10 |
| Sundry creditors on open account | 14,239 | 6 | 0 |
| Debenture stockholders, for interest accrued, less tax, payable Jan. 1, 1904 | 2,504 | 13 | 9 |
| Unclaimed dividends | 31 | 19 | 0 |
| Net revenue account | 25,244 | 16 | 11 |
| | £565,492 | 11 | 9 |

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| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended | 439,522 | 10 | 8 |
| Central Electric Supply Company, Limited, 10,000 £5 ordinary shares | 50,000 | 0 | 0 |
| Investments | 36,347 | 2 | 0 |
| Stores on hand | 7,032 | 19 | 9 |
| Sundry debtors for current | 25,633 | 2 | 3 |
| Other debtors | 888 | 14 | 2 |
| Cash at bankers and in hand | 6,068 | 2 | 11 |
| | £565,492 | 11 | 9 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Units generated | | | 6,662,228 |
| Units purchased | | | 1,118,082 |
| Quantity utilised | Private supply | 6,871,881 | 7,140,205 |
| | Public lighting | 145,848 | |
| | Used on works | 122,476 | |
| Quantity expended in distribution | | | 640,105 |
| Number of lamps on circuit at Dec. 31, 1903 | | | 254,468 |

## CENTRAL ELECTRIC SUPPLY.

The report of the directors for the year ended Dec. 31 last states that energy has been supplied to the St. James's and Pall Mall Electric Light Company, Limited, and the Westminster Electric Supply Corporation, Limited, throughout the year to an amount of 2,601,087 units. The cost of production has fallen rapidly as the supply has grown. It has already reached a low point, and from the experience gained the directors are assured that they will henceforth be able to produce on a large scale with very satisfactory results. It has been necessary to charge 3d. a unit during the past year, but it is anticipated that this price will be largely reduced in the early future. Further debenture stock, amounting to £38,782, has been issued during the year, and the premium on the issue, after deducting the expenses, has been carried to the credit of the capital reserve account. The net earnings of the Company for the year 1903 were £3,902. 6s. 11d., to which is added balance brought forward from 1902, £500. 13s., making a total of £4,402. 19s. 11d., which amount the directors propose to carry forward.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d |
|---|---|---|---|
| Generation and distribution of electricity | 9,803 | 7 | 8 |
| Purchase of current | 277 | 1 | 4 |
| Rents, rates, and taxes | 1,969 | 1 | 10 |
| Management expenses | 1,922 | 17 | 4 |
| Law expenses | 19 | 3 | 2 |
| Special charges, insurances, etc. | 386 | 2 | 11 |
| | 14,377 | 14 | 3 |
| Balance carried to net revenue account | 19,254 | 9 | 0 |
| | £33,632 | 3 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current | 32,637 | 4 | 3 |
| Rental of meters | 2 | 15 | 0 |
| Rents receivable | 960 | 0 | 0 |
| Transfer fees | 6 | 12 | 6 |
| Discounts on purchases | 25 | 6 | 6 |
| Sundry fees, etc. | 0 | 5 | 0 |
| | £33,632 | 3 | 3 |

ABSTRACT OF GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 388,782 | 0 | 0 |
| Due to sundry tradesmen and others | 23,185 | 14 | 5 |
| Sundry creditors on open accounts | 2,452 | 13 | 5 |
| Interest on debenture stock and interest warrants | 1,068 | 6 | 4 |
| Premium on sale of debenture stock, less expenses | 2,379 | 5 | 11 |
| Sinking fund | 5,000 | 0 | 0 |
| Balance at credit of net revenue account | 4,402 | 19 | 11 |
| | £427,271 | 0 | 0 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 400,951 | 7 | 9 |
| Stores on hand | 207 | 15 | 9 |
| Sundry debtors for current supplied | 21,074 | 9 | 1 |
| Other debtors | 1,183 | 12 | 11 |
| Rates and insurance paid in advance | 710 | 16 | 3 |
| Investment in Consols at cost | 1,615 | 8 | 6 |
| Cash at bankers and in hand | 1,527 | 9 | 9 |
| | £427,271 | 0 | 0 |

## MANX ELECTRIC RAILWAY.

The general meeting of the proprietors of this railway was held last week at the offices, Cornhill, Mr. Ernest Schenk presiding.

The **Chairman**, in moving the adoption of the report (*vide* issue for 22nd ult.), stated that during the period under review works had been begun on capital account which would cost in all just under £50,000. The bulk of this expenditure, £44,398, was for new plant and equipment. When the line was taken over a little more than a year ago it was in liquidation, arising out of the Dumbell's Bank failure, and, having been in that state for some time, it was possible that not so much had been expended on it as the Board had considered it advisable to spend in the course of the past year. It was, however, satisfactory to note that the total capitalisation at present, including the new expenditure of £50,000, was actually less than the original cost of the railway. The directors were quite satisfied that the Company had a good property, and one which was likely to increase in value in the future. The railway covered the best route in the Isle of Man. Having referred to the development of the passenger traffic and explained the steps which were being taken to increase the goods and live-stock traffic, he stated that passenger fares had been reduced, especially for long distances, with encouraging results. It was proposed to make a further slight reduction on the Snaefell route, and it was believed that the effect would be to increase the traffic on that part of the system. The Company's prospects might be described as most favourable.

**Mr. Bernard E. Greenwell** seconded the motion, and it was carried.

## NEW COMPANIES REGISTERED.

**Peto and Radford.**—Capital, £40,000. Objects: to adopt two agreements with Peto and Radford, Limited, and with the P. and R. Storage Battery Company, Limited, and to carry on the business of manufacturers of and dealers in electric meters and any other electrical instruments, apparatus, appliances, machines and contrivances, electricians, accumulator manufacturers, etc.

**Uranium-Radium Mines Development Syndicate, Limited.**—Capital, £20,000. Object: to acquire and turn to account any mines, mining and other rights, concessions, grants, prospectors' and diggers' licenses, and metalliferous land in Great Britain or elsewhere; in particular, to acquire options to purchase properties containing uranium ores or pitchblendes, tin, and other valuable minerals in Cornwall and Devonshire.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Woolstanton and Burslem.**—The Guardians will shortly invite tenders for supplying the workhouse with an electric light installation.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Punta Arenas, Chile (Straits of Magellanstrasse).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Brussels.**—The Government Railways invite tenders for a number of electric light apparatus. Specifications, 1,022, may be obtained from the above authority. Tenders by Feb. 10.

**Leeds.**—Tenders are invited for wiring for electric lighting at the branch library, Wesley-road, Armley. Specifications, etc., from the Town Clerk, Town Hall, Leeds. Tenders by Feb. 10.

**Hammersmith.**—The Council invite tenders for various supplies. Particulars from Mr. G. Gilbert Bell, Electricity Works, 57, Fulham Palace-road, W. Tenders by Feb. 10. See advertisement in last issue.

**Swindon.**—The Corporation invite tenders for wiring school for electric lighting. Specifications, etc., from Mr. J. G. Griffin, Electricity Works. Tenders by Feb. 15. See advertisement in last issue.

**Maratea (Italy).**—The Municipal Authorities require tenders for an electric lighting installation. Particulars may be obtained from the Secretary of the Municipality, Maratea, Province of Potenza, Italy.

**Bristol.**—The Corporation invite detailed particulars of standard single-phase H.T. and three-phase E.H.T. switchgear. Further particulars from the City Electrical Engineer. See advertisement in former issue.

**Bedford.**—The Electrical Committee invite tenders for high-tension switchboard. Specifications from Mr. R. W. L. Phillips, electrical engineer, Cauldwell-street. Tenders by Feb. 9. See advertisement in last issue.

**Marcinelle (Belgium).**—The Municipal Authorities of this town, in the province of Hainaut, require tenders for erection of an electric station and supply of current. Tenders by Feb. 26. By registered letter Feb. 24.

**Portsmouth.**—Tenders are invited for 12 months' supply of various stores for the electric lighting station from April 1 next. Tenders by Feb. 10. Particulars from the Manager, Electric Lighting Station, Gunwharf-road.

**Sunderland.**—The Corporation invite tenders for the supply of travelling crane and storage battery. Specifications, etc., from Mr. John F. C. Snell, M.I.C.E., Town Hall. Tenders by Feb. 26. See advertisement in last issue.

**Islington.**—The Lighting Committee invite proposals for the carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals by Feb. 17. See advertisement.

**Pontevedra (Spain).**—Tenders are invited for the construction of an electric tramway from Mondariz to Porrino. Particulars may be seen at this office, or obtained from the Public Works Department, Madrid. Tenders by Feb. 12.

**Camberwell.**—The Baths Sub-Committee invite tenders for a new engine and dynamo, etc. Specifications can be obtained from borough engineer, Mr. W. Oxtoby, Town Hall, Camberwell, S.E. Tenders by 6 p.m. on Feb. 16. See advertisement.

**Canterbury.**—The Corporation invite tenders for supply and erection of four motor-driven centrifugal pumps for lifting sewage. Specifications, etc., from the City Electrical Engineer. Tenders by Feb. 8. See advertisement in former issue.

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**Madrid.**—The Public Works Department require tenders for the construction and the working of an electric tramway from San Cristobal de la Laguna á Tacoronte, in the province of Canarias. The adjudication will take place on March 23, at 12 noon.

**Battersea.**—The Borough Council invite tenders for a 750 kw. steam dynamo, electric pumps, etc. Specifications from Mr. H. R. Forbes Mackay, Electricity Department, Lombard-road, S.W. Tenders by Feb. 15. See advertisement in last issue.

**Hanley.**—The Corporation invite tenders for the supply, delivery, and erection of alternators, condensing plant, superheaters, etc. Specifications from Mr. C. A. Cowell, Electricity Works, Park-road. Tenders by Feb. 22. See advertisement in last issue.

**Edinburgh.**—The Corporation invite tenders for engine and dynamo for electricity supply station at M'Donald-road. Specifications, etc., from the Electrical Engineer, Dewar-place Station. Tenders by Feb. 22. See advertisement in former issue.

**Zurich (Switzerland).**—The Municipality require about 200 single-phase alternating-current meters as follows: 100 five-ampere 100-volt, 50 10-ampere 100-volt, 50 15-ampere 100-volt. Tenders to the Vorstand des Bauwesens II, Stadthaus, Zurich, by 31st inst.

**Bootle (Lancs.).**—The Education Committee invite tenders for the installation of about 200 electric lights at the Linacre-lane School. Specifications, etc., may be obtained at the Electrical Engineer's Office, Pine-grove. Tenders to the Town Clerk by 10 a.m. on Feb. 11.

**Kirkcaldy (Scotland).**—The Corporation invite tenders for the wiring complete of the Pathhead Halls, including fittings. Specifications, etc., can be obtained from Mr. O. F. Francis, Electricity Works, Victoria road. Tenders to the Town Clerk by noon on Feb. 15.

**West Ham.**—Tenders are invited for supply of engine-room stores, cable, recording wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Particulars from Central Electricity Station, Abbey Mills, West Ham. Tenders by Feb. 11.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Barcelona.**—Tenders for public arc lighting will be received at the Town Hall, Casos Consistoriales, by Feb. 9. Particulars may be obtained there or at the Local Government Office (Ministrelo de la Gobernacion), Madrid, or at this office. Sixty-four arc lamps are required.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Brighton.**—The Town Council invite tenders for the supply and erection of a 20-ton four-motor electrically-operated crane at their power station, Southwick. Specifications can be had at the office of Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by 10 a.m. on Feb. 8.

**Horwich (Lancs.).**—The Hospital Committee invites tenders for the work of installing electric light in the five buildings of the new hospital for infectious diseases, Fall Birch-lane, Horwich. Specifications from Messrs. Crossey and Keighley, Euston-road, Morcambe, E Tenders by Feb. 6.

**Birkenhead.**—The Corporation invites tenders for various stores and materials required at the electricity works during year ending March 31, 1905. Particulars may be had on application to Mr. William Bates, A.M.I.C.E., Craven-street Generating Station. Tenders by 5 p.m. on 15th inst.

**Manchester Ship Canal.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection of 25 electric hoists and 10 electric fixed cranes for transit sheds. Specification, etc., can be obtained from Mr. W. H. Hunter, M.I.C.E., chief engineer, 41, Spring-gardens, Manchester. Tenders by March 1.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**London, N.**—The Hornsey Borough Council invite tenders for (Section A) two dry-back or water-tube boilers; (B) smoke-consuming apparatus; (C) two 300-kw. steam dynamos, one 100-kw. steam dynamo, two motor-generators. Specifications, etc., may be obtained of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by 10.30 a.m. on Feb. 8. See advertisement in former issue.

**Greenwich.**—The London County Council invite tenders for the supply and delivery of five tubular fuel economisers, of 320 tubes each, complete with scraper gear, and five motors with starting gear, for erection of the plant in the station at Greenwich, and dampers and frames for flues and chimney openings. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders before 10 a.m. on Feb. 16.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Islington.**—Tenders are invited for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors and pilot cable, with feeding, junction, and service boxes. Specifications, etc., from the Borough Electrical Engineer, 50, Eden-grove, Holloway, N. Tenders by Feb. 24. See advertisement in last issue.

## RESULTS OF TENDERS.

**Harrismith.**—The tender of Messrs. Mather and Platt, of Manchester, at £5,617, for electric lighting plant has been accepted.

**Belfast.**—The contract for the sanitary fittings for the new city hall has been given to Messrs. G. Jennings, Lambeth Palace-road, S.E.

**Aston Manor.**—The Town Council have accepted the tender of Mr. G. Trentham, at £11,000, for the execution of the Witton-lane depôt.

**London County Council.**—The Council have accepted the offer of Mr. Bertram Thomas to supply and erect a low-tension switchboard for £580.

**Johannesburg.**—The Council have accepted the tender for electric cables and boxes by the Telegraph Manufacturing Company (Colonial), Limited, at £348.

**Medomsley.**—The tender of Messrs. Reed, Ferens, and Co., at £9. 5s., has been accepted for erecting two sets of guard wires to protect the Post Office wires.

**Long Eaton.**—The Urban District Council have placed an order with Messrs Browett, Lindley, and Co., Limited, for a 250-kw. steam dynamo complete with condensing plant and pipework.

**Sydney (N.S.W.).**—W. T. Henley's Telegraph Works Company, Limited, London-wall, have secured the contract for supplying and laying cables (including three-phase cables) for the Government tramways.

**Netley.**—The War Office have placed an order for the storage battery of 115 cells required for the electric lighting of the Royal Victoria Hospital, Netley, with the Hart Accumulator Company, Stratford, E.

**Fife Electric Power Company.**—The company have accepted the tender of Messrs. Bruce Peebles and Co., Limited, for generating machinery (Dunfermline station), engines, alternators, boilers, switchgear, etc. (2 000 h.p.), at £23,590.

**Bexley.**—The Urban District Council have placed an order for a 150-kw. steam-engine fitted with a Schmidt interheater for use with highly superheated steam for their extensions, with Messrs. Browett, Lindley, and Co., Limited, Patricroft.

**Bermondsey.**—The tender of Messrs Babcock and Wilcox, Limited, for the construction, supply, and erection of two water-tube boilers, overhead flue, coal bunkers, and coal-handling plant, and extensions to steam, feed, and exhaust pipes, at £7,930, has been accepted.

**Tiverton.**—The Corporation have placed an order with the British Westinghouse Company for two gas-engines and auxiliaries, through Messrs. Frank Suter and Co., Berners-street, W. These engines are of 125 b.h.p. each, and are of the three-cylinder (15in. by 14in.) type.

**Chesterfield.**—The Corporation have recently ordered from the British Westinghouse Electric and Manufacturing Company a new 400-kw. steam dynamo, together with switchboard and auxiliary apparatus, a Babcock and Wilcox boiler, and a Worthington jet condenser.

**May-Oatway Fire Appliances, Limited.**—The Scottish office of this company report the following successful tenderers for contracts for wiring with the fire brigades at Govan and Glasgow: Govan Ropeworks Company, Limited—Messrs. Carrick and Topping; Messrs. J. Templeton and Co., Greenhead—Messrs. Wylie and Lochhead, Limited; Messrs. J. Templeton and Co., West-street—Messrs. Wylie and Lochhead, Limited.

**Whitby.**—The Urban District Council have received the following tenders for the supply and delivery of feeding and distributing mains:

| | |
|---|---|
| Callender's Cable and Construction Company (accepted) | £1,396 16 6 |
| Land and Sea Cable Company | 1,508 1 1 |
| Western Electric Company | 1,400 4 8 |
| Siemens Bros. and Co. | 1,414 0 0 |
| British Insulated and Helsby Cables | 1,407 14 8 |
| Union Cable Company | 1,395 17 11 |
| St. Helen's Cable Company | 1,382 12 11 |
| Johnson and Phillips | 1,378 15 4 |
| Glover and Co. | 1,284 19 8 |
| Electrical Company | 1,242 16 7 |

**Chiswick.**—The Urban District Council have received the following tenders for a refuse destructor and auxiliary plant:

| | |
|---|---|
| Horsfall Destructor Company | £5,837 0 0 |
| Horsfall Destructor Company (with Custodis chimney) (accepted) | 5,637 0 0 |
| Goddard, Massey, and Warner | 7,469 19 0 |
| Heenan and Froude, Limited | 6,924 10 0 |
| Meldrum Bros. | 6,540 16 0 |
| Refuse Destructors, Limited | 5,584 8 11 |
| Hughes and Stirling | 5,214 0 0 |
| W. F. Mason, Limited | 3,235 15 0 |
| J. Baker and Sons (part only) | 2,900 0 0 |

The Council have also accepted the tender of the Horsfall Company for additional works, making a total of £7,481.

**Brighton.**—The Town Council have accepted the following tenders for the supply and delivery of the following materials: Stewarts and Lloyds, Limited, steel poles, £969. 11s. 6d.; F. Smith and Co., trolley wire, £325. 5s. 2d.; Rowland Carr and Co., bases and section pillars, £313. 15s. 7d.; J. Needham and Sons, cast-iron fittings, £42. 2s.; Dick, Kerr, and Co., pole brackets, £173. 4s.; W. Wood and Co., overhead line fittings, £97. 9s.; F. Smith and Co., span and guard wire, £15. 10s. 6d.; W. Wood and Co., switchgear, £38. 7s. 6d.;

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British Insulated and Helsby Cables, Limited, feeder, distributing, and telephone cables, £3,209. 15s. 3d.; R. W. Blackwell and Co., Limited, bonds, £580. 19s. 2d.; Acme Wood Flooring Company, Limited, wood paving blocks, £7,100; Brooks, Limited, London, granite setts, £615.

**Engines and Dynamos.**—Messrs. W. H. Allen and Sons, Limited, Queen's Engineering Works, Bedford, report the following recent contracts: one engine coupled to dynamo for H.M.S. "Canopus"; five engines coupled to dynamos for H.M. ships "Albion," "Glory," "Ocean," "Vengeance," and "Goliath"; two engines coupled to dynamos for H.M.S. "Thames." The London Electric Supply Corporation, Limited, Deptford, two engines for direct-coupling to centrifugal pumps. Messrs. W. O. Roper and Co., two engines for coupling to Electric Construction Company's dynamo for Portland Hospital The British Westinghouse Company, two engines for direct-coupling to centrifugal pumps at Yoker power station. Messrs. A. H. Briggs and Co., Bradford, one engine for direct-coupling to British Westinghouse Company's dynamo. Messrs. Laird Bros., 21 engines for H.M. ships "Liffey," "Moy," and "Ouse." The Ansell Brewery Company, Birmingham, one enclosed engine for coupling to General Electric Company's dynamo. Messrs. J. I. Thornycroft and Co., 14 engines for H.M. ships "Colne" and "Chelmer." Messrs. J. S. White and Co., 14 engines for H.M. ships "Ness" and "Nith."

**Wimbledon.**—The Urban District Council have received the following tenders for the supply and erection of a complete water-softening and storage plant at their electricity works:

| | | | |
|---|---|---|---|
| Paterson Engineering Company* | £1,153 | 0 | 0 |
| Baker's Patent Appliances Company | 958 | 0 | 0 |
| Kennicott Water Softener Company | 1,150 | 0 | 0 |
| Masson, Scott, and Co. | 1,197 | 0 | 0 |
| A. Koppel | 1,200 | 0 | 0 |
| Gimson and Co. | 1,336 | 0 | 0 |
| Potter and Co. | 1,350 | 0 | 0 |
| Doulton and Co. | 1,399 | 5 | 4 |
| Doulton and Co. | 1,412 | 9 | 10 |
| Doulton and Co. | 1,514 | 12 | 10 |
| Lassen and Hjort | 1,450 | 0 | 0 |
| Babcock and Wilcox | 1,526 | 0 | 0 |
| T. Waite | 1,690 | 0 | 0 |
| Mather and Platt | 1,750 | 0 | 0 |
| Royles, Limited | 1 800 | 0 | 0 |
| Bowes-Scott and Western | 1,975 | 0 | 0 |
| W. Boby | 2,427 | 0 | 0 |

* Recommended for acceptance.

# BUSINESS NOTES.

## TRACTION.

**Nottingham.**—The Tramways Committee have decided to experiment with covers for the tops of the cars.

**Aberdeen.**—In another fortnight or so the construction of the Suburban Electric Tramways will be commenced.

**Aston.**—In order to make room for a double line of tramways in Park-road the carriageway is to be considerably widened.

**Worcester.**—Some successful trials have been made over the new electric lines, which are now rapidly nearing completion.

**Gloucester.**—Up to the present about seven miles of track of the new electric tramways have been laid and the cars are now being delivered.

**Edinburgh.**—An agreement has been arrived at for the sale of the Edinburgh Tramways Company's undertaking to the Leith Corporation for £60,000.

**Wallasey.**—On a poll the Wallasey Tramways and Improvements Bill has been rejected by the ratepayers, the voting being 1,635 for and 2,517 against.

**Coatbridge and Airdrie.**—The Board of Trade inspection of the new electric tramways was expected to take place yesterday, but may be postponed for a few days.

**Eastbourne.**—The Town Council have decided to apply to the Local Government Board for permission to borrow £3,267 for the purchase of four motor 'buses.

**Western Wagon and Property Co.**—The directors report a total revenue at the end of 1903 of £18,170, and recommend a dividend of 10 per cent. on the share capital.

**Poole.**—A sub-committee has been appointed to take into consideration the desirability of further extensions of the tramway system in the borough, and to report thereon.

**Stoke-on-Trent.**—The Potteries Electric Traction Company have submitted to the Town Council plans of the cables to be laid in High-street in connection with the tramways.

**Manchester.**—The result of the poll on the question of the promotion of the Corporation Tramways Bill this session is a decisive majority in favour of the measure of 5,821 votes.

**Kirkcaldy.**—As an instance of how the tramways are being taken advantage of, they have already carried, for 11 months' running, passengers equal to 60 times the population of Kirkcaldy, or about 2½ millions.

**Dublin.**—A motorman in the employ of the tramways company has been remanded on bail charged with the manslaughter of the driver of a brewer's wagon "by negligence and carelessness in the management of the tramcar."

**Metropolitan District Railway Co.**—A dividend on the 4 per cent. guaranteed stock at the rate of 1½ per cent. per annum for the past half-year is recommended by the directors, the same as for the corresponding period.

**St. Marylebone.**—At the last meeting of the Borough Council a recommendation of the Parliamentary Committee was rejected. It urged the Council to support the Holborn Council to oppose tramways in Tottenham Court-road.

**Cardiff.**—Major Druitt has inspected the new line of tramways between the Monument and Corporation-road, Grangetown. After going over the line Major Druitt expressed himself satisfied with the way in which the track had been laid.

**St. Helens.**—On the instructions of the Tramways Committee, the town clerk has applied to the Local Government Board for their sanction to the borrowing of £6,000, the estimated cost of relaying the tramway track from the Toll Bar, St. Ann's, to Portico.

**Woking.**—The Light Railway Commissioners have held an enquiry into the application of a syndicate for powers to lay down light railways in Woking, Horsell, Chobham, Windlesham, and Bagshot. The Commissioners decided to recommend the granting of an order.

**Accrington.**—In their annual report, the directors of the Steam Tramways Company say: "We regret to have to report that the negotiations with the Accrington Corporation in reference to the transfer of the running powers of the company have proved abortive."

**Scarborough.**—The ratepayers' association have decided to obtain legal opinion as to whether an anomaly exists in the case of individuals acting in the dual capacity of officials of the Scarborough Electric Tramways Company and representatives of the ratepayers on the Town Council.

**Motor 'Buses in South London.**—A service of motor 'buses was this week inaugurated between Forest Hill railway station and Camberwell-green, by way of Peckham Rye. The route is over two miles, and the new 'buses will replace a horse service which was recently discontinued.

**Hounslow and Twickenham.**—A conference is proposed to be held between representatives of the Urban District Councils of Southall, Heston and Isleworth, and Twickenham on the subject of improved means of communication between the districts of Southall, Hounslow, and Twickenham.

**Watford.**—The Board of Trade have confirmed the Watford and District Light Railways Order (1903) made by the Light Railway Commissioners authorising the construction of light railways in the county of Hertford, in the parish of Watford urban, and the urban district of Watford.

**King's Norton.**—The District Council are negotiating with the city of Birmingham for the working by the latter of the suggested extension of the tramways from Selly Oak to Northfield. The Council, however, are disinclined to grant a lease for a longer period than up to June 30, 1911, while the company ask for a 21 years' lease.

**Leith.**—The Town Council have received a letter from the town clerk of Edinburgh asking for another conference between the two Corporations on the question of the tramways. The proposed conference, it is stated, is for the purpose of further discussing through traffic and other matters in which both Corporations are interested.

**Middlesbrough.**—At a meeting of the Streets Committee the Town Clerk reported that he had drawn up certain amendments to the Imperial Tramways Company's Bill, such as should be put in for the protection of the Corporation. He recommended that a sub-committee be appointed to safeguard the interests of the Corporation, and this was agreed to.

**Cardiff-Penarth.**—At the monthly meeting of the Urban District Council on Monday a communication was read stating that the syndicate in connection with the Cardiff-Penarth tramway had resolved to abandon the measure for the present session of Parliament, but proposed to bring it forward for the following session, and hoped then to have the concurrence of the Council.

**Beckenham.**—There has been great delay on the part of the British Electric Traction Company in giving security for carrying out their scheme of tramways in the district, and the District Council have decided, in the event of the company failing to give an assurance to provide such security without further delay, to proceed for the specific performance of the agreement between them.

**Bolton.**—A meeting of the Tramways Committee was held on Monday, when specifications for the proposed new motor 'bus for Darcy Lever were referred to the chairman, vice-chairman, and the manager for further consideration. A design for the indication of stopping places on Chorley New-road, so as not to interfere with the lighting arrangements of the district, was approved.

**Torquay.**—Two points in dispute between the Corporation and the Dolter Electric Traction Company have been satisfactorily settled. The first is that the company shall not run trams on Sunday without the permission of the Corporation except between noon and 10 p.m., and, secondly, that the company shall be liable for compensation in the event of damage to water mains and pipes through electrolysis.

**Rotherham.**—Saturday last was the first anniversary of the opening of the electric tramways. The two sections which have completed the 12 months are Rawmarsh-road and Fitzwilliam-road. According to a return submitted to the Tramways Committee, the total passengers on the whole system from Jan. 31 to Dec. 31 numbered 4,009,892. Receipts for the same period amounted to £16,614. 17s. 10d.

**Keynsham.**—A parish meeting has passed a resolution expressing the opinion that an ample supply of electric current for power and other purposes is likely to lead to the development of industries in the district, and that therefore every reasonable effort should be made by the District and County Councils to procure the insertion in the Bristol Tramways Company's Bill of a clause enabling the company to supply current in bulk to local authorities and also to private consumers.

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**Ashton.**—A deputation from the Manchester Corporation have met the members of the Ashton Tramways Committee with a view to coming to terms with regard to through running from the boundary at Audenshaw to Ashton Market-place. The route was traversed from the Snipe Inn to the Stalybridge boundary and thence to the car-shed. From the subsequent consideration of the points at issue terms were practically agreed upon for a through 10 minutes' service from Manchester to Ashton.

**Newport (Mon.).**—The Corporation having applied to the Local Government Board to borrow £60,500 for electric lighting and tramway purposes, Mr. M. K. North has held an enquiry. Mr. Bishop, the tramway manager, said the first four years' tramways working showed a deficit, the fifth a small profit, in 1900 there was another deficit, and since then a profit. On behalf of the ratepayers' association it was suggested that if rates, taxes, and depreciation were included in the municipal returns, there would be a loss of from £2,000 to £3,000. The inspector will report to the Board.

**Derby.**—Messrs. Thos. Nash and Sons, who have been appointed to test the rails to be used in connection with the electric tramways, have reported that certain rails submitted to them for testing are not as regards certain constituent parts in strict accordance with the specification. The committee being of opinion that the defects are not of a serious nature have decided to accept 400 tons of rails which have already been rolled, on the distinct understanding that no further rails will be taken by the committee which on the worst results obtained independently are not absolutely within the terms of the specification.

**Rochdale.**—A special meeting of the Town Council has approved the draft working agreement between the local authorities and the directors of the Bury, Rochdale, and Oldham Tramway Company for the transfer of the company's undertaking, also an agreement between the Corporation and Wardle as to tramways. The meeting further decided to authorise the town clerk to apply to the Board of Trade for the appointment of an arbitrator in succession to the late Sir Frederick Bramwell, with reference to the purchase of the tramways constructed in Rochdale borough under the tramways orders of 1881 and 1882.

**Walsall.**—On Saturday it was reported that a strike of the Corporation tramway employés was likely to take place as a result of a rearrangement of the tramway service having been made by which the men are placed on shorter time. Enquiries, however, proved that, although a difficulty had arisen, it was not serious, the men having merely memorialised the Tramway Committee to grant them more favourable terms, and it was denied that they contemplated any resort to such extreme measures as had been suggested. It may be pointed out that the rate of pay is better than that on other tramways in the district.

**Lincoln.**—Alluding to the proposed purchase of their undertaking by the Corporation, the directors of the Lincoln Tramways Company, in their annual report, say that, having regard to the very heavy expense (the amount of which is at present unascertained) incurred in preparing for a prospective Board of Trade arbitration as to the sum to be paid by the Corporation for the undertaking, the directors deem it prudent to reserve part of the profit until the winding-up of the company. At a meeting of the City Council on Tuesday an agreement was sealed with the tramways company for the purchase of their undertaking by the Corporation for £10,437.

**Reading.**—On Friday evening, Jan. 29, a "social" was held at the car-shed depôt of the Corporation tramways in connection with the tramways social and athletic club. During the evening the finals of a billiard and draughts tournament were played off, and an interesting collection of photographs and curios was on exhibition in the clubroom which had been contributed by a number of tramway employés who had been engaged on service abroad. During the evening selections of vocal and instrumental music were given by several members, and at the close of a very enjoyable evening Mr. Binns, the general manager of the tramways, with a few appropriate remarks, presented prizes to the successful competitors of the tournaments.

**Liverpool.**—According to the Corporation auditor's report, it is expected that the contributions in aid of the rates during the current year from the electric supply and the tramways undertakings will be £10,000 and £32,000 respectively. Thus the general fund of the Corporation will receive a sum of £42,000 from those useful undertakings, and to that extent—it is equivalent to a rate of nearly 3d. in the £—the ratepayers are relieved. Last year the sum contributed by these two trading concerns was a little over £37,000, compared with £25,000 in 1902. It will be noticed, therefore, that the available surplus is annually increasing. This extra £5,000 comes very opportunely, for without it there would have been more than a possibility of an increase in the general rate.

**Additional Traffic Returns.**—Anglo-Argentine, £1,774 increase; Barcelona Ensanche y Gracia, £49 increase; Barcelona, £180 increase; Brisbane, £193 increase (month of December, £11,915, increase £371), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £14 increase (month of January, £14,055, increase £962); Calcutta, £641 decrease; Cape Town (month of December), receipts £18,088, expenditure £8 235; Isle of Thanet Electric, £33 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of December), receipts £47,600, expenses £27,400; Perth Electric, £163 increase (for the year 1903: receipts £62,097, expenses £34 871); Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**Newcastle.**—A poll is to be taken on the question of the proposed tramway extensions. These are: (1) a continuation of the Scotswood-road tramway across the Scotswood Bridge into Blaydon; (2) a tramway from Shields-road along Chillingham-road and Benton-road through Longbenton to Killingworth; (3) a line joining up the Scotswood-road and the Westgate-road tramways, *viâ* Gloucester-street, Wentworth-place, and Gloucester-road; (4) a line from the bottom of Stanhope-street along Barrack-road, Ponteland-road, and Nuns Moor-road to the Fenham Estate; (5) a line from the bottom of Grey-street to the quayside; (6) a line connecting the Shields-road tramway with the Jesmond-road tramway, *viâ* Ridley-street, Clarence-street, Portland-road, and Sandyford-road; (7) a continuation of the Jesmond-road tramway along Benton Bank to Benton-road. The Town Council on Wednesday approved the promotion of the Bill.

**Paris.**—A large number of tramway men are out on strike. Telegraphing on Monday night, a Paris correspondent says the strike on the Eastern Parisian tramway system still continues, not a single car leaving the depôts. The men held a meeting that morning and decided to refuse an offer made by the directors of the company that the justice of the peace of the Ninth Arrondissement should act as arbitrator. On the other hand, they requested M. Caron, vice-president of the Municipal Council, to undertake the duties of arbitrator, and he has consented to do so. M. Caron afterwards saw the directors of the company, who explained its position, and the reasons for the changes it had made and intended to maintain. This unsatisfactory result of M. Caron's intervention has been communicated to the men, and it is now decided that the managers of the company and the men's delegates shall meet before the justice of the peace.

**Wednesbury.**—At the last meeting of the Town Council the Mayor referred to a correspondence which had taken place with the town clerk of Walsall with regard to the inconvenience to the public generally which had resulted from the break in the through tramway service between the two towns, consequent upon the Walsall Corporation taking over a portion of the line. The town clerk of Walsall wrote that, as there appeared to be no probability of any arrangement being arrived at, further conferences would be useless. Consequently no blame attached to Wednesbury for the present inconvenience of the tramway service, the effect of which must be more serious to Walsall than to Wednesbury. Recently the tramway company had made their service all that could be desired, but he hoped it would yet be found possible for the through service to be restored. The Town Council have received the consent of the Board of Trade to the purchase of the tramway in Walsall-road from Windmill-street to the borough boundary at Wood Green. The Board of Trade are not prepared to sanction the purchase of the tramways from the Bull Stake, Darlaston, to James Bridge, or the portion of the Dudley line from the Dartmouth Arms to the junction with Great Western-street.

**Snowdon Light Railway.**—Colonel Boughey and Mr. Henry Allan Steward, Light Railway Commissioners, have held an enquiry at Beddgelert into an application for the extension of the present light railway from Snowdon (4½ miles away) on to Beddgelert. It is proposed to construct a light railway from Beddgelert to Portmadoc (seven miles away) and from Beddgelert to Gwynant (four miles away), whilst application has been made to the Commissioners to authorise a line from Gwynant to Bettws-y-coed (10 miles off). This district, except for the line from Snowdon to Dinas (a distance of 10 miles), is now without any railway. The proposed railways are to be worked by electricity, the scheme providing for the generation of electrical energy at a low cost by means of water power from lakes on Snowdon and in the neighbourhood of Conway. The engineers, Mr. Harper and Sir Douglas Fox, stated that one-fifth of the water power available would meet the requirements of the whole of the railway system. This was the first case in the British Isles where economic arrangements of this nature for generating electricity had been adopted. No opposition is offered, an undertaking being given to threatened opponents that the scenery at the Aberglaslyn Pass and Beddgelert's Grave would not be disturbed.

**Greetland.**—At the last meeting of the Town Council a letter was read from the Halifax Corporation stating that the powers for taking trams to West Vale had lapsed, but consideration would be given to the Council's request for the construction of a line prior to the next parliamentary application. A firm of solicitors wrote that they were approaching several district councils on behalf of a syndicate with a view to supplying them with electric light, power, and traction. As the powers of the Halifax Corporation to construct a line to West Vale had expired, probably arrangements might be come to for joining the districts of Halifax, West Vale, Elland, or Brighouse and Huddersfield, by a new tramway system. The district councils could take over the scheme in 14 or 21 years if desirable. The Clerk said it was true that the powers down Salterhebble-hill had lapsed, but the other powers in Greetland still existed. The Halifax Corporation had absolutely played with the District Council. He felt sure that if this company went to Parliament they would take no notice of Halifax after they had treated the Council in such a way. He suggested that the syndicate should be asked to try to get powers to Salterhebble-hill top. The best scheme would be to run through Brighouse, on to Elland, down to West Vale, and forward to Halifax. A resolution on these lines was carried.

**Berlin.**—The Berlin correspondent of the *Financial News* says that some time ago the Town Council decided to municipalise the services of the Berlin Electric Tramway Company, for which purpose the shares of that company had to be acquired at a premium of nearly 70 per cent. Messrs. Siemens and Halske on the other hand, who had the concession for the working of the lines, guaranteed interest of 5 per cent., which, in proportion to the amount actually paid for the shares, works out at only 3 per cent. Since then the operation has turned out a very bad investment for the city and an onerous contract for Messrs. Siemens and Halske. The city of Berlin usually has to pay for its loans 3½ per cent., losing consequently on its tramway shares about 30,000 marks per annum in interest, whilst the lessees of the working, according to the stipulations, had to contribute during the last year no less than 511,000 marks to make up the deficiency. But even this shortage will ultimately fall on the shoulders of the Berlin ratepayers; for the contract, which the city is free to break at the end of the

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present year, contains a clause to the effect that the amounts paid by Messrs. Siemens and Halske to complete the 5 per cent. interest are only to be considered as an advance, to be refunded with the repudiation of the contract. The city of Berlin will never see an improvement in its tramway speculations until it is in a position to acquire the General Berlin 'Bus Company. Then the "fat" lines will compensate the "meagre" ones.

**Pontypridd.**—A special meeting of the Electricity and Tramways Committee was held on Friday, when Mr. R. P. Wilson, the Council's engineer, attended to explain certain large amounts of money expended on the local tramway and electric lighting schemes. The first matter dealt with was the extra cost entailed in the erection of the generating station at Treforest, which Mr. Wilson had estimated at £9,541, but was now put down at £18,878. The difference was explained as having arisen owing to car-sheds being included in the present contract, which were not originally intended; the remainder was accounted for by alterations in the plans. It transpired that the work had been commenced without a contract being signed with Messrs. Hughes and Stirling, who were erecting the building. The clerk was instructed to prepare a contract, so that the Council might sign it at an early date. The next explanation was regarding the laying of the permanent way, which Mr. Wilson had estimated to cost £18,000. This was increased to £24,000 as a result of the Board of Trade having decided, owing to their recent experience and the opposition of the Glamorgan County Council, to alter their previous attitude as to the cheaper construction. They insisted on the Council putting in granite setts throughout the system. Wood paving for Taff-street was an extra amounting to £5,287, and other unavoidable extras brought the cost of the work, when completed, to an estimated total of £33,142. To meet this it will be necessary to apply to the Board of Trade for power to borrow money to cover the extra cost.

**London County Council.**—Among tramway matters dealt with at the usual weekly meeting of the London County Council on Tuesday was the reconstruction of the northern system for electrical working. The Highways Committee brought up a long report, in which they stated that they hope shortly to place before the Council definite suggestions for putting in hand the reconstruction of the first section to be dealt with. After tracing the steps which have already been taken in connection with the scheme the committee proceeded: "In accordance with a subsequent decision of the Council of Dec. 1, 1903, plans illustrating the Council's proposals were forwarded to the Board of Trade, the local authorities concerned, and the North Metropolitan Tramway Company. The plans are now under consideration by the Board of Trade, which has before it various suggestions from the local authorities as to the details of the system and the manner in which the work shall be carried out. A communication was sent to the North Metropolitan Tramways Company, asking whether they desired to submit any suggestions with regard to the manner in which the work should be carried out, in order to minimise as much as possible any inconvenience that might be caused thereby to the tramway, as well as to the general traffic, whilst the work is in progress. The company in a letter dated Jan. 27, 1904, has replied stating that 'until they are in possession of certain further information with regard to the working of the conduit system, they consider that the time has not arrived when they can with advantage to themselves or the Council make, as they are invited to do in your letter under reply, any suggestion to the Council in respect to the adoption of the underground system of electric traction on any of the Council's northern system of tramways now leased to the company.' The history of the Council's past negotiations with reference to this matter indicates clearly how extremely difficult it is to reconstruct the northern tramways if the company, the Council's lessees of the lines, are not prepared to accord full assistance and co-operation in the work. We feel, nevertheless, that the Council is under an imperative duty to do all within its power to expedite the adaptation of the lines for electrical traction, and we hope, as already stated, very shortly to submit, in accordance with the instructions which have been given to us from time to time, definite proposals to enable the reconstruction of the first section of the tramways to be commenced at an early date. With regard to the employment of overhead traction on portions of the lines, we have to report, after communicating with the 10 metropolitan borough councils concerned, that eight of the local authorities are opposed to the adoption of this system of traction, one authority has expressed qualified approval of the Council's proposals so far as it is affected, while no definite opinion has been expressed by the other local authority concerned. We have under consideration the question of the course which in the circumstances should be adopted in view of this expression of opinion as to the use of the overhead trolley system where it appears to be necessary, and we propose also to report at an early date with regard to the question of the reconstruction of the lines, over and above the 22¼ miles above referred to, on which it is proposed to instal the conduit system. In conclusion, we feel it right to state that we have given unceasing attention to this matter, the grave importance of which we have realised from the first, and we greatly regret that the difficulties referred to should have hindered a prompt and effective settlement of the question. We regard the electrification of this system as of pressing urgency, as it is not possible in any other way to so develop the tramways as to enable them to adequately meet the needs of the densely populated districts through which they pass. The Council will, however, see that with the company, on the one hand, refusing to assist in the installation of the conduit system of traction any of the lines which are the subject of the lease, and the borough councils, on the other hand, refusing, under the powers given to them by the Electrical Power Act of 1900, to have any other system within their districts than the conduit system, the difficulties which have faced us in dealing with this question have been of a most serious and complicated character." There was some discussion on this report between Mr. Beachcroft and Mr. J. Williams Benn, the chairman of the committee. The former detected in the report the implication that the company was responsible for the fact that the lines had not been electrified, and energetically defended the company from that charge, pointing out incidentally that the leasing of the lines had been beneficial to the public, inasmuch as, according to the auditor's report, the northern tram system revenue account had a surplus of £37,794, while the southern system account showed a deficiency of £2,251. Mr. Benn, however, held to it that the company had opposed the application of the conduit system to the lines leased by them. Another report submitted by the committee referred to the necessity for the erection of a sub-station at Streatham depôt in connection with the reconstruction of the cable section for electric traction, and it was recommended that the offer be accepted of Mr. Bertram Thomas to supply and erect for £580 a low-tension switchboard at the new sub-station. In a further report the Council were advised to approve an estimate of £1,500 for acquiring property for providing an improved entrance to Clapham car-shed. The report of the district auditor was submitted, in which the following passage in reference to the Council's tramways undertaking occurred: "The balance on the tramways appropriation account at the beginning of the year amounted to £45,182. At the end of the year the balance was £29,869. During the year £45,000, part of the surplus balance for year 1901-2, was carried from tramways account to the special county account in relief of rate, £8,100 being in respect of the southern system and £36,900 in respect of the northern system. At the end of the year the southern system revenue account had a deficiency of £2,251 and the northern system revenue account a surplus of £37,794. In consequence of the decision of the House of Lords on Feb. 7, 1902, that the Council had no legal power to run omnibuses, the horses, vehicles, and other property used in connection with the omnibus service have been disposed of. The original cost amounted to the sum of £29,266. 3s. 5d., and as the amount realised by the sales and set aside for sinking fund only amounted to £23,820. 17s. 5d., there is a sum of £5,445. 6s. in respect of the omnibus service capital outlay now included in the debt outstanding on tramways account. I understand that arrangements will shortly be made to reduce this debt by the sum in question."

## LIGHTING AND GENERAL.

**Wednesbury.**—The Town Council have concluded a loan of £11,000 for electricity supply purposes.

**Poplar.**—The Council have decided to petition against the East London and Lower Thames Electric Power Bill.

**Cheshunt.**—The electric supply company have agreed to commence operations within three years from Sept. 29 last.

**Kirkcaldy.**—We note that consumers of the electric light are increasing steadily in number, 119 being now on the list.

**Long Eaton.**—New plant to the cost of £2,346 has been ordered for the extension of the Urban District Council's electric lighting.

**Brierley Hill.**—The Board of Trade will defer the consideration of the revoking of the Council's Electric Lighting Order, 1900, for one year.

**Mafeking.**—The Town Council are consulting Mr. J. Mordy Lambe, electrical engineer, with a view towards formulating an electric light scheme.

**Tynemouth.**—We are informed that the vacancy at the electricity works, North Shields, for a mains assistant, recently advertised in our columns, has now been filled.

**New Branch.**—The Hart Accumulator Company have decided to open a branch office at Prince's-chambers, Corporation-street, Birmingham, in charge of Mr. F. R. Hill.

**Gainsborough.**—The Urban District Council are applying for a provisional order for power to construct an electric lighting station and to lay electric mains along the streets.

**Bexhill.**—During the counting of the votes in connection with the Bexhill Improvement Bill at the town hall on Saturday night the electric light failed, but lighting was resumed within an hour.

**Broxburn and Uphall.**—A vote of ratepayers of Broxburn and Uphall is to be held in connection with the decision of Bathgate District Committee to light Broxburn and Uphall by electricity.

**Newcastle.**—The Council have agreed to purchase a new generating set at the price of £4,400. This set is already in use, having been accepted in an emergency on hire with the option of purchase within a year.

**Wisbech.**—At the last Town Council meeting the report of the electrical engineers on the subject of electrical lighting in the borough was received. Mr. Robert Hammond was present, and explained the scheme.

**Bray.**—At the last Urban District Council meeting it was proposed that Mr. J. McCormick continue in the chair of the Electric Light Committee. Mr. McCormick not desiring to hold this office any longer, Mr. Burke was elected.

**Aston Manor.**—The resident engineer has been instructed, in conjunction with the borough surveyor, to prepare plans, etc., for the extension of the power station and for the provision of a 750-kw. generating machine and appliances.

**Todmorden.**—The electricity scheme for the town is estimated to cost £12,500, including £2,000 allowed for contingencies. Nearly half that amount has already been spent, and tenders for the necessary buildings, etc., are shortly to be invited.

**Beckenham.**—The Blackheath and Greenwich Company intend to lay cables under the Crystal Palace and District Electric Lighting Orders, 1890 and 1894, in a small piece of the Beckenham parish which the Beckenham Council are about to take over.

**Portishead (Somerset).** — The Urban District Council have consented to the application of the Western Electric Distributing

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Corporation, Limited, for a provisional order to supply electricity for public and private purposes within their district.

**Hackney.**—The Council have decided to petition against the East London Lower Thames Electric Power Bill of 1904. The National Electric Construction Company have obtained orders to wire a number of new houses in Millfields-road, and a main is to be laid at a cost of £85.

**Brompton and Kensington Electricity Supply Co.**—The directors recommend a final dividend on the ordinary shares at the rate of 11 per cent. per annum for the half-year ended Dec. 31 last, making (with the interim dividend at the rate of 9 per cent. per annum paid in August) 10 per cent. for the year.

**Durham.**—The County Council have decided to object to the provisional orders under the Electric Lighting Acts in respect of (1) Southwick-on-Wear urban district and Sunderland and Houghton rural districts, and (2) Houghton-le-Spring, Hetton-le-Hole, and Seaham Harbour urban districts and Easington rural district.

**Hampstead.**—It is stated that since the introduction of the maximum demand indicator the cost of the electric light consumed in the workhouse during the last six months shows a saving of £51 as compared with the cost of the light in the corresponding six months in 1902, although there had been no reduction in the number of lights.

**Chelsea Electricity Supply Co.**—Subject to final audit of the accounts, the directors have decided to recommend to the shareholders in general meeting a dividend on the ordinary shares at the rate of 7 per cent. per annum for the half-year to Dec 31, 1903, making a total dividend of 5½ per cent. for the year 1903, carrying forward about £1,100.

**Birtley.**—The Chester-le Street Rural District Council have been asked by the Birtley Co-operative Society to consent to the society approaching the Board of Trade for an electric lighting provisional order for public and private purposes for the township of Birtley. We understand that the matter will come shortly before the Highways Committee.

**Lindsey.**—The County Council will oppose the Lincolnshire Electric Powers Bill, with a view to negotiation for the introduction of clauses, and the matter has been referred to the Highways Committee. The company propose to establish at Market Rasen an electric generating station for the distribution of power in Lindsey and the adjoining counties.

**Brighton.**—The Corporation desire to extend their electric lighting at Rottingdean, and the Rural District Council have informed them that they would give permission to exercise their power in a portion of the parishes of Rottingdean and Ovingdean if the Corporation were prepared to meet them as to the drainage and the protection of the local electric lighting company.

**Derby.**—The Town Council have received sanction to the borrowing of £29,900 for electric lighting purposes. The Incorporated Municipal Electrical Association have decided to hold their ninth annual convention at Derby on June 29 and 30 and July 1 and 2, 1904, and the Electric Lighting Committee are making all necessary arrangements for the holding of such convention.

**"Central-Station Directory."**—Our attention has been drawn to a paragraph on p. 301 in the above publication, where, under the heading of "St. Helens," it is stated that the St. Helens Cable Company's diatrine cables are used in that town. As Messrs. W. T. Glover and Co., Limited, are the sole manufacturers of diatrine cables, that name ought to be substituted instead, and we hasten to give publicity to this correction.

**Newbury.**—The Urban Electric Supply Company yesterday started their works at Newbury for the supply of electricity for lighting and power purposes. The Newbury Corporation originally secured the electric lighting order from the Board of Trade, but, being the owners of the borough gas undertaking, they allowed the matter to remain in abeyance, and the work has now been taken up by the Urban Electric Supply Company.

**Alnwick.**—The Northern Electric Lighting Company, having acquired a site at Amble, and having secured a grant from the Government authorities, will presently commence to erect a power station to supply the requirements of Amble and district. Warkworth will be included if 100 subscribers can be found there. The question of street-lighting as a natural consequence will be coming once again before the public here.

**Dover.**—The Council have adopted the surveyor's report with regard to the National Telephone Company's laying of underground wires in the streets. He stated that the company had agreed to lay the mains in some cases in the road, and to keep at least 2ft. clear of the electric light cable. He recommended that the work should be allowed on condition that a large scale plan showing the position of the mains should be submitted and approved.

**Post Office Telephones.**—The Post Office authorities have already opened nine exchanges in London, and 15 000 subscribers have been connected since the central exchange was opened in Doctor's Commons two years ago. At present ducts are being laid for the exchange at Hampstead, and when that is opened the work which the late Mr Hanbury undertook when Postmaster-General will be complete, though further extensions are already contemplated.

**Liverpool.**—At Wednesday's meeting Mr. A. B. Holmes, now consulting electrical engineer to the Council, presented his annual report, showing that the output of electric energy had increased from 1,452,511 units in 1896 to 26,010,071 in 1903. The increase of 1903 over 1902 was 17 per cent. for lighting, 60 per cent. for power, and 7¼ per cent. for tramways. On Jan. 1, 1904, 525,812 lamps of 8 c.p. were connected to the mains, or increase of about 34,000 during the 12 months. Motors increased from 827, with an aggregate horse-power of 2,877 to 1,111, with 4,234 h.p.

**Middlesbrough.**—The engineer (Mr. H. M. Taylor) in his last report states that the number of units sold during the month was 84.000, as compared with 69,000 in the corresponding month of last year. The revenue was £1,151, compared with £1,022, and the costs £363, or 1·04d. per unit, or £321, or 1·12d. per unit. The total profit was £788 11s. The number of lights applied for and connected up to date was 44,258, against 33,506. Application is to be made for sanction to a loan of £20,000 for extension purposes, instead of £15,000 as previously agreed upon.

**Lincolnshire and Yorkshire Electric Power Bill.**—At a meeting at York on Wednesday of representatives of the local authorities of York, Hull, Scarborough, Beverley, Ripon, Harrogate, Bridlington, Filey, and Hessle, a resolution was adopted to the effect that it is desirable that the above Bill should be opposed by all the local authorities affected, each authority to deposit a separate petition, their interests not being identical, and that the several authorities should unite as far as possible in their opposition and in obtaining clauses for the protection of their interests.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Commercial Cable Company's further issue of £21.979 sterling 500-year 4 per cent. debenture stock, redeemable, and London United Tramways (1901), Limited, further issue of 17.500 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 82,501 to 100,000. Application has been made to the committee to allow Perth Electric Tramways, Limited, further issue of £18,287 5 per cent. first mortgage debenture stock to be quoted in the official list.

**St. Annes (Lancs.).**—The electric light cable is to be extended to Sir John Thursby's home, provided he contributes £400 towards the cost of extension. The proposed extension of the electric light works and plant is to be carried out. The electrical engineer in his last report shows that the units sold to Dec. 31 were 50,525, against 21,824 the previous year. The number of consumers was 223, against 153 a year ago. Seven new applications had been received. Terms are to be arranged with Messrs. England, Winstanley, and England for preparing plans, etc., in connection with the extension of the electric lighting works.

**Acton.**—The question of a combined dust destructor and electricity works *versus* separate systems is not yet decided, notwithstanding the District Council negotiations with the Metropolitan Electricity Supply Company for the supply of electrical power in bulk. The North Metropolitan Electricity Supply Company have, it is stated, offered better terms than the Metropolitan Electricity Supply Company for the supply of electricity in bulk. The supporters of the combined system of dust destructor and electricity works last week secured the appointment of a deputation which proceeded to visit the combined works of the Fulham Borough Council.

**Anglo-American Telegraph Co.**—The directors, after placing £12,000 to the renewal fund for the half-year, recommend balance dividends of 16s. per cent. on the ordinary consolidated stock, and of £1 10s per cent. on the preferred stock for the year ended Dec. 31, and a first and final dividend of 2s. per cent. on the deferred stock for the year 1903, payable on Feb. 13, less tax. After paying the dividends there will be a balance of about £1,128 to be carried forward. The above dividends, together with those already paid, will amount to £3. 1s. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and 2s. per cent. on the deferred stock for the year 1903.

**Islington.**—The Lighting Committee will report at to-night's Council meeting as follows: "We have, pursuant to Council reference of Aug. 7 last, reconsidered our report of July 22, 1903, recommending that the charge for public arc lamps be increased to the exact cost to the undertaking of production and maintenance, and are of opinion that, having regard to the long hours during which electricity is consumed for public arc lighting, and to the fact that we propose, with the approval of the Council, to transfer from the electricity account to the general rate for the next half-year an amount of £1,200 to provide for carbons and labour, the charge of 3½d. per unit is a reasonable one, and should be adhered to."

**St. Marylebone.**—It is reported that the Mayor of St. Marylebone has declined to give effect to the resolution mentioned in another column—viz., to write a letter to the ratepayers recommending them on behalf of the Council to give their consent at the poll on Monday next to the Bill which is being promoted by the Council. At the meeting of the Council last night the following motion by Mr. E. White, L.C.C., was discussed: "That it be referred to the Legal and Parliamentary Committee to prepare and submit to the Council a Bill to be introduced in the next session of Parliament to relieve the borough of St. Marylebone from the obligation of purchasing the St. Marylebone portion of the Metropolitan Electric Supply Company's undertaking upon equitable terms." It is proposed that Mr. Boulnois, M.P., be asked to introduce the Bill, and the President of the Local Government Board be requested to assist in passing the Bill into law.

**Whitby.**—The report on the electric light of the town presented at the meeting of the Urban District Council on Tuesday night shows a considerably increased consumption, mainly due to the extension of street-lighting. Additional facilities are shortly to be provided for private business. During the year 1,332 lamps were applied for. The amount of capital expended up to Dec. 31, 1903, was £26,240 out of £28.000 authorised, and the amount of capital repaid to date was £1.122. It was further stated that the loss on working during 1902 amounted to £433, but this had been turned into a profit of £56 during 1903. The contemplated use of electricity in pumping at the sewage outfall works, the increase in the public lighting, and the addition of private consumers would in the future have the effect of considerably reducing the works cost of production, and provided increased profit year by year. The number of customers last year was 98; now the number is 164. The number of public lamps lit by electricity last year was 36, and now there are 160.

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**Dundee.**—It is reported that Mr. George Balfour has been appointed to act for Messrs. Handcock and Dykes, the consulting engineers in connection with the proposed new electric scheme for Dundee. We have already referred to the scheme, under which it is proposed to erect a generating station, at a cost of about £250,000, at the Stannergate, and run the necessary cables through the streets to the works. A halfpenny per unit is provisionally stated as the price.

**Hornsey.**—At the last Borough Council meeting the Highways Committee reported the receipt of a further letter from the Postmaster-General in reply to the Council's letter of Jan. 1, stating that it was feared it would not be practicable to begin the work of constructing and equipping a telephone exchange at Crouch End before the spring; but the work would be expedited as much as possible, with a view to giving subscribers exchange facilities at the earliest possible moment.

**Agencies.**—We are informed that Messrs. Royce, Limited, of Manchester, makers of the "Royce" dynamos, electric motors, cranes, switches, etc., have appointed Mr. E. C. Amos, M.I.Mech.E., 20, Bucklersbury, E.C., sole representative for the London district, from whom all particulars of their specialities can be obtained. The Paul Heater and Condenser Company, 63, Queen Victoria-street, London, E.C., and Liverpool, have appointed Messrs. Herbert and Gilchrist, Wellington-chambers, 146, West Regent-street, Glasgow, their agents for that district. The London office is now under the management of one of the firm's directors, Mr. R. H. Haylock, who was for many years chief engineer to the Sturtevant Engineering Company.

**Portsmouth Telephones.**—The Local Government Board having disallowed a sum of £3,000 out of the £12,000 asked for by the Telephone Committee, a sub-committee, consisting of the chairman (Councillor Dittman), vice-chairman (Councillor H. R. Pink), Alderman T. Scott Foster, and Councillor G. W. Edmonds, has been appointed to consider the letter and bring up a report to the full committee at as early a date as possible. Should they deem it necessary to interview the Local Government Board, the sub-committee has received full power to proceed to London as a deputation. The revenue for nine months ending Dec. 31 last shows a surplus on the working amounting to £768. 19s. 1d., after meeting all legitimate calls on revenue, including principal and interest.

**London Gazette.**—The first meeting in the estate of Gardener Bros. and Co., electrical engineers, Horninglow-street, Burton-on-Trent, Staffordshire, will be held at 11.30 a.m. on Feb. 10, at 47, Full-street, Derby. Feb. 14 is the last day for receiving proofs of claims in the estate of Edwin Ward (trading as E. Ward and Co.), plumber and electrician, 38, Osbourne-road, Southampton, lately carrying on business at 108, Bevois-valley, 47, Lodge-road, and 38, Osbourne-road, Southampton. Mr. W. J. F. Hunt, Midland Bank-chambers, High-street, is the official receiver. At a general meeting of the Electric Traction Company, Limited, the resolution was passed that the company be wound up voluntarily. Mr. William Barclay Peat, 3, Lothbury, London, is the liquidator.

**Smoke Nuisance.**—The *Birmingham Daily Post* prints the following letter: "Sir,—My attention has been called to several letters that have appeared recently in the Press with reference to the quantity of smoke that has been issuing from the chimneys at the electricity works in Water-street. I have to inform you that the smoke in question is produced by some new boilers that have recently been installed. Owing to the necessity of providing for the heavy load that has to be met at this time of the year, we were obliged to put these boilers to work before they had been fitted with proper smoke-consuming appliances. These appliances are, however, now well in hand, and will be completed almost immediately.—R. A. CHATTOCK, City Electrical Engineer, Electric Supply Department, 14, Dale-end."

**Cheshire Electricity and Power-Gas Co.**—The area proposed to be covered by this company's operations is to include the whole of Cheshire, within which it is intended to supply electricity in bulk and to manufacture and distribute power gas for the purposes of motive power and heating, but not for illumination. The price to be charged for power gas is not to exceed 3d. per 1,000 cubic feet if over 4,000,000 cubic feet are consumed per quarter, or 4d. per 1,000 cubic feet if less than that quantity is taken. The price for electricity will range from ½d. to 3d. per unit, according to the quantity required. The capital of the company is to be £1,000,000. It is proposed to issue debenture stock to the extent of £333,000. The Bill contains express provisions that the granting of this Act shall not be construed as entitling the company to any monopoly or exclusive right to supply power gas within the county of Cheshire, but powers are sought to acquire "by agreement" any authorised electric lighting undertaking within the company's area of supply.

**York.**—The Electric Lighting Committee reported on Monday with regard to the proposed scheme of lighting the city by electricity that they consider that if a scheme be adopted it would be better for a portion of the city to be dealt with at first, the remainder to stand over until the financial results have been ascertained. The committee consider that the Fulford district would be a suitable one in which to commence the lighting, and they have instructed the electrical engineer to prepare a plan of the streets proposed to be lighted, and to submit a report on the cost. The consideration of the Bill promoted by a company which intend to supply electricity in Lincolnshire and a part of Yorkshire has been referred to the Finance Committee, with power, if necessary, to join other authorities in opposing it. A very satisfactory report for the nine months has been received by the Electric Lighting Committee, showing that during a period of nine months they had received £6,051, and the cost of producing the electricity which had earned that amount had been £3,290, a profit of over £2,700 towards sinking fund and interest.

**Hull.**—The electrical engineer (Mr. H. Bell) has just submitted his estimate of expenditure for the year ending March, 1905, in which he says that the capital expenditure of £10,000, for which it was resolved to obtain borrowing powers, was estimated as being necessary to provide for plant, mains, etc., sufficient to deal with the load estimated for next winter. It would be necessary to set aside a sum of £1,500 to provide for modifications to the old high-tension switchgear. Coal and other fuel was estimated at £10,200, as compared with £8,750 last year; wages (generation), £2,200; wages (sub-stations and mains), £950; engines and boilers, £750; other machinery, £1,000; salaries, £1,500; rents, rates, and taxes, £3,320, as compared with £1,750 last year; interest, £10,140; sinking fund, £8,270; meters and switchboard depreciation, £2,900; the total with other items, and including balance of £2,061, amounting to £45,491, as against £41,789 last year. On the revenue account it is estimated that the sale of current per meters will be £44,148, as compared with £40,364 last year; public lighting, £343, as against £324: the total, including £1,000 for the rental of the meters, being £45,491, as compared with £41,789 last year.

**London County Council.**—On Tuesday it was agreed to lend the Hackney Borough Council £7,406 for electric light installation. Notices under Electric Lighting Acts and Orders were agreed to from the Blackheath and Greenwich District Electric Light Company to build transformer boxes at the corner of Shooter's Hill-road and Eastbrook-road and in Watling-street, and to lay low-tension mains across Mayow-road and along Queenswood-road, and in Lee High-road and along portions of Eastdown-park and Dermondy-road; from the Brompton and Kensington Electricity Supply Company to lay mains along a portion of Redcliffe-square; from the Charing Cross and Strand Electricity Supply Corporation to lay mains across Macklin-street, and along portions of Goldsmith-street, Smart's-buildings, High Holborn, Museum-street, and Hyde-street, and to build boxes in Macklin-street, Smart's-buildings, at the junction of Hyde-street and Museum-street, and in New Oxford-street; and from the County of London and Brush Provincial Electric Lighting Company to lay high and low tension mains along a portion of Allfarthing-lane.

**Newport (Mon.).**—An enquiry was held on Friday into an application of the Corporation for sanction to borrow £60,500 to meet the expenses of the electric light and power undertaking. The Town Clerk (Mr. A. A. Newman) said the application was to borrow two sums, £15,500 representing ordinary necessities of the undertaking due to extensions for light and power, and £45,000 in respect of the increased expenditure upon the power station. Mr. H. Collings Bishop, the electrical engineer, said that the progress of the undertaking was indicated by the following figures, comparing the state of affairs in 1895 and last year (the year 1902-3); in 1895 the capital was £34,562—last year it was £177,470 (including the present applications); the number of consumers in 1895 was 79—last year 705; the arc lights were about the same; lamps connected in 1895 numbered 7,200—last year 53,000, and up to date another 10,000 or 12,000 had been added; the total revenue in 1895 was £1,499—last year £12,485, and in the present year it was estimated to reach close upon £20,000; the total cost in the first year was £1,225—last year £4,902. In the first four years there was a deficit; in the fifth year there was a profit of about £403. Then came the years 1900 and 1901, when coal went up to fabulous prices, which caused a heavy deficit. Since that time there had been a profit on every year, and he was able to say that the result for the present year, including the power station and the old station, would be on the right side. Mr. Parry, the assistant to Mr. Parshall, the engineer who carried out the present station, also gave evidence.

**Fulham.**—A trial is to be made with 25 incandescent electric lamps and 25 electric Nernst lamps in place of the present street gas lamps. In 40 cases the present lanterns will be utilised. The total estimated cost is £200. The borough electrical engineer has been in negotiation for some time past with the directors of the Granville Theatre of Varieties with regard to obtaining the supply of electric current. He finds that, taking into account the number of lights used and the consumption of energy in the past, the charge for current would work out according to the Council's present scale at about 3½d. per unit. The directors are willing to enter into an agreement to take the whole supply of current from the Council's mains for a term of seven years, and to guarantee a minimum consumption of £450 per annum, provided the Council agrees to a charge of 3d. per unit. The directors are further prepared to agree to the use of their engine-room for the purposes of a sub-station upon payment of a rent of £25 per annum. The Council have adjourned for further consideration the question of using the engine-room for a sub-station, and have recommended that the offer of the directors of the Granville Theatre of Varieties to take the whole of their electric current from the Council's mains for a term of seven years at 3d. per unit, and to guarantee during that period a minimum consumption equivalent to £450 per annum, be accepted subject to their entering into a satisfactory agreement embodying this arrangement and safeguarding the Council's interests. The size of the Munster-road sub-station is to be increased at an estimated cost of £65.

**Nottingham.**—According to the last report of the Joint (Health and Electricity) Committee, the destructors and the electricity generating plant in the Eastcroft are an undoubted success. The committee add that it is impossible to come to a proper conclusion as to the amount of electricity which may be fairly expected to be obtained from the electricity generating plant, and the costs thereof, until the committee have had the experience of a full year's working. The committee, however, are convinced that whatever amount of electricity may be obtained from this source of supply, it will not do away with the necessity for the raising of the additional capital required for completing the equipment of the first section of the St. Ann's electricity station, mentioned in the report of the Electricity Committee presented to the Council at the last meeting. A joint report of the city engineer (Mr. Arthur Brown) and the electrical engineer (Mr. Herbert Talbot), appended, states that the Eastcroft destructor was practically completed, as regards the structure, in March, 1903, but a start could not be made with the actual working of the destructor until July. The plant at the Eastcroft consists of a 12-cell destructor and Babcock and

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Wilcox water-tube boilers. At the commencement, the week ending July 29, 1903, 386 tons of material produced 6,191 units, or 16 units per ton; in September, one week realised 10,917 units from 468 tons of material, showing 23·30 units per ton, and the best record in September was on Friday, the 25th, when 2,003 units were obtained from 75 tons 9cwt. of material, realising 26·54 units per ton; in October there should, of course, have been a considerable increase in calorific value of the material. In consequence, however, of the very mild weather this was not the case, and the exceedingly wet weather was also against good results being obtained. However, the results have been improving week by week, and during the week ending Jan. 13 this year 27,641 units were obtained from 517·5 tons of refuse, giving 53·4 units per ton. The record day up to the present was on Jan. 12, when 4,878 units were obtained from 75 tons 6cwt. 2qr., showing 64·75 units per ton. The electricity plant consists of two 240-i.h.p. Willans and Robinson's central-valve engines, coupled to Siemens generators, together with switchboard, etc. Up to Oct. 27 only one engine was running, and at times more steam was being made than this engine could take. From that time up to the present two engines have been running, one on the lighting main and one on the traction main, but when the second engine was shut down only half the steam made by the destructor was utilised. The Electricity Committee have ordered a third engine, which will be delivered in March and which will be used as a stand-by. With the three engines there is no doubt that much better results will be shown than those already obtained, as in case of an engine having to be stopped for repairs or examination, the stand-by can be used and the whole of the steam made be utilised. Both the destructor and the electricity plant are working satisfactorily. The Council have passed the second reading of the report of the Electricity Committee, which approved the raising of additional capital amounting to £100 000 required for completing the equipment of the first section of the electricity station on St. Ann's Well-road, and extending mains, services, etc. The resolution further stated that application should be made to the Local Government Board for their consent to the borrowing of the sum. The spending of the money would extend over three years, but £43,000 or £44,000 would be required during the next few months.

**St. Marylebone.**—At the special meeting of the Borough Council on Monday, the Mayor (the Rev. H. Russell Wakefield) read the following report from the deputation to the company: "We have to report that we have had two meetings with representatives of the company since our appointment by the Council on Jan. 25, 1904. The Metropolitan Electric Supply Company's previous suggestions 'for facilitating the completion of the purchase' were contained in the two letters submitted to the Council on the 21st ult., and recorded on the minutes. The company has now expressed willingness to take bonds bearing interest at 3¾ per cent. in payment of the award of £1,212,000, and on the new capital expenditure to the end of this year, roughly estimated at £150,000. This includes the £60,000 cheque paid by order of the Court on account of capital expenditure incurred since the date of purchase, but not any of the legal expenses, amounting to nearly another £60,000. The company is prepared to pay as rent interest at 3¾ per cent. on these bonds and to pay the whole expense of their issue, and to contribute as additional rent £7,000 per annum, which would go as a contribution towards the Council's sinking fund; and, further, that from January, 1913, the company would give the Borough Council 10 per cent. of their total net profits after deducting 4½ per cent. on their total capital employed and 1½ per cent. for depreciation. The lease to the company would be for 27 years, or a shorter time if competition were allowed by Parliament and the company required us to release them. They would continue for two years from the date of their notice to determine, and on such determination the borough would be obliged to take current in bulk from the company up to 1931 to supplement any deficiency which could not be made by our own generating stations. The price would be the same as is now agreed—namely, 'by agreement, if possible, and, if not, by arbitration of the Board of Trade.' In the event of the determination of the lease, or at the expiration of the lease, the borough would not be liable to reimburse the company for capital expenditure outside the borough area, but only for the capital expenditure within the area. This capital expenditure within the area would be paid by the borough either at the valuation or at a fixed depreciation of 1½ per cent. per annum.—H. RUSSELL WAKEFIELD, Mayor; ERNEST R. DEBENHAM, chairman of the Electric Supply Committee; G. J. ELGOOD; A. FORBES SIEVEKING. Feb. 1, 1904." The Electric Supply Committee reported on the above report as follows: "Feb. 1, 1904. We have further considered the present position of the St. Marylebone Electric Lighting Bill, 1904, and the offers of the Metropolitan Electric Supply Company and the General Electric Company, Limited, and we recommend that the Council resolve to undertake that, if the poll of electors with reference to the promotion of the St. Marylebone Electric Lighting Bill shall decide in favour of the promotion of that Bill, the Council will, before attempting to work the undertaking themselves, take all necessary steps and will use their best endeavours either (*a*) to make some satisfactory arrangement with the Metropolitan Electric Supply Company, Limited, or (*b*) to enter into an agreement with a company of sufficient financial ability to temporarily or permanently work the undertaking on behalf of the Council, in accordance with the principles of the letter from the General Electric Company, Limited, to the Council of Jan. 19, 1904. That inasmuch as it is necessary to continue the promotion of the Bill for the purpose of enabling the Council to negotiate terms with the Metropolitan Electric Supply Company or to carry out an arrangement on the principle of the offer of the General Electric Company, Limited, the Council strongly recommend that the Bill be proceeded with.—ERNEST R. DEBENHAM, chairman." The Mayor said the negotiations were not exhausted, but very considerable concessions had been made by the company. After discussion, the recommendation of the Electric Supply Committee was put to the meeting in the form of a resolution, and carried by 34 to 9.

## PROVISIONAL PATENTS, 1904.

JAN. 25.

1846. **Improvements in electrical switches.** George Eason, 52, Queen Victoria-street, London.

1847. **Improvement in the manufacture of electric cables and the like.** John Stratton and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

1848. **Improvements in the covering of electric cables.** Edwin Shirley Seymour and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

1851. **Improvements in or relating to apparatus for obtaining a flow of current in one direction from an alternating source.** Peter Cooper Hewitt, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 3, 1903, being date of application in United States.) (Complete specification.)

1860. **Improvements in the working of an electric railway or tramway service.** Frederick Richard Boardman, 10, Southwark Bridge-road, London.

1863. **An improved electric incandescent lampholder and combined switch.** Joseph Smith Cunnington, 93, St. Martin's-lane, London.

1878. **Arc lamp.** Tito Livio Carbon, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Aug. 22, 1903, being date of application in Germany.) (Complete specification.)

1884. **Improvements in electric cranes and the like.** Stothert and Pitt, Limited, and Walter Pitt, 24, Southampton-buildings, Chancery-lane, London.

JAN. 26.

1952. **An improved automatic device for cutting off the electric current when a line wire breaks.** Frederick Parker, 5, Hatton-garden, London.

1964. **Improvements in and relating to apparatus for the production and application of electric oscillations.** Alexander William Sharman, 13, Broderick-road, Upper Tooting, London.

1968. **Improvements in motor-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

1973. **Improvements in electric telegraph systems.** Charles Adams-Randall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 27.

2055. **Improvements in or relating to trolley pulleys and trolley heads for overhead electric traction.** William Cowell and Archibald Cowell, 254, Colne-road, Burnley.

2063. **Improvements in static electrical machines for lighting gas, ether, etc.** Henry Nehmer, 36, Clifton-street, Finsbury-square, London.

2066. **Improvements in and relating to electric receiving apparatus for telegraphic and other purposes.** James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

2093. **Improvements in systems of excitation for induction machines.** Maurice Leblanc, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 28, 1903, being date of application in United States.) (Complete specification.)

2096. **Improvements in or relating to apparatus for use in the distribution of alternating currents.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

JAN. 28.

2141. **Improvements in the means or appliances for applying electricity and light for curative purposes.** Arthur George Witherby, 1, Great St. James-street, Bedford-row, London.

2152. **Improvements in electrolytic cells.** Julius Raschen, George Christopher Clayton, and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

JAN. 29.

2202. **Improvements relating to electric tramways.** Joseph Wilkinson and Sydney Weiss Mitchell, 18, Southampton-buildings, Chancery-lane, London.

2230. **Improvements in electric arc lamps.** August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford.

2243. **Improvements in or relating to trolleys for collecting electricity.** Andrew Thompson, 111, Hatton-garden, London.

2273. **Improved manufacture of magnetic material.** Robert Abbott Hadfield, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 12, 1903, being date of application in United States.) (Complete specification.)

2274. **Improvements in telegraphic transmitters.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (James Harvey Pierce, United States.) (Complete specification.)

2277. **An improved electric low-water alarm for boilers and the like.** John Henry Sugrue, 4, South-street, Finsbury, London.

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**2249. An improved electric fire-alarm.** Harry Simmins, 23, Coleman-street, London.

**2279. Improvements in trolley heads.** Frederick Howe Hadfield, Clun House, Surrey-street, Strand, London.

**2282. Improvments in or relating to electric light fittings.** Ernest Roberts and Robert Mitchell, 45, Southampton-buildings, Chancery-lane, London.

**2285. Apparatus for polarisation of Hertzian waves.** Francis James Green, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 29, 1903, being date of application in United States.) (Complete specification.)

**2288. Improvements in or connected with electric signalling apparatus for tramways and railways.** Reginald Page Wilson and Arthur Grotjan Marshall, Norfolk House, Norfolk-street, Strand, London.

JAN. 30.

**2307. Improvements in electric arc lamps.** Veritys, Limited, and John William Ewart, 11, Burlington-chambers, New-street, Birmingham.

**2315. An improved electrical terminal attachment device.** John Colin MacIver and Arthur Frederic Guy, 10, St. George's-crescent, Liverpool.

**2344. Improvements in electro-mechanical regulators.** Egmont Charles Hoegerstaedt and Robert Graham Fothergill, 36, Wellington-road, Old Charlton, Kent.

**2347. An improved composition for electrical conduits.** Robert Starke, 195, Upper Thames-street, London.

**2361. Improvements in and relating to emergency governing devices.** The British Thomson-Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

**2362. Improvements in and relating to coil windings for electrical apparatus.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**2363. Improvements in automatic switches or circuit breakers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**2373. Improvements relating to safety apparatus in connection with overhead electrical wires.** Edward Wakley and William Harris, 322, High Holborn, London.

**2380. Device for protecting a wire branch which depends from an overhead electric wire.** Olympi Albert Rosen, 77, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 18, 1904.*

1902.

**23289. Galvanic dry cell.** Schauli and Lorwenstein.

1903.

**1717. Method of drying materials which clog or matt under compression and other substances and materials, either by hot air or by the use of electrical currents.** Doull.

**2053a. Electro-capillary relays and the like.** Armstrong and Orling. (Date claimed under Patents Rule 9, Jan. 28, 1903.)

**2112. Electrostatic apparatus for relay and other recording and operating purposes.** Rung and La Cour.

**2162. Electric ignition apparatus.** Lodge and Lodge.

**2192. Electrically-propelled tramcars.** Raworth.

**2696. Incandescent electric lamps and switches.** Sweetser.

**3164. Electric distribution and switchboards therefor.** Parry.

**4346. Insulated electric conductors and in methods of manufacturing the same.** Carolan. (General Electric Company.)

**4675. Apparatus for forms for use in the construction of conduits and pockets or boxes specially applicable as containers for the underground conductors of electric traction systems.** J. G. White and Co., Limited, and Fisher.

**4732. Reversing mechanism for dynamo-electric machinery.** Leitner and Lucas.

**5346. Magnetic compasses.** Whyte.

**6133. Moving-coil galvanometers.** Paul.

**6282. Apparatus for automatically extinguishing lights, whether gas burners or electric lights, or the like, after they had burnt a given length of time.** Abel. (Compagnie Anon. Continentale pour la Fabrication des Compteurs de Gaz et autres Appareils.)

**6434. Electrical switches known as two-way tumbler switches.** Sperryn and Wood.

**6513. Operation and regulation of electric motors.** Vickers, Sons, and Maxim, Limited, and Williamson.

**6528. Electrical insulators.** Lea.

**6735. Candle fittings of electric incandescent lamps.** O'Connell.

**6951. Alternating electrical current meters.** Bloxam. (Luxsche Industriewerke A.G.)

**7286. Holder for electric light shades.** Simmonds.

**7842. Means for connecting together the sections of drain-cleaning tools, chimney-cleaning brushes, pulling through rods for electrical conduits, and for certain other purposes.** Davis, Davis, and Davis.

**7842. Electric arc lamp.** Bureau.

**8605. Electrically-driven machines for sawing logs and the like.** Kottmann.

**9390. Manufacture of accumulator plates or grids.** Von der Poppenburg.

**17185. Field magnets for alternating-current motors.** Finzi and Korrodi.

**18841. Selective systems for electrical communication.** Reed.

**20916. Electric current regulators.** Page. (International Electric Controller Company.)

**20921. Insulated electric conductors and method of producing the same.** Heany.

**21090. Electric meters.** Boult (Turner.)

**21466. Electric arc lamps.** Jeannot and Bermudez. (Date applied for under International Convention, Sept. 12, 1903.)

**23161. Electrically-heated handles and hand-wheels for motorcars and for other purposes.** Fliess.

**25389. Magneto-electric machines.** Bloxam. (Schoeller.)

**26058. High-voltage spark arresters.** Johnson. (Elektricitäts Aktiengesellschaft vorm W. Lahmeyer und Co.)

**26261. Magneto-electric igniting devices for internal-combustion engines.** Bailly.

**28399 Magnetic ore separators.** Snyder.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-⅝ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅜ xd |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 4-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ¾-1¼ |
| — Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1⅝-1⅞ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9½-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 11¼-12½ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5½ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18 19 |
| —— 4 per cent. Debentures..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14½-15½ |
| Telegraph Construction and Maintenance..... | 12 | .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 | .. | 100-103 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ¾-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9¾-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10¼-10⅜ |
| —— 7 per cent. Preference ..... | 5 | .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14¼ |
| —— " " " £10 Ord. .... | 6 | .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 8¾-9¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-6 |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 103-105 |
| Chelsea Electricity Supply ..... | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 105-108 |
| City of London, Ordinary..... | 10 | .. | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 8-9 |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11½-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5¼-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Mort. Deb..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 99-102 xd |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 102-105 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9⅜-10⅛ |
| London Electric, Ordinary | 3 | 1⅞-2⅛ |
| —— 6 per cent. Pref. | 5 | 5⅛-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 95-98 |
| Metropolitan Ordinary | 10 | 17½-18½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 96-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 93-101 |
| —— Preference | 4 | 100-103 |
| Notting Hill Electric Lighting | 10 | 13-14 |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | 98-102 |
| Oxford Electric, Ordinary, 1-96 and -14,310 | 5 | 5⅛-5⅜ |
| —— 4 per cent. Debenture Stock | 100 | 97-100 |
| Royal Electrical Company of Montreal, 3½ per cent. First Shares Mortgage Debentures | 100 | 95-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | 3½-3⅜ |
| —— 4 per cent. Debenture Stock | 100 | 85-90 xd |
| South London, Ordinary | | 3⅜-4⅛ |
| St. James's and Pall Mall, Ordinary, 101-90,080 | 5 | 14½-15⅛ |
| —— 7 per cent. Pref. | 5 | 8 9 |
| —— 3½ per cent. Deb. | 100 | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4⅛-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4⅞-5⅛ |
| Westminster, Ordinary | 5 | 12⅛ 13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 6-6⅛ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 94 97 |
| —— 4 per cent. Pref. | 100 | 98-101 |
| —— ,, ,, deferred | 100 | 91-94 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 113-116 |
| City and South London, Consolidated Ordinary | 100 | 50-53 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 126-129 |
| —— ,, ,, ,, '96 | 100 | 123-126 |
| —— ,, ,, ,, '01 | 100 | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7⅛-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | 4⅞-5⅛ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10-10⅛ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 103-105 p.c. |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | 11-11⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | 11⅛-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3-3⅛ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅛-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 4⅜-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-107 |
| —— Prov. Cert., all paid | 100 | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅜-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅜-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12⅛-13⅛ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22⅛ |
| —— 6 per cent. Cum. Pref. | all | 14⅛-15⅛ |
| —— 4½ per cent. Deb Stock | 100 | 113-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3⅛-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3⅛-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 11⅛-11⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,514,016 | 1 | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | ⅛-1⅛ |
| New General Traction, Ordinary | 5 | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | 1⅛-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 10⅛-10⅜ |
| —— 5 per cent. Cum. Pref. | 10 | 11⅛-12⅛ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8⅛-8⅞ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 102-104 |
| —— Deferred Stock | 100 | 78-81 |
| —— 6 per cent. Cum. First Pref. | 10 | 13⅛-14⅛ |
| —— 6 per cent. Cum. Second Pref. | 10 | 14-15 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5⅛-5⅜ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 95 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 100-102 |
| Oriental Telephone and Electric Company | 1 | ⅛ 1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Jan. 29 | 1,057 | 788 | + 269 | + 8,257*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | — | — | — | — | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 29 | 747 | 653 | + 94 | + 1,652 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 28 | 263 | 270 | − 7 | − 219 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·62 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 30 | 181 | 200 | − 19 | − 44 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 31 | 1,625 | 1,518 | + 107 | + 8,793 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 27 | 777 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 31 | 3,534 | 3,174 | + 360 | +18,856 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 31 | 688 | 735 | − 47 | + 2,642*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 29 | 4,372 | 4,196 | + 176 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 30 | 808 | 654 | + 154 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 31 | 232 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 30 | 1,811 | 1,560 | + 251 | +21,891 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | — | — | — | — | — | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 30 | 6,992 | 7,004 | − 12 | + 118*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 31 | 3,258 | 3,315 | − 57 | − 945*h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 28 | 385 | 387 | − 2 | + 29 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 29 | 205 | 203 | + 2 | − 242 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 30 | 161 | 169 | − 8 | + 44 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 31 | 91 | 86 | + 5 | + 24*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 29 | 3,618 | 3,531 | + 84 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 29 | 702 | 694 | + 8 | | | | | | | | | | | |
| Dundee City Tramways | ,, 29 | 781 | 754 | + 27 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 30 | 581 | 475 | + 105 | + 8,039 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 30 | 13,420 | 11,918 | +1,502 | +50,932*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 27 | 2,180 | 1,877 | + 283 | + 6,182 | 31⅔ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 30 | 1,104 | 974 | + 130 | — | 34 | 34 | March 31 | 56,631*h* | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 30 | 1,985 | 1,701 | + 284 | + 6,196 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 27 | 102 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 27 | 190 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 30 | 4,978 | 4,642 | + 312 | +15,154 | 77 | 77 | March 25*g* | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 23 | 9,557 | 8,889 | + 668 | + 1,938 | 103 | 101 | Dec. 31 | 524,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 31 | 1,505 | 1,416 | + 89 | + 423*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 23 | 8,906 | 7,407 | + 499 | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 125 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 16 | 94 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 30 | 3,506 | 3,051 | + 445 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | — | — | — | — | — | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 25 | 103 | 93 | + 10 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 28 | 407 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 18 | 3,443 | 2,628 | + 815 | +45,490 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 31 | 4,101 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 28 | 811 | 799 | + 12 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 31 | 1,072 | 1,014 | + 58 | + 2,584 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,943 | 6·4 |
| Wallasey U.D.C. | ,, 30 | 571 | 518 | + 53 | + 3,630 | 10 5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Physical Society.**—Dr. R. T. Glazebrooke's address as president of the above society will be delivered to-night at the Royal College of Science at eight o'clock. The subject chosen is "The Theories of Microscopic Vision," and the paper will be illustrated by experiments.

**Electrical Engineers Volunteers.**—The ball which the corps have arranged to hold on the 26th inst. is to be at the Kensington Town Hall, not at the Hotel Métrôpole as previously stated. A large gathering is expected, and the function is likely to be a very successful one.

**Faraday House.**—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., will commence a special course of lectures to the senior students upon "Direct-Current Motor Construction" on Thursday, the 18th inst., and Mr. J. B. C. Kershaw, F.I.C., will deliver a lecture on "Fuel Economy" on Saturday, the 20th inst.

**North-East Coast Institution.**—Part 1, vol. xx., of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders has just been published. In this issue Mr. Max Wurl's paper on "Technical Education in Germany" is printed together with the discussion. The report of the council for the session 1902-3 is also given.

**Russo-German Telephones.**—The technical department of the Russian posts and telegraphs has decided on the establishment of telephonic connection between St. Petersburg and Berlin by way of Wilna and Eydtkuhnen. The cost of the line, which will be about 600 miles long, is put at over £40,000. In the spring work will be commenced on the section between St. Petersburg and Eydtkuhnen

**Junior Institution of Engineers.**—At the meeting of this institution held on the 5th inst., a paper was read by Mr. Hal Williams on "Producer-Gas Power for Factories, Cold Stores, and Freezing Works." The paper was essentially a practical one. An animated discussion ensued, and the proceedings closed with the announcement of the ensuing visit on Feb. 20 to the Colonial Consignment and Distributing Company's Frozen Meat Store, Nelson Wharf.

**Great Northern and City Railway.**—There has been some delay in opening this new tube railway owing, as we understand, to the requirements of Colonel Yorke, the chief inspecting officer of railways. Colonel Yorke went over the line on Saturday, and gave his approval subject to some small alterations being made in the signalling arrangements. Otherwise everything is in readiness for the public opening of the railway, which will take place immediately the Board of Trade's requirements are carried out. This, it is believed, will not occupy more than a day or two.

**Institution Journal.**—Part 1 of vol. xxxiii. of the *Journal* of the Institution of Electrical Engineers has just been issued. It contains the inaugural address of Mr. R. Kaye Gray on Nov. 12 and the following papers: "The Testing of Electric Generators by Air Calorimetry," by Mr. R. Threlfall, F.R.S.; "The Edison Accumulator for Automobiles," by Mr. W. Hibbert; and "The Slow Registration of Rapid Phenomena by Strobographic Methods," by M. E. Hospitalier. This issue also gives the official account of the proceedings in connection with the Gilbert tercentenary commemoration on Dec. 10.

**New Books.**—"Electrical Engineers' Pocket-Book," by Horatio A. Foster (London: E. and F. N. Spon, Limited). Third edition, 21s.—"Care and Handling of Electric Plants," by Norman H. Schneider (London: E. and F. N. Spon, Limited). 3s. 6d.—"Machine Design," Part 2, "Form, Strength, and Proportions of Parts," by Forrest R. Jones (London: Chapman and Hall, Limited). Third edition, 12s. 6d.—"Elements of Electromagnetic Theory," by S. J. Barnett, Ph.D. (London: Macmillan and Co., Limited). 12s. 6d.—"Dynamo-Electric Machinery," vol. i., by Silvanus P. Thompson, D.Sc., F.R.S. (London: E. and F. N. Spon, Limited). Seventh edition, 30s.

**Selenium and Light.**—Mr. E. A. Hopius, in an investigation on connection between the conductivity of selenium and the intensity of the incident light, recently described before the Russian Physico-Chemical Society, showed a series of experiments with an apparatus constructed by Mr. M. Kohl and another apparatus designed by himself on selenium supplied by the firm of E. Merk, Darmstadt. The former apparatus was illuminated by a standard amyl-acetate burner at distances ranging from 10cm. to 200cm., and the other by a Nernst lamp placed at the same distance. The measured current intensity agreed fairly well with the hypothesis of a direct ratio between the increase in the conductivity of selenium and the cube root of the intensity of illumination.

**National Roads.**—The advocates of a national system of roads in this country will be interested to hear of a similar movement on the other side of the Atlantic. A Bill is now pending in the United States Congress which has for its essential object the appropriation of £4,800,000 as national aid for the building of good roads. This sum would be increased to double its amount by contributions from the various states. Commenting editorially on the scheme, one of our New York contemporaries remarks that aside from the direct influence that good roads would have upon horse-drawn traffic, they would prove a decided incentive to even better conditions than this; and with a national system of good roads, it would not be long before the horse would be entirely withdrawn and his place taken by motor-driven vehicles, leaving out of the question at this moment the type of motor to be employed.

**London Post Office Telephones.**—Lord Stanley, the Postmaster-General, in the House of Commons on Monday, replied to a question by Sir Thomas Dewar as to the present position of the Post Office telephone system in the Metropolis. He stated that nine Post Office telephone exchanges have been opened in the London area, and that three others are in course of construction. On the 4th inst. 15,020 telephones were working in connection with these exchanges. The expenditure for the working lines and for a large amount of general construction available for the further development of the system and the establishment of additional exchanges amounted on Nov. 30 to £1,441,773. Lord Stanley added that he proposes at the earliest opportunity to introduce a Bill to privide further moneys for the extension of the telephone system.

**"Telefunken."**—This is the new title which has been given to the combined Slaby-Arco and Braun-Siemens system of wireless telegraphy. The inventors have directed special efforts to bringing the system to practical perfection. Comparing the results of these efforts with what has hitherto been attained, progress is shown in the field of spark telegraphy similar to that effected by the syntonised dispositions introduced in the year 1900 to replace the non-syntonised and inferior arrangements till then in use. We are informed by the Gesellschaft für drahtlose Telegraphie that their present capabilities enable them either to double their standard of safety in all stations hitherto erected by them, or, retaining the present standard, to double the maximum carrying distance. It is promised that descriptions of the new methods employed will be shortly given

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to the public. About 250 stations on the "Telefunken" system are now at work.

**The Oscillograph.**—Mr. C. J. Spencer in the *Electrical World* describes a particular modification of an oscillograph of his own construction, in which the feature of particular interest lies in the method of marking off the time. It consists in employing an alternating-current arc lamp as the source of light for the reflected photographing ray. This has the advantage that when the wave to be recorded has a relatively long and somewhat uncertain or variable period, as in the secondary member of an induction motor, the time can be reckoned from the dotted photographic line of an alternating-current arc lamp, knowing the frequency of that current, whereas the full photographic line obtained from a direct-current arc would require separate and additional means of determining the time measure. This device of a dotted photographic line might be very serviceable in some researches on long and variable wave-lengths, although it seems to have a lessened or doubtful value for short waves of readily measurable and definite lengths.

**Artificial Lighting.**—Before the Edinburgh Association of Science and Arts on Monday Mr. D. Macfie read a paper on "Artificial Lighting—Ancient and Modern." A very interesting section of the paper dealt with the means adopted by the ancients of obtaining artificial illumination, and it is noteworthy that up to the dawn of the nineteenth century torches, candles, and oil lamps were the only appliances in use. Gas lighting was a nineteenth-century invention, and before its close electric lighting had been introduced and perfected. The early progress of electric lighting was referred to, and the success of the Edinburgh electric lighting department described in complimentary terms. But the system at present ruling in that city, of lighting some 150 miles of streets with flat-flame burners, was warmly condemned. A series of slides showing the diverse effects of Edinburgh street-lighting brought out in strong contrast the antiquated forms of illumination and the up-to-date electric-lighting. At the end of his paper the author gave details of the progress of lighthouse illumination, for which electricity is now coming to be extensively used.

**Electric Traction in Italy.**—Electric propulsion by means of accumulators on the Italian Meridional Railway route has not proved a success, and is to be replaced by steam. The electric overhead trolley system on the 90 odd miles of railway along Lake Como has, however, according to a consular report, met all requirements, and recently a meeting of interested parties took place at the instance of the Chambers of Commerce of Milan, Lecco, and Chiavenna, which resolved to request the Italian Government to immediately establish the trolley system upon the lines of Lecco to Milan. It is further stated that the results of working with the third-rail system on the 45 miles of line of the Milan-Varese-Porto Ceresio Railway have been entirely satisfactory. The traffic on this line, which connects Milan with Lake Lugano, has increased surprisingly on account of the cheaper rates, better service, and increased speed with electric traction. The Mediterranean Railway contemplates the extension of the electric system with a third rail over the lines Verese-Laveno-Gallarat-Sesto-Calende-Arona, so that then Milan will be directly connected with the upper Italian lakes by four standard electric railways.

**Tramways v. Motorcars.**—At the Society of Arts on Wednesday last week, there was an attractive discussion on the relative merits of the electric tramcar and the motor 'bus. Mr. T. Clarkson introduced the subject with a paper in which he described the "Chelmsford" steam automobile, which uses cheap paraffin as fuel instead of the more costly petrol. He argued that self-propelled road vehicles could now be used both in town streets and on country roads at a profit, and with enormous advantages in the way of cleanliness. Electric tramways were not always suitable; cars must be found that could mingle with the rest of the traffic, threading their way through the streets with ease and at any rate of speed desired. The public service car must have economical and reliable production of power, combined with sufficient weight and strength. Colonel R. E. Crompton, C.B., echoed Mr. Clarkson's views, and complimented him on his success in designing a car to use paraffin as fuel. Mr. Shrapnel-Smith also praised the Chelmsford car. He regarded it as a mistake for towns of from 60,000 to 100,000 inhabitants to go in for electric tramways. A motor omnibus service would only mean about one-sixth of the capital expenditure, and would be better able to cater for the class of traffic. Other speakers took a similar line, and all were agreed as to the merit of the paraffin car, which in the recent reliability trials cost for fuel only 0·211d. per gross ton-mile.

**Chemical Society of South Africa.**—We have received a copy of the December number of the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa, which prints a number of interesting papers read at the meeting of the society on Dec. 19. One of the subjects dealt with is the ventilation of deep mines by Mr. T. Johnson; and in the discussion which took place on the paper, Mr. T. L. Carter made some important remarks which are particularly applicable to makers of electric rock drills. To quote the passage in question, Mr. Carter said: "No doubt the reason for the little attention that has been given to ventilation on the Rand is due to the fact that compressed-air plants are universally used, and these are looked upon as supplying sufficient air to the underground workings. Were it possible to obtain an electric drill as equally efficient as the air drills, no doubt the ventilation of mines would obtain greater consideration. It takes nearly 8 h.p. to run an air drill. An electric machine to give the same effect would require between 2 h.p. and 3 h.p. The difference between 2 h.p. and 8 h.p. would allow ample margin for the erection of an elaborate ventilating plant. The man who can get out an electric drill which will compare favourably with every good point of the best made air rock drill has a fortune awaiting him." Mr. Carter also discussed the question of mine illumination in its relation to efficient ventilation. This question he again decided in favour of electricity. One of the greatest advantages of electric lights in a mine is that they do not contaminate the mine atmosphere, and Mr. Carter recommended that when possible, therefore, electric lighting should be employed.

**Development of Electrical Machinery.**—The third meeting of the present session of the Bristol Association of Engineers was held in the Imperial Hotel, Clifton, on Saturday last, the president, Mr. J. S. Martin, H.M. inspector of mines, in the chair, when a paper on "The Development of Electrical Machinery" was read by Prof. Robertson, of the Merchant Venturers' Technical College. Starting with Faraday's discovery in 1821 of continuous motion produced by an electric current, the author traced out the various stages in the development of electrical motors before the discovery that "motor" and "generator" were converse functions of the same machine. He then went back to Faraday's other great discovery of induced currents in 1831, traced the gradual development of this idea until, with the researches of Hopkinson in 1884, modern electrical engineering may be said to have dawned. He showed a number of illustrations of the Siemens, Pacinotti, Gramme, Hopkinson, Brown, and other historical

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machines before and since that time, and explained the typical construction of the present day. He also explained some of the difficulties that are now met with in connection with very low E.M.F.'s, very high E.M.F.'s, and high-speed machines for turbine driving, and pointed out the chief ways in which they are being overcome. In the discussion which ensued, Mr. Frank Brain gave an account of his experiences of electrical driving in the colliery he is connected with about 20 years ago, using the old A Gramme machine. He stated that even that old plant had saved its cost in a couple of years' working. Contributions to the discussion were also given by Mr. Thomas Morgans, past-president, Principal Wertheimer, and various other gentlemen.

**Glasgow Corporation Telephones.**—Mr. A. R. Bennett gave a lecture under the auspices of the Glasgow Corporation last week on the subject of the municipal telephone system of that city. He prefaced his remarks by stating that that was his third appearance as a Corporation lecturer, and the last. At the end of May this year he would retire from the general managership of the telephone department. After a reference to the accounts for the first year's working of the system, which, he said, were admitted to be satisfactory by all impartial critics, Mr. Bennett stated that the results this year would be far better. Any fear of the rates being raised to meet the expenses of this department might be dismissed. He then gave a concise *résumé* of the progress of the municipal system. In February, 1902, there were 3,833 instruments working in the system, the following year 8,540, and this year 11,490. In addition they had 250 public call offices. The revenue showed a similar satisfactory increase. In January, 1902, the income was £18,120, the following year it was £38,544, and this year £51,156. Touching on the work that had been accomplished by the department, Mr. Bennett said that the underground pipes laid to carry the cables would, if placed end to end, extend from Glasgow to Sunderland, Manchester, or Dublin. Similarly, the metallic circuits contained in the cables, measuring about 17,000 miles, would, if joined together, extend from New York to Glasgow, and thence through the Mediterranean, the Suez Canal, Red Sea, and Indian Ocean to Melbourne. Mr. Bennett afterwards entertained the audience to a "telephonic" concert. Around the hall were placed a number of large receivers in connection with transmitters placed in the principal exchange in Renfield-street. There a concert was given, and the different items were heard in the hall with remarkable clearness.

**St. Marylebone Electric Lighting.**—The result of the poll of the ratepayers by which the Borough Council, by a majority of 1,176 votes, have been empowered to proceed with their Bill in Parliament this session, can have nothing but a salutary effect on the crisis which had arisen in connection with the purchase of the Metropolitan Company's undertaking. It was by no means a foregone conclusion that the Council would get their mandate on a poll, but at the last moment the ratepayers would seem to have recognised that the promotion of a Bill in Parliament is the only way out of the present imbroglio. The poll was conducted very much on the lines of a parliamentary election in the most stirring times. The borough was flooded with literature bearing upon the question, and sandwichmen paraded the streets. Full opportunity was given the ratepayers to record their votes, but less than a third took advantage of it. There are 21,000 names on the register, and altogether 6,382 votes were recorded, the division being as follows: in favour of the Bill, 3,779; against, 2,603—majority in favour, 1,176. This result is in striking contrast to the verdict of the ratepayers' meeting held at the Queen's Hall a week or two ago, when the opponents of the Bill were present in such numbers that there was an overwhelming majority against the measure. That they did not represent the true feeling of the borough on the matter is evidenced by the result of the poll, and it inclines to show that all along the opposition has been in the minority. The new turn events have taken will have the effect of staving off for the present at least any further complications. The responsible committee of the Council will, we presume, continue negotiations with the Metropolitan Company or any other company in their discretion, but from recent utterances of the committee it seems that they have no power to conclude agreements with one or the other until the Bill receives the sanction of Parliament! As we indicated last week, the present inclination of the committee is to lease the undertaking to the General Electric Company or some other company for a term of years, which would relieve them of the responsibility for its success or non-success during the first years of working. The Bill yet remains to be formally approved by the Borough Council, but a meeting of that body was called for last night with that object.

**Electric Driving of Machinery.**—The subject of electric motors in their application to the driving of machinery was dealt with by Mr. T. Harding Churton in a paper which he read before the Yorkshire College Engineering Society this week. He first emphasised the importance of the profession understanding the peculiarities of driving machinery by electric motors, which are frequently used in disadvantageous ways. The explanation is that the difference between driving with motors and driving with steam or gas engines is overlooked. He pointed out the advantage of electric motors for variable or intermittent work, and said that steam and gas engines are economical when run at full power, but if run at half or quarter power the efficiency is very low. In the case of the electric motor, although the efficiency is lower at low load than at high, there is not nearly so much difference between efficiency at full load and light load as in the case of the steam-engine or the gas-engine. As to the question of the grouping of machines and the driving of each machine by individual motors, no hard-and-fast rule can be applied. It depends upon existing conditions whether it be advantageous to employ a motor to each machine or to group the machines driven by shafting. Referring to the power required in small units scattered over a large area and the increasing use of electrical power in collieries, Mr. Churton mentioned that at the Middleton Colliery the coal is worked by electric cutting machines, which cut away the substratum, after which the coal is readily detached by the colliers and filled into small trucks or corves, which are then hauled along the underground roads by electric power. Alluding to the various installations of motors supplied by two-phase currents from the Leeds Corporation mains, Mr. Churton said the use of this system for power purposes is very greatly increasing. During last year two million units were thus sold, the average price being 1·27d. per unit. With a good motor and fairly regular use, the cost of working is practically 1d. per horse-power per hour. This compares favourably with the cost of driving by gas-engines, with which the horse-power-hour at full load actually costs less. The saving is effected with the electric motor by obviating the loss in transmission by shafting and the inefficient working of the gas-engine at light load. A discussion followed the reading of the paper, and Mr. Churton was accorded a hearty vote of thanks.

**New York Rapid-Transit Power Station.**—The new power-house of the Interborough Rapid-Transit Company, of New York, is now pretty well advanced, and when

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completed will be one of the largest and most powerful in the States. The *Street Railway Journal* has published a long illustrated article describing the new structure and the plant it will ultimately contain, which will have a total capacity of from 80,000 h.p. to 100,000 h.p. To this, however, should be added 30,000 h.p. proposed for a future extension. The engines are already in place. Extending through the main building is a row of 8,000-h.p. to 10,000-h.p. engines direct connected to 5,000-kw. alternators, the row being broken in the centre by an installation of four 2,000-h.p. turbo-generators for lighting purposes. The engines are of the twin compound type, having horizontal high-pressure cylinders and vertical low-pressure cylinders, the high-pressure cylinders being provided with poppet valves for superheated steam. Each low-pressure cylinder is placed in direct relation with the condensing chamber of a barometric tube condenser. For the present installation the boiler plant will consist of 60 safety water-tube boilers, each having 6,000 square feet of effective heating surface. Six boilers are provided for each engine, and the entire plant is designed on a unit or sectional basis. Thus, each section will consist of one chimney, 12 boilers, and two engines, in connection with the respective auxiliary equipment for each engine, consisting of one boiler feed pump, one feed water heater, and one condensing outfit. By this arrangement any section may be thrown out or operated independently by means of power-operated valves. A new feature is the use of a distributing coal conveying system under the bunkers, by which coal of a high grade stored in any one bunker can be distributed to all boilers without handling, thus permitting the use of two or more grades of coal when needed at different times of the day. The pipe fittings are made especially heavy, all pipes being designed for the strains incident to 200lb. pressure, with steam superheated to 500deg. F., as all the boilers will ultimately be provided with superheaters. A novel feature is the location of the auxiliary pump equipment for each engine. This is placed back of the engine, and is controlled from the point where the engine throttles are situate. The nine 5,000-kw. alternators generate energy at 11,000 volts, the machines being of the three-phase, revolving-field type for 25 cycles.

**The Cauvery Power Plant.**—As we recently stated, it has become necessary to carry out an immediate extension of this pioneer hydro-electric power plant in India in order to meet the greatly increased demand for electrical energy at the Kolar goldfields. A report has been issued by the resident engineer of the Cauvery power-house which shows in detail what form this extension is to take. Its primary object is to increase the available output of the station from 4,000 h.p. to 6,000 h.p. The new plant will consist of five units of direct-coupled turbines and generators, with one exciter set, all of type identical with those in the old power-house and of similar capacity—viz., 1,250 h.p. and 720 kw. for turbines and generators respectively. Each generating unit will in the present case be served by an independent supply pipe from the forebay, instead of having but one pipe to two waterwheels, as in the existing system. There will be nine additional transformers—three banks of three—in both the step-up and step-down transformer stations. The lines upon which this second installation will be carried out differ in several important respects from those followed in the original installation. The whole of the work will be carried out directly by the Government instead of by the manufacturing companies, and in place of the Government the gold-mining companies concerned will supply, erect, and house the whole of the distribution plant. The main transmission line is to serve under the new conditions, but the voltage carried will be raised from 30,000 to 35,000 volts. The power-house itself is to be extended to practically double its present size, and the plant is to be concentrated as far as possible in order to reduce initial cost and future working charges by minimising the number of operators. The extension scheme also provides for the construction of an entirely new forebay and three new section houses on the transmission line. An interesting feature of the installation work will be the replacing of the temporary light railway down the face of the "bluff" by a permanent line, laid with 40lb. rails and worked by a 15-h.p. electric motor hoist. The total estimated cost of the extension is over £86,000, and the plant and machinery will be supplied by the original contractors—viz., Messrs. Escher, Wyss, and Co., of Zürich the General Electric Company, of America; and Messrs. Mechan and Sons, of Glasgow. The existing power plant has been fully described in this journal (*E. E.*, vol. xxx., pp. 618.)

**Electric Lighting in Germany and the States.**—It has long been regarded as a *sine qua non* that the Germans are in the very front rank of electrical progress, but our New York contemporary the *Electrical World* has set itself to prove that this is not quite the case. Taking electric lighting from central stations as an example, our contemporary shows that, in the first place, there are 3,620 American stations against 971 German stations, giving nearly twice the number of plants in proportion to the population, and nearly four times the absolute number to the credit of the States. Again, the American stations have over 18,000,000 incandescent lamps connected, as against 5,000,000 in the German stations, and 385,000 arcs, against 93,000 in Germany. The upshot of the matter is that in proportion to the population electric lights are now used almost twice as freely in the States as in Germany. In particular, America uses arc lights conspicuously more extensively, in which work the small plants take a very important part. As regards the general character of the installations, there are some very notable differences in the practice of the two countries. The German stations, thanks to the general density of the population, adhere far more closely to direct-current machinery than America. Five-eighths of the total dynamo capacity in Germany is in direct-current generators, while in America five-eighths is in alternating generators, polyphase and other. As a natural result of this preponderance of direct-current working, the German stations use storage batteries far more freely than they are used in the States, not only relatively, but absolutely. In fact, they employ battery capacity aggregating 87,000 kw., while in America the meagre total is barely over 30,000 kw. Likewise, the Germans use gas-engines relatively more than the Americans do, 61 stations, aggregating 6,378 kw., reporting gas as a motive power, while the American total is 1,218 rated horse-power in the engines. Moreover, there is a preponderance of German effort in wind power, one station of 220 kw. capacity reporting that unique condition. In the use of water power America is at an obvious advantage in the matter of natural resources, and, in fact, 22·2 per cent. of its total capacity is in waterwheels, the German figure being about 15 per cent. As regards the sale of the product, it is noticeable that proportionately the Germans use meters far more freely than is the custom in the States. This, it is concluded, is the result again of the many small American stations doing a disproportionate amount of arc lighting, and letting things go on the contract basis.

**Welding of Aluminium.**—Before the Faraday Society on Tuesday, Feb. 2, Mr. Jonas read an abstract of a paper by Mr. S. O. Cowper-Coles on the welding of aluminium.

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He commenced with the remark that soldered aluminium joints have proved unsatisfactory. One of the chief difficulties encountered other than the formation of oxide in soldering aluminium is that a few degrees below its welding point it passes into a pasty or brittle state, and being a very good conductor of heat, the solder very rapidly cools and freezes before it has time to flow sufficiently. He next described Dick's machine for welding aluminium by the removal of the oxide mechanically, combined with pressure; referred to Heraeus's process of welding aluminium, which consists in heating the aluminium in a reducing atmosphere until it reaches the pasty stage, when the joint is made by kneading and hammering. Emmé's process, which is somewhat similar, consists in heating the aluminium up to 600deg. C., and welding by hammering. The electric welding of aluminium has not proved commercially successful. A description was given of Schmidt's electric welding apparatus, which consists of a carbon stick, which is used in much the same way as a soldering iron, by being moved over the portion to be welded to remove the oxide, the aluminium forming one electrode, the carbon stick the other electrode. Jones's machine for welding aluminium tubes was also illustrated; a strip of aluminium is wrapped round a mandrel, and the joints are fixed together by passing a low-tension current through the portions to be welded. The author then went on to describe his own process, which requires no flux or solder, and does not necessitate the hammering of the joint when in the pasty state, the process being especially suitable for wire, rods, and tubes. The machine employed is fitted with clamping screws which are controlled by levers. The aluminium is heated by a benzine lamp, and when raised to the point of fusion pressure is applied to the levers, which causes the aluminium to be welded to unite, a ring of metal being squeezed out. This ring, which is largely composed of oxide, acts as an insulating and supporting collar, the molten metal being retained within it. Water is then projected on to the joint by turning a handle at the same time a screen is moved in front of the flame. The rod is then removed, and when the collar is filed off the joint will be found to be as strong as the rest of the metal. A table was given showing the tensile strength of 12 consecutive welds; in all the tests the specimen broke at some distance from the weld, and in no case did it actually break through the weld. The author concluding by showing illustrations demonstrating how molten aluminium can be encased in a shell of aluminium oxide. In the discussion which followed, Mr. D. A. Sutherland remarked that the great difficulty in the method was where large pieces of aluminium had to be welded, with which observation Mr. Murray Morrison agreed. The chief novelty of the Cowper-Coles process lay in the apparatus. On the other hand, Prof. Huntington thought that the chief novelty in the process lay in the fact that the metal was actually fused. Mr. E. Kilburn Scott thought the important point to remember was the value of the hard outer skin of the metal. If aluminium wires were used for transmission of electricity uniformity of section was unimportant, and the blob at the weld need not be removed, but otherwise, *e.g.*, if used as trolley wires, it would be necessary to harden the joint in some way. This might be done by burnishing with agate. He showed by a diagram how a connection might be made without welding. Mr. Jonas, in his reply, stated that the quenching was an essential feature of the process, and one which distinguished it from all others, the process being primarily a fusion process.

**Separation of Metals by Electrolysis.** — The Faraday Society at its ordinary meeting on the 2nd inst. discussed a paper by Mr. Hollard on some applications of the theory of electrolysis to the separation of metals from one another. The paper opened with the remark that the only principle hitherto involved in electrolytic separations has been based on the method of successive potentials, each metal depositing at the potential proper to that metal. In practice this principle has only been applied to metals (copper and silver, silver and bismuth, mercury and bismuth) whose polarisation potentials are lower than that of hydrogen. Metals whose polarisation potentials are higher than that of hydrogen cannot be separated by gradual increase of the E.M.F. on account of the extremely small fraction of the current then used to precipitate the metal, hydrogen ions carrying most of the current. The author has, therefore, made use of three other applications of the theory of electrolysis. The first of these is the reduction of the resistance of the bath by suppressing the formation of gas at the anode. The current may thus be increased in two ways: (1) By suppressing the liberation of oxygen at the anode. To effect this a reducing agent such as sulphurous acid may be introduced. The same potential will then greatly augment the current and hasten precipitation. The method has been successfully applied to separate nickel from zinc. (2) By the use of soluble anodes. The anode must replace in the solution the metal that is to be separated, and that only, and it must be immersed in the solution of an indifferent salt, a membrane separating the anolyte and catholyte. Obviously an external source of electricity is unnecessary. The nickel zinc separation is again given as an example, the operation being described in detail. In this case there is a limit to the relative quantities of zinc and nickel that can be separated. For by Nernst's formula

$$e = \frac{k}{v} \log \frac{P}{C} - \frac{k}{v'} \log \frac{P'}{C'},$$

where $e$ is the E.M.F. between the metals, $k$ a constant for a definite temperature, $v$ and $v'$ the valencies, and C and C′ the concentrations of the precipitating and precipitated metals. When the concentration C of the zinc in the inner cell increases $e$ will diminish. There must not, therefore, be too much nickel to deposit. The phenomenon is complicated by secondary reactions which must be taken into account in the cases of other separations, such as concentration E.M.F.'s, increase of E.M.F. due to local action, and migration. These are discussed fully in the paper. Secondly, as regards the influence of the nature of the cathode, by suitably choosing the metal for the cathode, the liberation of hydrogen may be completely avoided, and the conductivity may be so much increased that the separation of the metals becomes possible. The division of metals into two groups, which can and cannot be deposited from strongly acid solutions, has for its basis the position occupied by hydrogen in the polarisation potentials of the metals. But this, as Caspari has shown, varies with the metal of the cathode. Hence by suitably altering that metal, metals can be made to pass from one group to the other, and thus separations, impossible with a platinum cathode, may be effected. The separation of zinc and cadmium (impossible on a platinum cathode) is given as an example. Platinum gauze covered electrolytically with tin and cadmium forms the cathode. Thirdly, with reference to the formation of complex salts, metals may be prevented from precipitating by causing them to form complex salts, which dissociate to give, not the metallic ions, but complex ions containing the metal. As an example, the separation of antimony and tin in a solution of sodium hydrogen sulphide is described in the paper. An interesting discussion followed, and the author was accorded a vote of thanks.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 170.)*

THE ETHER (OR ÆTHER).

The ether (not the anæsthetic) is a very imponderable medium supposed to exist in all space and between and around the ultimate particles of all bodies. Indeed, the particles themselves may be centres of strain in the ether. The old theory, "Nature abhors a vacuum," rendered the existence of the ether a very necessary conception, but it is not so easy to see the necessity from that point of view now. It still exists, however; nay, it is more imperative now than ever. Newton endeavoured to account for his great generalisations about the laws of gravitation, attraction, etc., by supposed differences of pressure in the ether. He did not publish his idea, nor did he in any way verify it by experiment. The ether of to-day is that of Huygens—a conception used by him to explain the propagation of light. Light is *not* a substance, but is due to a disturbance or wave-motion which, acting on the optic nerves, gives rise to the sensation associated with the term. Light is propagated with a velocity of about $3 \times 10^{10}$ centimetres (nearly 186,000 miles) per second in a vacuum. It must have *some* medium for its propagation, hence the necessity for the conception of the ether. The vibrations or disturbances follow a sine law, and the physical process involved in the propagation of light is a vector quantity, but one capable of having its direction reversed, and this vector is at right angles to the direction of the ray. The process may be—is believed to be—an electromagnetic one, and in this case the electric displacement and the magnetic disturbance are at right angles.

If it be true (as assumed by Lord Kelvin) that the density of the ether is about $9{\cdot}36 \times 10^{-19}$ and its coefficient of rigidity 842·8 (the coefficient for steel being $2{\cdot}4 \times 10^{11}$) and the density of air near the earth and at 0deg. C. is $\cdot001293 = 12{\cdot}93 \times 10^{-4}$, the air, then, under these conditions is about $1{\cdot}38 \times 10^{15}$ times as dense as the ether ($1{\cdot}38 \times 10^{15}$ is 138 followed by 13 ciphers). On the other hand, in interstellar space the ether is much more dense than the very attenuated air there. For if the atmosphere were all at 0deg. C. and at rest, the earth also being at rest, its density at a distance which for calculation purposes may be called infinite would be about $3 \times 10^{-346}$, and since the ether density is $9{\cdot}36 \times 10^{-19}$, the ether in these remote regions is about $3 \times 10^{327}$ times as dense as the attenuated atmosphere there. Vibrations in the air (sound-waves) travel about one million times slower than the transverse vibrations of the ether (light). Solid bodies, it is true, transmit transverse vibrations, but comparatively slowly. The velocity of light varies in different bodies, therefore the particles of the body are vibrating, and take part in the transmission of light. Opaque bodies also are probably permeated by this all-prevading ether, though in dense bodies it must be somewhat loosely connected with the particles of the body. Light is transmitted at the same rate as an electromagnetic disturbance, hence we may conclude that the medium through which light is transmitted is identical with that through which the electromagnetic disturbance is propagated. This has been proved by Boltzmann and many others. Whether Lord Kelvin's "theory of vortices" or molecular whirls be true or not (and it seems a little difficult to reconcile the vortex theory with all known phenomena, and to account for the energy required to keep up the whirls), it is, nevertheless, pretty well established that the ether pervades interstellar space, and is probably the most uniform and generally disposed of all the things of which we can form any conception.

The question suggests itself, Does this vast isotropic ocean not only exist as a medium for the interchange of physical action between bodies at a distance, but also to perform other functions of even a higher order? Certainly a study of the subject inclines one to the belief that an affirmative answer is probable.

*The Ether and the Propagation of Electric Disturbances.*—If a vibrating body vibrates in a medium capable of taking up and transmitting the vibrations, it, itself, gradually comes to rest if left alone, as it has to make waves in the medium which are transmitted to a distance. The energy of the vibrator is thus gradually conveyed to a distance through the action of the medium. The *rate* at which the disturbance travels through the medium depends merely on the medium itself, but the *length of a wave* depends partly on the medium and partly on the rate of vibration of the vibrator. Only some media can convey such a disturbance—in fact, a medium may not be able to take up and convey the motions of a particular vibrator at all.

The commoner fluids, such as air and water, radiate or propagate wave disturbance in a way well known to us, as in the case of sound—the velocity of propagation being proportional to the square root of the elasticity ÷ density. The elasticity here is the volume elasticity coefficient, and if this be high, the density being low, the rate of propagation is high. In the ether this coefficient is enormously high, and as the density is so low the rate of propagation is exceedingly great. To get an idea of this velocity we have only to consider the fact which Dr. Lodge states in "Modern Views," p. 276, that when the earth receives a spark, as from a flash of lightning, its charge may oscillate between the antipodes and back 17 times in a second. Evidently, if we wish to send messages rapidly, the ether is so constituted as to fulfil that condition at any rate. In fact, we know that it takes only one-sixtieth of a second for the signal to travel from Cornwall to America. The velocity with which electromagnetic disturbance is propagated by the ether is $2{\cdot}9857 \times 10^{10}$ centimetres per second, and the velocity of light in air is practically the same. The following deductions have been made by scientists and mathematicians: good conductors of electricity are opaque to light, and for transparent media (transparent to both) the specific inductive capacity or "specific inductivity" is found to be about equal to the square of the index of refraction. [*Note.*—The specific inductive capacity of a condenser depends not only on its dimensions, but on the inductive power of the dielectric used, and is the ratio of its capacity to that of an air condenser of equal size at 0deg. C. and 76cm. pressure. The index of refraction is the ratio which the sine of the angle the incident (or entering) ray makes with the perpendicular to the refracting surface bears to the sine of the angle which the refracted (or emerging) ray makes with the same perpendicular.] Some bodies conduct electricity better in one direction than another, and the opacity to light differs accordingly; crystals which conduct better along one axis than another show a corresponding difference in the case of light. In fact, light is propagated by vibrations in the ether, and electric disturbances such as those by which messages are conveyed "wirelessly" are exactly similar but differ in wave-length from those of light.

WHAT IS ELECTRICITY? THE ELECTRONIC ANSWER.

The various answers which have been given to this question at different times by different authorities prove, by their diversity, very confusing to the student. At one period electricity is a single fluid, at another two fluids called positive and negative. Positive electrification at one time is supposed to be due to an excess of a single fluid, just as negative electrification is evidence of a deficit. An electric charge has been regarded as something put upon or transferred to a conductor, and, again, it is a state of strain of the surrounding non-conductor or dielectric. As a matter of fact, no complete answer to the question, "What is electricity?" has yet been given, though many things have recently been found out about electric phenomena, and we are beginning to see our way to an answer. We have already referred to the ether, and suggested that certain states or motions of the ether account for all electric phenomena. Something, however, is wanting to complete the connection—something through or by which the ether may be acted upon, and the electronic theory comes to our aid.

Lord Kelvin and others have taught us that matter is atomic in structure (see Dr. Fleming's "Electronic Theory"); that, in fact, the smallest free portion of a compound body, such as a salt, is a molecule, which in turn is made up of *atoms*. These atoms were supposed to be the smallest particles or portions into which the molecules could be

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divided, and Lord Kelvin approximated to the size of a molecule (the smallest portion, say, of a salt which retains all the properties of the salt), and gave its diameter as between $\frac{1}{100}$th of a micromil and two micromils. A millimetre is about $\frac{1}{25}$in., a micron the $\frac{1}{1000}$th part of a millimetre, and a micromil the $\frac{1}{1000}$th part of the micron. From this it follows that an atom may be taken as that exceedingly small portion of a body, approximately one micromil, say, in diameter, which according to old conceptions it is impossible to sub-divide into small portions. Various authorities have estimated that the number of molecules in a cubic centimetre of air at ordinary temperature and pressure is from $10^{18}$ to $10^{21}$. The mind fails to grasp the significance of these figures, but some idea of the greatness of these numbers may be formed by considering that, small as these molecules are, so great is the number of them in the cubic inch of air that they would if placed in a row *reach nearly from the earth to the sun and back.* Now there are two atoms of hydrogen, say, to the molecule, though as to the relative sizes of atoms of different substances we are at sea. We have, then, some idea of the size of the supposed atom in a given case. But now comes on the stage the newer "electronic theory," or hypothesis, that the atoms may be composed of yet more minute portions, called corpuscles, each with its charge of one electron of electricity, and itself often called an electron. The electron charge is really an exceedingly small quantity of electricity, being equal to about $22/10^{20}$ of a coulomb, or in other words, the coulomb is nearly five million million million electrons, the British Association unit of quantity—viz., that quantity which, placed on a very small sphere, repels a similar sphere similarly charged, when the centres of the two spheres are 1cm. apart, with a force of one dyne—being equal to 1,540 million electrons.

Now, the electronic theory attempts to answer our question, "What is electricity?" These electrons constitute what we call by the name "electricity," the atom of matter in its neutral condition consisting of a shell or envelope of negative electrons with a core or matrix of positive electrons. If an electron be withdrawn from the atom, the latter is left positively electrified. Thus the neutral atom *minus* one electron may be considered as the natural unit of positive electricity. In this theory conductors are substances in which electrons free to move exist, a current of electricity being due to a movement of electrons, an electron in motion being a moving centre of ether strain. An electron in *vibration* creates an ether wave.

In good conductors it is supposed that the atoms are broken up into positive and negative ions, or electrons and remainders of atoms. There may be constant divorce and remarriage of the ions going on, one electron forming now part of one and then part of another group or atom. In non-conductors the ions are much restricted in their movements—if pulled apart a little, they spring back when released. The application of E.M.F. to a conductor causes migration of the ions, for conductors are mostly simple substances whilst non-conductors are complex. According to this theory, what takes place when we rub a glass rod with silk is that the double layer of electrons and co-electrons on the surface of the silk is roughly treated and broken up, the majority of the positive co-electrons getting left on the glass and the negative electrons on the silk. On the whole there are just as many positive and negative ions as before, but their distribution is altered. This theory explains why the air in the neighbourhood of a fresh-water cascade is charged negatively and near salt-water spray it is charged positively due to the breaking up of the double layer of ions on the surface of each drop when it touches the ground. The theory also explains many of the known facts of chemical decomposition under influence of an electric current, voltaic action in its turn being due to some force which drives electrons across the boundary between, say, copper and zinc, this diffusion constituting what we call the current. Again, when a conductor is moved across a magnetic field of force a current is produced in it. We must remember that an electron in motion causes a magnetic force, and the field may be considered as if due to a moving sheet of electrons. The cutting of a conductor through it is accompanied by the same reactions as if a movement of electrons were started in it in certain directions depending on the direction of motion across the field. This sudden starting involving the backward reaction or push on surrounding electrons which we call induction, which tends to hinder the current. Similarly, the reaction at stopping will tend to make the current flow on. Many interesting explanations of thermo-electric effects have also been advanced by the exponents of this theory. Briefly, then, the theory assumes that: (1) at exceedingly small distances the electrons repel each other; (2) at greater distances positive electrons repel positive, and negative repel negative, or unlike electrons attract; (3) that all *atoms* attract each other at distances very great in comparison with this size, an atom being in many respects like a planet of which the satellites are electrons.

The question may now be asked, How does this theory fit in with our conceptions of the ether, and the part it plays in electrical phenomena? The matter may be explained, in one case at least, as follows: the corpuscle, with its charge of negative electricity—*i.e.*, the electron—creates an *electric* force in the space around it; if the corpuscle moves, it creates a condition of strain in the ether, to which we give the name *magnetic* force. If we know the difference in the values of the electric force at two near points, we know the time-rate at which the magnetic force is changing between them, and in a direction at right angles to the line joining them. Thus electrons and the movements of electrons give rise to forces, but it is equally true that these forces move electrons. Now suppose we take two insulated conductors, one with a spark-gap in it. To charge the one rod positively and the other negatively, we must force more negative electrons into the latter and remove some from the former. A dynamo, or induction coil with battery, or any "electron pump" will do this. The excess of electrons in one causes a strain in the surrounding air or insulator, the air in the spark-gap having the greatest strain; and if the electron pressure be still further increased, the strain becomes so great that the insulating qualities of the air in the gap breaks down, and a spark passes. Too many electrons rush across the gap through the passage thus formed, and we have an electric current, but some of them come back, giving us the backward current, and this is repeated, giving rise to a surging current in the conductor and a series of electric oscillations, or rapidly reversed electric and magnetic forces giving rise to ether waves. The electron has some kind of grip on the ether; in fact, it is itself, according to Dr. Larmor, a centre of convergent strain in the ether, so that its sudden starting or stopping produces a disturbance in the ether which Dr. Fleming has called "a splash" (see "Waves and Ripples"). If a multitude of electrons are suddenly set moving in one direction, the effect on the ether is like that on the air caused by a number of men simultaneously striking drums with sticks or firing off rifles at the same instant. The more sudden the first rush of electrons across the air-gap the greater the disturbance in the ether, and this may be the reason why, with high frequencies, want of polish, or roughness of surface of the spark balls reduces the ether wave effect of the discharge, as it probably prevents the first rush of electrons from being so sudden and vigorous by allowing premature migration of some of them. Compression of the air in the spark gap, on the contrary, *increases* the suddenness of discharge.

The electron, then, is the connecting link; is itself, in fact, a centre of strain in the ether. At rest it constitutes an electric charge, but in motion an electric current. If isolated, it is negative electricity; groups of electrons in proper combination with co-electrons form the atoms of matter. Steady flow of electrons in one direction, with co electrons in the opposite direction, constitute a steady or continuous electric current, but the current may be alternating if the electrons merely oscillate. The oscillations of the electron, if sufficiently rapid, produce ether waves, and by the aid of these communication may be made between places hundreds—even thousands—of miles apart without the aid of a connecting metallic conductor.

Seeing its many functions and all-pervading nature, the reader may be inclined to ask, "Is there, then, any form of matter not composed of electrons, and, if not, how are the different characteristics of different forms of matter

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accounted for?" We leave the question for the *savants* to answer. The new theory agrees with Maxwell's mathematical deductions and supplements them. The inertia of matter is probably due to the inductance of the electron, just as moving electrons constitute an electric current and rotating electrons give rise to magnetic phenomena. The theory also explains much in optics hitherto only vaguely guessed at, and it shows how the ether may be strained or set oscillating in accordance with previous hypotheses explaining known electric and magnetic effects, but it is yet very incomplete. What has here been given is but a brief outline of some of the ideas of prominent workers in this fruitful field of research, especially in their relation to the laws and phenomena of the formation and propagation of the ether waves by which "wireless" messages are usually conveyed.

*(To be continued.)*

## ON ASYCHRONOUS MOTORS.

BY N. PENSABENE.

The increased application of the induction motor in the electrical industry makes it necessary for the engineer to solve many and sometimes complicated questions about the same. Great progress has been made by the introduction of the circle diagram known as the Heyland diagram, which is specially adapted to aid testing purposes and verification. Though the application of this diagram may be simple when we neglect the primary resistance, it becomes complicated otherwise (as frequently occurs, especially in small motors), because the diagram needs special constructions for the corrections, and it does not give the total power absorbed, and one is obliged to add to the power given the loss in the stator copper.

The explanation of a method which would avoid this inconvenience would have some interest for the readers of the *Electrical Engineer*, and for this purpose I will endeavour to give it in the shortest and clearest manner possible. I assume the reader thoroughly understands the subject.

Neglecting for a moment the primary resistance, the constant terminal voltage, $e_0$, will be equal to the E.M.F. induced, $e_1$, by the magnetic field $\mathfrak{N}$, which will be constant if the frequency is constant. In this case it is well known that the induction motor diagram appears as follows, and we have

A B, magnetic flux $\mathfrak{N}_1$, balancing the terminal voltage or corresponding induction, $B_1$;
A L, magnetic flux $\mathfrak{N}_2$, interlinked with the rotor conductors or corresponding induction, $B_2$;
A M, flux produced by the primary winding or corresponding induction, $B^1_1\ V_1$;
Q L, flux produced by the secondary winding or corresponding induction, $B^1_2\ V_2$;
A Q, flux produced by the primary and interlinked with primary and secondary conductors, or corresponding induction, $B^1_1$;
M B, flux produced by the secondary and interlinked with primary and secondary conductors, or corresponding induction, $B^1_2$;
$\frac{A\ M}{A\ Q} = V_1$, $\frac{Q\ L}{M\ B} = V_2$ are the primary and secondary leakage coefficients.

The inductions are measured in the air-gaps.
A M, primary and magnetising current, $i_{1\mu}$;
A $A^1$, watt current, $i_1{}^{11}$, for iron loss;
$A^1$ M, total primary current, $i_1$;
B M, secondary current, $i_2$;
M N, developed torque, C;
M $N_2{}^{11}$, absorbed power, $P_1$;
tan $\epsilon$, percentage slip, $s$;
$\frac{A\ B}{B\ C} = \sigma$, leakage factor given by $\sigma = V_1\ V_2 - 1$.

The secondary copper loss is proportional to $B\ M^2$, and

$$B\ M^2 = B\ N\ .\ B\ C = \frac{A\ B}{\sigma}\ .\ B\ N \quad . \quad . \quad . \quad (1)$$

$\frac{A\ B}{\sigma}$ being a constant, we can say the secondary losses are represented by a rectilinear diagram with the primary wattless currents as abscissæ.

If B D represents the equation (1), D will be the starting point.

Taking M T = N P, and tracing T S normal to M T, the intersection point, S, with M C will move itself on the circle B S C. In fact

$$\frac{M\ T}{B\ N} = \frac{M\ S}{B\ M} = \text{constant},$$

and, therefore, the angle B S C = 180deg. − B S M is constant.

It is easy to find that C D is a tangent to the circle B S C, that this circle has its centre on B $O^1$ traced with C B $O^1$ = C B D. We will see further the meaning of the angle D B C.

For what follows and in order to better understand the phenomena through the diagram, it is interesting to find the scale of same for the quantities mentioned. Supposing a three-phase motor with wound rotor,* let us call:

$n_1$ number of primary conductors per phase;
$n_2$ number of secondary conductors per phase;
$r_1$ primary resistance per phase;
$r_2$ secondary resistance per phase;
$p$ = number of poles;
$d$ air-gaps;
$K_1$ $K_2$ constant coefficients depending on the construction data of the machine;
S scale of induction;
$S_i$ „ primary current;
$S_{i_1}$ „ secondary current;
$S_p$ „ power;
$S_c$ „ torque;
$S_s$ „ slip.
L = net length of the motor;
D = diameter measured in the air-gaps;
$f$ = frequency.

We know that

$$i_2 = \frac{p\ d\ B^1_2}{K_2\ n_2}\ ; \qquad i_{1\mu} = \frac{p\ d\ B^1_1}{K_1\ n_1}\ ; \qquad P_1 = 3\ e_0\ i_1 \cos U\ A^1\ M\ ;$$

$$C = K_c\ L\ n_2\ B_2\ i_2\ ;$$

and being

$$\frac{B_1}{A\ B} = S\ ; \qquad B^1_2 = B\ M\ .\ S\ ; \qquad B^1_1 = \frac{A\ M}{V_1}\ S\ ;$$

we get $S_{i_2} = \frac{i_2}{B\ M} = \frac{p\ d}{K_2\ n_2}\ S\ ; \qquad S_{i_1} = \frac{p\ d}{V_1\ K_1\ N_1}\ S\ ;$

$$P_1 = 3\ e_0\ i_1 \cos U\ A^1\ M = 3\ e_0\ S_{i_1}\ M\ N_2{}^{11}\ ;$$

hence, $S_p = \frac{P_1}{M\ N_2{}^{11}} = 3\ e_0\ S_{i_1}$.

We easily arrive at

$$S_c = \frac{k\ p}{D\ .\ f}\ S_p$$

We see that by fixing the induction scale, the scale of currents, power, and torque are determined.

We have now

$$\mathfrak{N}_2 = K^1\ \frac{L\ B_2\ D}{p}\ .$$

and if $e_2$ is the secondary E.M.F., $e_2 = K^{11}\ \mathfrak{N}_2\ .\ f\ .\ s\ .\ n_2$.

But $i_2 = B\ M\ S_{i_2}$ and $B_2 = A\ L\ S \qquad A\ L = \frac{M\ C}{V_1}\ \sigma$, then we get

$$s = \frac{r_2\ p}{K^{11}\ L\ .\ D\ .\ f\ n_2}\ .\ \frac{p\ d\ V_1}{K_2\ n_2\ \sigma}\ \tan \epsilon, \text{ being } \tan \epsilon = \frac{B\ M}{M\ C}$$

and the slip scale is

$$S_s = \frac{r_2\ p^2\ d\ V_1}{K_s\ L\ .\ D\ .\ f\ .\ n_2{}^2\ \sigma}$$

On the starting point D we have $s = 1$ and

$$S_s = \frac{1}{\tan D\ C\ B} = \tan D\ B\ C = \frac{r_2\ p^2\ d\ V_1}{K_s\ .\ L\ .\ D\ .\ f\ .\ n_2{}^2\ .\ \sigma}$$

and the slip will be $s = S_s\ .\ \tan \epsilon$.

* The results will hold good for any other kind of motor, unless the numerical value of the coefficients differ.

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The speed of the machine is

$$N = \frac{120 \cdot f}{p} \cdot (1 - s) = \frac{120 \cdot f}{p} \cdot (1 - S_s \cdot \tan \epsilon).$$

This formula points out the four different methods to vary the speed in induction motors.

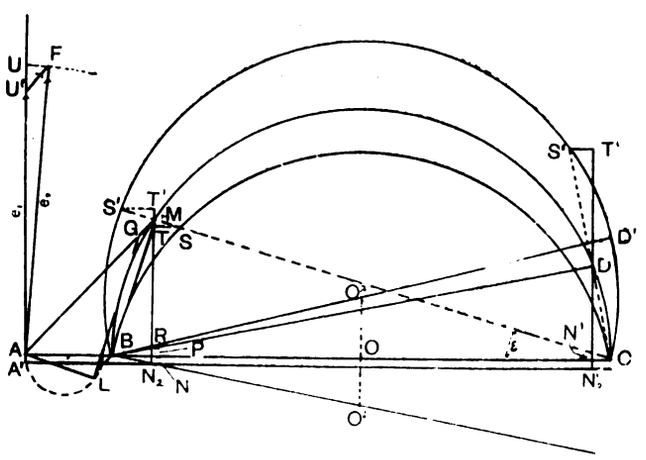
If the primary resistance be taken into account, the E.M.F., $e_1$, is not equal to the terminal voltage, $e_0$, but it is variable with the primary current.* We will suppose, only for a moment, that the difference between $e_0$ and $e_1$ is negligible; or, in other words, that the primary flux, $\Phi$, remains constant. We will also take into account the Joule loss, $3 i_1^2 r_1$. On this hypothesis the current $i_1$ will be the same as in the preceding case, the primary resistance having no other influence upon the current than this of reducing the E.M.F. induced and the flux $\Phi_1$. Then, if we take $i_1 \mu$ instead of $i_1$, we find that the power lost in the primary is represented by

$$\overline{A\,M}^2 = A\,B^2 + \frac{A\,B}{\sigma}\,B\,N + 2\,A\,B \cdot B\,N,$$

or,

$$A\,M^2 = A\,B^2 + A\,B\left(\frac{1}{\sigma} + 2\right) B\,N,$$

and we may say the primary losses are represented by a




rectilinear diagram with the primary wattless currents as abscissæ. Neglecting $A\,B^2$, or, say, the primary copper loss at no load, which is very small,

$$A\,M^2 = A\,B\left(\frac{1}{\sigma} + 2\right) B\,N,$$

and $B\,D^1$ may represent this equation. We have

$$A\,M = \frac{i_1 \mu}{S_{i_1}}; \qquad A\,B = \frac{B_1}{\sigma};$$

hence

$$\frac{i_1 \mu^2}{S_{i_1}^2} = \frac{B_1}{S}\left(\frac{1 + 2\sigma}{\sigma}\right) B\,N;$$

or being

$$S_{i_1} = \frac{p\,d}{V_1\,K_1\,n_1}\,S;$$

we have

$$i_1 \mu^2 = B_1 \frac{p^2 d^2}{V_1^2\,K_1^2\,n_1^2} \cdot \frac{1 + 2\sigma}{\sigma} \cdot S \cdot B\,N;$$

and the copper loss

$$p_1 = 3\,i_1 \mu^2\,r_1 = 3\,B_1 \frac{p^2 d^2}{V_1^2\,K_1^2\,n_1^2}\,r_1\,\frac{1 + 2\sigma}{\sigma} \cdot S \cdot B\,N;$$

and

$$\tan D^1\,B\,C = \frac{\frac{p_1}{S_p}}{B\,N} = B_1 \frac{3\,p^2 d^2 r_1}{V_1^2\,K_1^2\,n_1^2} \cdot \frac{1 + 2\sigma}{\sigma} \cdot \frac{S}{S_p}$$

But

$$\frac{S}{S_p} = \frac{V_1\,K_1\,n_1}{3\,e_0\,p\,d};$$

then

$$\tan D^1\,B\,C = B_1 \frac{d\,p\,r}{e_0\,K_1\,n_1\,\sigma}(1 + 2\sigma).$$

If we remember that $\frac{B_1}{e_0} = \frac{p_1}{L \cdot D \cdot n_1 \cdot f \cdot K}$, we may write

$$\tan D^1\,B\,C = \frac{p^2\,d\,r_1\,(1 + 2\sigma)}{K^1_s \cdot L \cdot D \cdot n_1^2 \cdot f \cdot \sigma},$$

which resembles the slip scale.

As we have shown for the circle B S C, it is easy to prove that if M T = N R, the locus of the points, like $S^1$, is the circle B $S^1$ C. This circle has its centre on B $D^1$; the angle $S^1$ B M is equal to the other $D^1$ B C; C $D^1$ is normal to B C. The total absorbed power will be represented by $N^{11}\,T^1$. At the short-circuit it is $T_1^1\,N_1^{11}$, and we have $N_1^{11}\,N_1$ iron loss, $N_1\,D$ secondary copper loss, $D\,T_1^1$ primary copper loss.

We must now correct all the elements given by the diagram (with the hypothesis $e_0 = e_1$), because the E.M.F., $e_1$, is not $A^1\,U = e_0$, but it is $A^1\,U^1$ if $r_1\,i_1 = U^1\,F$ is the potential drop in the stator winding.

With a sufficient approximation we can say that the real elements are smaller than those already found in the ratio, $\frac{e_0}{e_1}$, for the current flux, etc., and in the other $\left(\frac{e_0}{e_1}\right)^2$ for the torque and power.

We will prove that

$$\frac{e_0}{e_1} = \frac{A^1\,T^1}{A^1\,M}.$$

In fact,

$$\frac{M\,T^1}{A^1\,M} = \frac{3\,i_1^2\,r_1\,\frac{1}{S_p}}{i_1\,\frac{1}{S_{i_1}}} = 3\,i_1\,r_1\,\frac{S_{i_1}}{S_p} = \frac{r_1\,i_1}{e_1} = \frac{U^1\,F}{A^1\,U^1}$$

but the triangles $A^1\,U^1\,F$ and $A^1\,M\,F^1$ have two sides parallel, then

$$\frac{A^1\,F}{A^1\,U^1} = \frac{e_0}{e_1} = \frac{A^1\,T^1}{A^1\,M} = a_m$$

It is then easy to find the coefficient $a_m$ for every working point of the motor without any special geometrical construction.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

661. In an actual installation for electrically driving a bar drawing machine a compound-wound, belt-driven generator is used to supply current to a compound-wound motor, this motor supplying nearly all the generator load. When at work the generator will suddenly stop and run backwards against the belt for a time at high speed, then stop again, and restart in its correct direction to again repeat the cycle of operations. The motor during this time varies considerably in speed. What explanation can be offered of this apparently miraculous phenomenon?—M. E. G.

662. Several water-tube boilers that had been working for about 12 months have had each a number of tubes in the bottom rows replaced with new ones. This was owing to the tubes being badly bulged and in places reduced too thin to render them fit for further service. The boilers are of the straight-tube type, and it should be borne in mind that the trouble was confined to the tubes in the bottom rows only. The feed water is of an average hardness of about 15deg., this being reduced to about 3deg. by means of a lime-soda water-softening process. The boilers, since retubing, have been in constant service for the past two years, and no recurrence of the above-mentioned trouble has been experienced during this time. Would any readers give what, in their opinions, they consider to be the cause of the trouble?—NIGHT SHIFT.

* See Boys de Latour, "Moteurs Asynchrones Poliphasés"; Behrend, "The Induction Motor."

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## ANSWERS.

*Question No.* 653.—Describe what you consider to be the best system of electric lighting for railway carriages. Give sketches.

*Best Answer to No.* 653 (*awarded* 10*s.*).—The system of railway train lighting that has received fairly numerous applications in England and elsewhere is that known as the Stone system. In this system each carriage has a generator which is driven by one of the axles through a belt, a secondary battery, and a number of auxiliary devices. These devices are employed to keep the direction of the current independent of the direction in which the train is travelling, and also to connect the dynamo to the battery only when the speed of the train is sufficiently high for the pressure at the terminals of the dynamo to be at least equal to that of the battery. From this point, and at all faster speeds, the dynamo furnishes the current required to light the lamps and to charge the cells at the same time. The current generated by the dynamo, which is the sum of the charging current for the batteries, and the current supplied to the lamps, remains approximately constant whatever the speed of the train, for in this particular system the speed at which the armature revolves is kept constant by the slipping of the belt on the pulley as soon as the resisting couple attains a certain value. This practice, of course, necessitates that the tension of the belt must have a constant and carefully determined value. This is done by letting the weight of the dynamo supply the tension, it being suspended by one of its ends from the frame of the carriage. There is an adjustable counterweight to balance more or less the weight of the dynamo, so that the tension can be regulated to any necessary value.

A modification of this system is now in use on the Paris, Lyons, and Mediterranean Railway Company, and is known as the P.L.M. system. It consists, as in the Stone system, of dynamo and secondary battery, but the method of regulation differs from that of the Stone system. In this case the generator has constant excitation, and therefore, as the speed is exactly proportional to the speed of the axle, the pressure at the terminals is also proportional to the speed of the train. When the pressure is less than that of the battery, the circuit connecting the dynamo to the battery is kept open by an automatic switch. The excitation of the field magnets is supplied from the battery, which supplies the lamps at the same time. When the speed of the train increases and the two pressures become equal, the automatic switch couples the battery in parallel with the generator, which then begins to supply part of the current necessary to feed the lamps and to excite the field magnets. As the speed further increases, the machine supplies a surplus current which charges the battery.

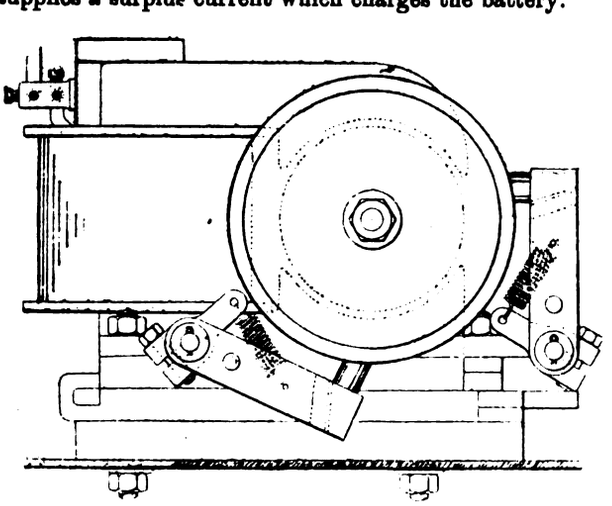

FIG. 1.

If there were no means of limiting the current provided by the generator, this might become too large on increased speed. On this account a regulating apparatus is added, which is essentially a small series motor, through which the current from the dynamo flows. To the motor is attached a pulley, on which a brake is applied with a certain pressure (Fig. 1). As soon as the total current through the generator assumes a certain value, this latter motor begins to turn in spite of the brake action. Then, as the speed of the dynamo and the pressure at its terminals increases, the back E.M.F. of the small motor increases automatically at the same time, since the motor also increases in speed, so that the tractive effort, and consequently the current, remains constant, whatever the speed of the train above normal. As well as the above regulator and an automatic switch, there is included an automatic reversing switch, which renders the

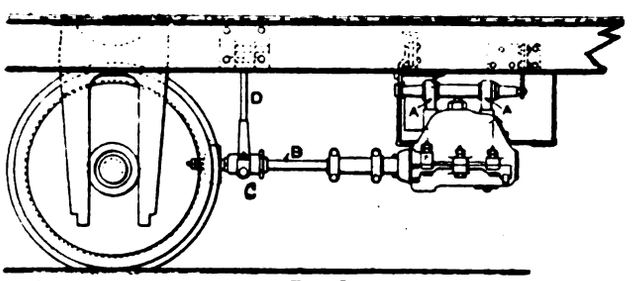


FIG 2.

direction of the current from the generator independent of the direction in which the train is travelling. In this case, however, no belt is employed, but the driving is done by friction; a small leather wheel presses against the inner flat surface of tyre, as will be seen in Fig. 2. The armature shaft is prolonged by a rod, B, and is connected to the armature shaft by a flexible rubber coupling. The rod is also supported near the friction wheel by a ball bearing fixed to the frame of the car by a hinged rod, D, the contact between the flange of the wheel and the friction wheel is ensured by a spiral spring fixed to the footboard, but not shown in the figure. This system of friction driving may in many cases not be necessary. Nevertheless, the system of regulating seems one of the best. The brake pulley of the small motor is of bronze, and the friction surfaces are carbon, and are pressed against it by springs. The tension on these springs is regulated in such a manner that the resisting couple determined by the adherence of these carbon brushes on the surface of the pulley is exactly equal to the couple which the motor develops when the current passing through it is only just sufficient to supply the lamps with currents. As the excess pressure at the terminals of the dynamo is compensated by the back E.M.F. of the regulator, the excess of current goes to charge the cells, excite the field magnets of the generator, and to supply the two auxiliary pieces of apparatus.—K.

*Answer to No.* 653 (*awarded* 7*s.* 6*d.*).—The first English railway to take up electric lighting in carriages was the London, Brighton, and South Coast in 1883, and they commenced with what is, no doubt, the best system—viz., axle-driven generators together with batteries. Briefly, there are three systems of train-lighting: (*a*) a battery on each car, which is charged or recharged at the station or car-sheds as may be required; (*b*) a steam-driven dynamo on the engine or in the guard's van; (*c*) each car fitted with its own axle-driven generator and battery of cells, with a variable speed or voltage regulating device to keep the pressure constant whilst the speed of the driving axle is varying. The latter is the best system of the three for English railways, owing to the frequent interchange of vehicles between companies, such as through carriages running on at least one foreign line.

The best-known system in England is the Stone system, which depends upon the slipping of the belt for regulation—that is, when the load on the machine reaches a fixed amount, the excess drag upon the belt causes it to slip on the pulley. Whatever may be one's opinion on this method, it works very well in practice, but naturally it is very heavy on belts and pulleys; in fact, on one train which the writer knows of the belts only last about six weeks, and wear nearly ¼in. off the steel pulley, and in that time run about 14,400 miles.

The following system has none of the above disadvantages. It has been introduced into England by the Electric Ordnance and Accessories Company, and is of American origin. It is belt driven; in fact, the elastic connection between the axle and dynamo spindle on all axle lighting devices is a valuable feature. The dynamo is shunt wound,

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dust-proof, with laminated fields, which contain a few sheets of hard steel which retain sufficient residual magnetism to enable the dynamo to build up its voltage promptly at low speeds. The armature spindle carries a worm gear and cam which throws over a switch when the direction of rotation is reversed, so that the polarity of the dynamo remains the same. Fig. 1 gives the connections, and it will be noticed

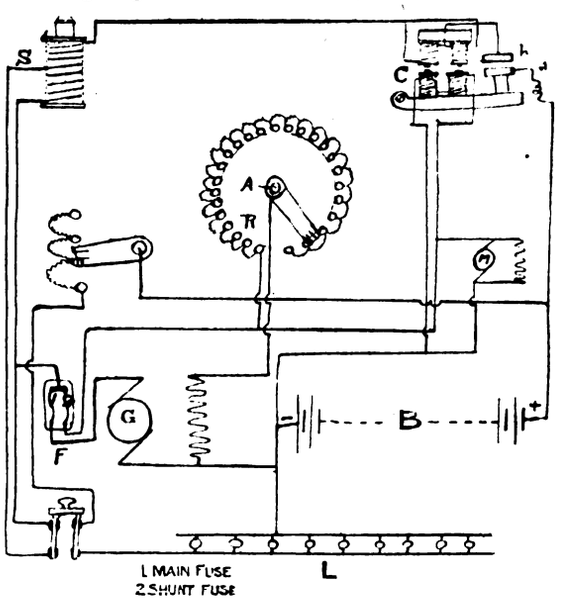


FIG. 1.

that the automatic switch has four bobbins, the two lower ones wound with fine wire and the two upper ones with heavy wire to carry the main current. As the train accelerates and the voltage builds up, current flows through the fine-wire coils until it reaches the battery voltage, when the magnetic pole of these coils causes the switch to connect the dynamo in parallel with the battery. The main dynamo circuit is then complete from the dynamo, G, fuse, F, solenoid, S, two thick-wire coils, C, cut-out switch, *h j*, battery, B, and back to the negative pole of the dynamo, G. When the lamps are on the current divides, part going through the resistance, E, to the lamps. As the speed of the train increases above the critical speed—that is to say, the speed at which the cut-out goes in—the current increases in proportion until it reaches the point where the magnetic pull on the solenoid balances the pull on its opposing spring. Any further increase of train speed will cause the solenoid to overbalance and throw into gear a ratchet mechanism (Fig. 2), which moves the generator

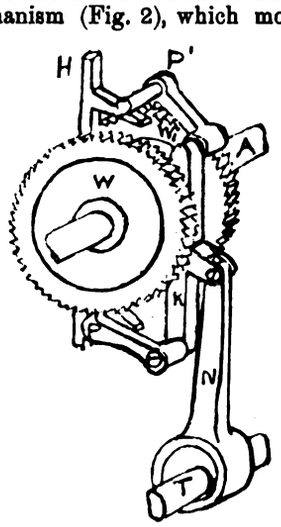


FIG. 2.

field rheostat arm until the current is cut down to the proper amount. A decrease in speed will cause the mechanism to act in a similar manner to cut out resistance from the dynamo field.

In Fig. 2 A is the spindle of the field rheostat, having mounted on it the ratchet wheel, W and W'. The vertical piece, H, is worked directly by the main solenoid plunger, and when the dynamo is generating the proper current, neither pawl can engage the wheel. The rocking piece, K, is fulcrumed on the shaft, A, and is actuated by a rod and eccentric, N, whilst the small motor, M (Fig. 1), drives the shaft through a worm gear. It will be seen that this is a constant-current system. A modification of the above is shown in Fig. 3, where a double battery system is shown. The battery reversing switch takes the place of the series resistance, E, in Fig. 1. By this, one battery is direct on the dynamo and the other on to the lamps, and they are connected through a resistance, *r*. The batteries are changed over automatically every time the train stops.

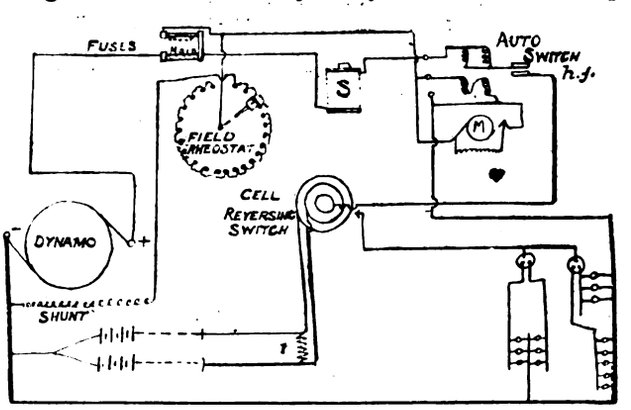


FIG. 3.

This method, it will be seen, is more economical in working than the first, in that there is no loss in the series resistance. For Figs. 1 and 2 I am indebted to the *Electrical Review* of April 10, 1903.—A. W.

*Answer to No.* 653 (*awarded* 5*s.*).—The advantages of electricity with reference to its steadiness, uniformity, etc., over gas and oil are too many, obvious, and well known to enter into, especially in a technical paper, but there should be borne in mind the ease with which it can be led to any position and there fixed to throw the bulk of its light at any required angle. These advantages being granted, the question for consideration is which is the best method of arranging or distributing the lamps, as it is always better, for many reasons, to employ two lamps of small candle-power, in preference to one of large candle-power, for a railway carriage compartment. There are three methods of doing this: (*a*) the lamps grouped together in couples, and fixed in the centre of the compartment on the under-side of the roof; (*b*) the lamps fixed on the roof, only separated, one towards each end or door of every compartment; (*c*) the lamps fixed on the partitions between the compartments.

(*a*) This method undoubtedly concentrates the light too much, the passengers sitting in the middle of the compartment gaining great advantage, but at the expense of those sitting near the windows. The lamps are always fixed in this manner when carriages are converted from the oil system of lighting to that of electricity, as, of course, the electric lamps occupy the place of the old oil globes. The only advantage of this system, which, however, does not lie on the side of the passenger, is its low first cost in fittings and wiring.

(*b*) By this plan the light is much more evenly diffused throughout the compartment, and for the purpose of reading it is immaterial where a passenger takes his seat. The first cost is, of course, greater than that of the former method, as two sets of fittings have to be provided, and also the wiring carried to two points in each compartment. The greatest drawback to this system, and which applies equally as much to system (*a*) is that the lamps are placed far too high, and a great portion of the light uselessly wasted on illuminating the racks, roof, etc.

(*c*) The method of fixing the lamps on the partitions between the compartments offers greater advantages, and in the following scheme it is claimed that the maximum of useful lighting effect can be gained. About over the head of the second passenger from each door a circular hole in the partition is cut, and a lamp fixed there by a very similar arrangement to that of a ship's bulkhead light, the lamps giving light to both the compartments on each side of the partition. A suitable reflector above each lamp should be

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provided, by which the light would be thrown downwards and not wasted on lighting the racks and roof, where it is not wanted. Two illustrations of this system are given, Fig. 1 showing a sectional plan of a carriage of six compartments cut through at the height of the lamps, and

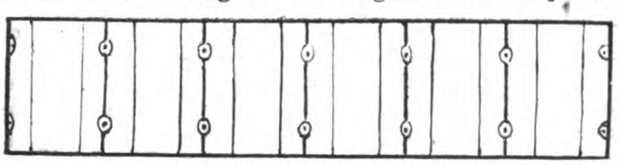

FIG. 1.—Sectional Plan of Carriage.

Fig. 2 gives a section of a partition, explaining the arrangement of the reflectors. As only half the illuminating power of each lamp would be available for each compartment, there would not be twice as much light as from two lamps

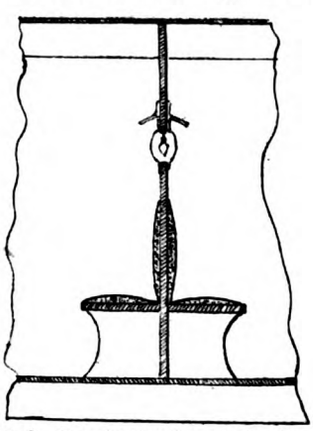

FIG. 2.—Cross-Section through Partition.

fixed on the roof; but it is certain that the illumination would be far more efficient, owing to the improved distribution and to the action of the reflectors.—G. A.

*Question No.* 654.—Describe fully the Hopkinson or other modern method of testing large numbers of electric motors quickly and economically.

*Best Answer to No.* 654 (*awarded* 10*s.*).—Electric motors are usually tested in pairs, one being run as motor off the supply and the other as generator, the latter being loaded up in small sizes by lamp bank, water, or other resistances. In larger sizes this would lead to a large consumption of power, and to obviate this the late Dr. John Hopkinson devised a method of testing which bears his name, although numerous modifications have subsequently been devised by Kapp, Swinburne, and others. This method, besides being economical in power consumption (since the power required is only that to make up the losses in the two machines), has also the advantage of being an accurate and simple way to determine the efficiency, since no measurement of mechanical power is required.

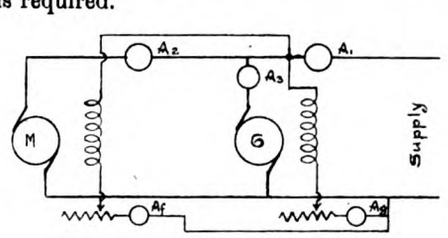


FIG. 1.

For the carrying out of the Hopkinson test two similar machines of the same output and voltage are required, though if the machines are rated at different speeds, each may be made to run at its rated speed when driven by the other by a suitable combination of pulleys. For efficiency determinations the machines should be exactly similar, otherwise the assumptions made in the efficiency calculations will be incorrect.

A diagram of the connections for the Hopkinson method is given in Fig. 1, the arrangement of switches being as in Fig. 2, which has been found to be very convenient. In Fig. 1 **M** is the machine running as motor, which drives the second machine, G, by means of a belt or coupling. The fields of both machines should be separately excited, field rheostats and ammeters being inserted as shown. When testing motors, a rheostat will not be required in the field of the machine acting as generator. The set is started up by putting a full field on the motor and starting this machine up with the starting rheostat. The field of the motor is weakened by inserting resistance, thereby increasing the speed, which latter is adjusted until both machines give the same voltage (the field of the generator, of course, being fully excited), when the armature switch of the generator is thrown in. It is very important to see that the generator volts "back" against those of the motor, otherwise a short-circuit will result when the switch is thrown in. On reference to Fig. 1, it will be seen that the generator is now running in parallel with the supply mains. The load on the motor is increased by further weakening its field, which causes the armature to run faster, and thus the generator volts are raised, causing this machine to feed more current into the mains. With the machines connected as in Fig. 1, ammeter $A_1$ measures the current taken from the supply to cover the losses in the system; ammeter $A_3$, the output from the generator; ammeter $A_2$, the input to the motor and ammeters; $A_f$, $A_g$, the field currents in the motor and generator respectively. If the connections are such that machine G runs as motor and M as generator, then $A_1$ gives the "losses" as before; but in this case ammeter $A_3$ gives the motor input and $A_2$ the generator output.

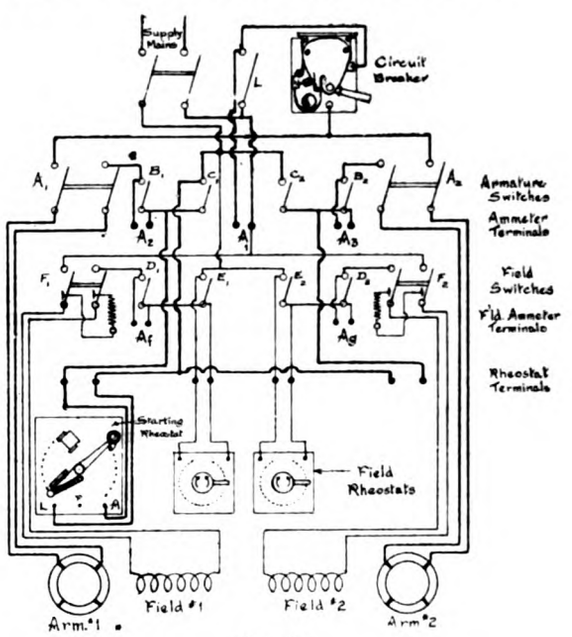


FIG. 2.

The current given out by the generator under the above conditions is designated as the "circulating current." When running a Hopkinson test on a pair of generators the circulating current should be equal to the full rated load of the generator, and on a pair of motors the motor input should correspond to the full load current of the machines. For machines of 15 h.p. and over the field switches should be provided with discharge resistances. A convenient way of ascertaining when the machines are giving equal voltage (previous to the throwing in of the generator switch), consists in connecting a voltmeter across one of the middle and one of the top contacts of one pole of the switch; when this voltmeter reads zero the switch may be thrown in. The efficiency of the combination, with the connections arranged as above, will evidently be $\frac{\text{circulating current}}{\text{total current input}} = \frac{A_3}{A_3 + A_1}$. If the machines are exactly alike, this will be the *square* of the efficiency of either machine, and hence the efficiency of each machine will be $\sqrt{\frac{A_3}{A_3 + A_1}}$. For efficiency readings Table I. may be found useful.

For ordinary heat runs the following figures (based on experience) may be found useful:

| | | |
|---|---|---|
| Motors up to 7½ b.h.p. ..... | 3 | hours run at full rated load. |
| Motors from 8 b.h.p. to 15 b.h.p..... | 4 | ,, ,, |
| Motors from 16 b.h.p. to 20 b.h.p. ... | 5 | ,, ,, |
| Motors above 20 b.h.p. ..... | 6 | ,, ,, |

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TABLE I.

| Line. | | Motor side. | | | | Generator side. | | | | Speed. | Direction of rotation. | Efficiency. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Armature. | | Field. | | Armature. | | Field. | | | | |
| Volts. | Amperes. ($A_1$). | Volts. | Amperes. ($A_2$). | Volts. | Amperes. ($A_f$). | Volts. | Amperes. ($A_3$). | Volts. | Amperes. ($A_g$). | | | $\sqrt{\frac{A_3}{A_1+A_3}}$ |
| | | | | | | | | | | | | |

TABLE III.

| Line. | | Motor side. | | | | Generator side. | | | | Speed. | Kilowatt output. | Efficiency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Armature. | | Field. | | Armature. | | Field. | | | | |
| Volts. | Amperes ($A_1$). | Volts. | Amperes ($A_2$). | Volts. | Amperes ($A_f$). | Volts. | Amperes ($A_3$). | Volts. | Amperes ($A_g$). | | | $\sqrt{\frac{A_3}{A_2+A_f+A_g}}$ |
| 235 | 22 | 235 | 92 | 166 | 1·6 | 235 | 70 | 230 | 2·4 | 1,100 | 16·4 | 88·3 % |
| 226 | 19·5 | 226 | 88·5 | 170 | 1·57 | 226 | 69·1 | 220 | 2·03 | 1,100 | 15·6 | 86 6 % |
| 235 | 16·5 | 235 | 66·5 | 180 | 1·75 | 235 | 50 | 235 | 2·2 | 1,100 | 11·7 | 84·2 % |
| 236 | 13·75 | 235 | 44·5 | 180 | 1·75 | 236 | 31 | 216 | 2 02 | 1,100 | 7·3 | 80·2 % |

Temperatures should be taken of the principal parts at the end of run, and also resistances of armature and field at beginning and end of run.

Referring to Fig. 2, it will be noticed that terminals are shown for the insertion of the various ammeters, and that all ammeters and rheostats are provided with short-circuiting switches, this arrangement being extremely convenient when running a test. The armature switches of the machines are denoted by $A_1$ and $A_2$, while $B_1$ and $B_2$ are the short-circuiting switches for ammeters $A_2$, $A_3$; $C_1$ and $C_2$ are the short-circuiting switches for the starting rheostat. Switches $A_1$ and $A_2$ should preferably be of the quick-break type, but all short-circuiting switches should be of the ordinary "knife" pattern. $F_1$, $F_2$ are the field switches, which should be provided with discharge resistances; $D_1$, $D_2$ the short-circuiting switches for the field ammeters ($A_f$, $A_g$); $E_1$, $E_2$ the short-circuiting switches for the field rheostats, and L the line ammeter ($A_1$) short-circuiting switch. All ammeter switches should be kept closed, except when readings are being taken. A voltmeter switch is not shown in the diagram, as the number of lines radiating therefrom would render the rest of the connections unintelligible.

Mr. H. M. Hobart, in his exhaustive series of articles on "The Design and Construction of Electric Motors," recently published in *Traction and Transmission* (vol. v, pp. 108 to 110), gives a diagram and explanation of the Hopkinson method of testing motors, accompanied by tables giving particulars of efficiency tests made on motors built by Messrs. Vickers, Sons, and Maxim, of Sheffield, from which Table II. is compiled.

TABLE II.

| Line. | | Generator side. | | | | Efficiency |
|---|---|---|---|---|---|---|
| Volts. | Amperes $A_1$ | Volts. | Amperes (circulating current). $A_2$ | B.H.P. | Speed (R.P.M.) | $\sqrt{\frac{A_3}{A_1+A_3}}$ |
| 220 | 6·5 | 220 | 19·5 | 5·75 | 683 | 86 6 % |
| 203 | 5 7 | 203 | 19·0 | 5·17 | 690 | 87·7 % |
| 204 | 4·3 | 204 | 15·0 | 4·10 | 685 | 88 1 % |
| 204 | 4 2 | 204 | 14 0 | 3 83 | 680 | 87·7 % |
| 203 | 3 4 | 203 | 10 0 | 2·72 | 665 | 86·4 % |

The motors are of the partially enclosed type, shunt wound, and rated at 5 b.h.p., 600 revolutions per minute, 220 volts. It will be observed that this motor has a very high "all day" efficiency. Table III. gives some efficiency readings from a generator test, the connections being arranged as in Fig. 2, where, it should be pointed out, the fields are taken right off the main switch, and ammeter, $A_1$, does not, therefore, include the field current The efficiency is calculated from

$$\sqrt{\frac{A_3}{A_1+A_3+A_f+A_g}} = \sqrt{\frac{A_3}{A_2+A_f+A_g}}.$$

The machines were rated at 16 kw., 230 volts, 1,100 revolutions per minute, and were of the partially enclosed type, shunt wound.—MONOPHASE.

*Answer to No.* 654 (*awarded 7s. 6d.*).—The Hopkinson test consists in coupling two similar machines together mechanically and electrically. One is run as a motor and drives the other as a generator, the current from the machine running as a generator being returned to the terminals of the one running as a motor. Supposing it were possible to have this arrangement without loss, the system would run continuously. This is, of course, impossible, and by noting the losses in relation to the energy circulating in the system, the gross efficiency can be calculated. The machines may be joined together either by a belt or by a coupling; some form of flexible coupling is preferable, as any trouble due to loss in belting is eliminated. In the original design the loss was supplied mechanically through a transmission dynamometer. It was, however, soon proposed to supply this waste electrically, owing to the ease and accuracy with which electrical measurements can be taken. There have been many variations of this test devised. A number of these are described and illustrated in the issue of the *Electrical Engineer* for Dec. 20, 1901. Fig. 1 is another arrangement

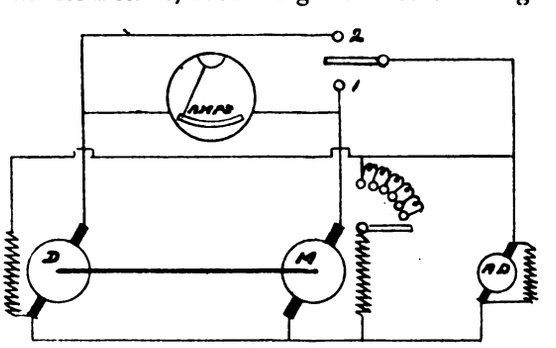


FIG. 1.

of this test due to Kapp. D and M are two similar machines, M running as a motor and driving D as a generator. A D is an auxiliary dynamo to start the combination and supply the losses. An adjustable resistance is necessary in the motor field to reduce its voltage. By means of the two-way switch readings are taken. Let $C_1$ be the amperes when on stop No. 1, and $C_2$ the amperes when on stop No. 2. In the first case we have the current in D, in the second case the current in D plus the current supplied by the auxiliary dynamo. As the voltages are the same, the ratio of these readings gives the gross efficiency. This gross efficiency is the product of the efficiencies of the machines. The efficiency of each machine is therefore $\sqrt{\frac{C_1}{C_2}}$. Swinburne's "stray-power" method is a quick and economical way of testing motors. There are only a few connections to make, and but a small percentage of the full-load current at which the motor is rated is required. The method is

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based on the fact that the commercial efficiency of a motor $= \frac{\text{output}}{\text{input}} = \frac{\text{input} - \text{losses}}{\text{input}}$. The losses are: copper resistance loss in the windings, eddy currents, windage, brush and mechanical friction. The loss due to resistance of the windings can be calculated. The whole of the other losses, which are difficult to determine separately, are called by Swinburne the stray power.

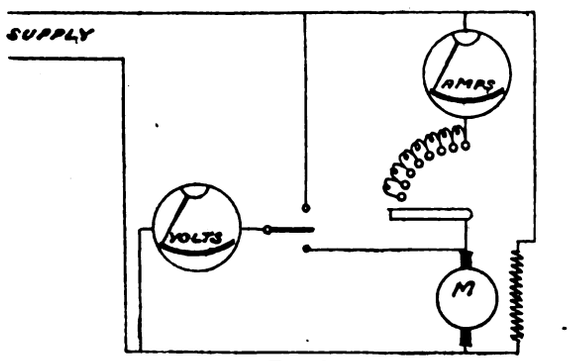


FIG. 2.

Fig. 2 is a diagrammatic sketch of the connections for this test. M is the motor under test, driven from a supply at the full voltage of motor so that the shunt winding may give normal excitation. By cutting out resistance in the armature circuit the motor may be brought up to its rated speed. The load on motor is now the stray power only. By means of the two-way switch note voltage of supply and take potential, $E_A$, between the brushes of the motor. The ampere-meter will give the current, C, flowing through the armature. The stray power $= C - E_A C^2 R_A$, where $R_A$ = resistance of armature.

The Hopkinson test is only suitable for similar and large motors; by the "stray-power" method machines may be tested singly, and it is more convenient for small sizes. When numbers of motors up to about 10 h.p. have to be tested, perhaps the most usual method of testing is by means of an absorption dynamometer. Fig. 3 is a sketch

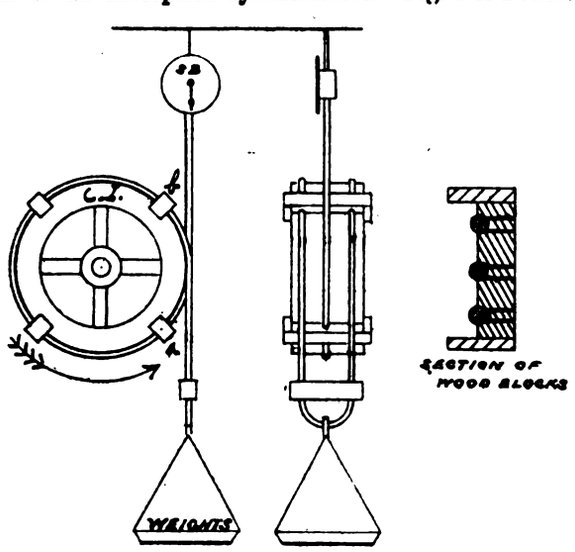


FIG. 3.

of Prony's brake; C I is a cast-iron pulley of U section, in which water may be trickled to keep it cool; S B is a spring balance, and weights are placed in the pan to load up motor. The ropes are connected to four wooden blocks by wires; an enlarged section of one of these blocks is shown. By arranging ropes as in sketch, one up to spring balance from block *a*, and two from block *b*, to the scale pan, there is no danger of twisting or fouling the ropes. The brake horse-power is obtained by multiplying the peripheral speed of the pulley in feet by the weights in pounds less reading on spring balance and dividing by 33,000. If the ropes are black-leaded, they will run many six hours' tests. For small motors, say, up to half-horse, a smaller pulley and a double thickness of stout linen tape may be used. For this purpose the linen tape used by cabinetmakers is very suitable. For speedy testing rails should be available to which the motors may be bolted with an overhead crane to move quickly about as required.—M. M.

*Answer to No.* 654 (*awarded* 5*s.*).—To answer the above question satisfactorily, one would have to know the limits of size of the motors and the tests that the designers ask for. In some test shops all motors designed for continuous running—that is driving pumps, workshop machinery, etc.—are run for six hours, while in others turning out as good a class of machine they are only run for a short time under load. Traction motors are usually run for one hour at their rated loads, and motors for intermittent work are run for such a length of time and at such an overload as the designer from his experience considers necessary.

The Hopkinson method is very suitable for testing large machines over long time runs, but for the ordinary commercial size of motor it has several disadvantages. Taking the case of a 10-h.p. motor, and assuming an efficiency of 85 per cent., and also that the efficiency curve about the 10-h.p. point is a straight line—this latter is not true, but will do for comparison—this figure gives us a combined efficiency of 85 per cent. of 85 per cent. = 72 per cent, and means that one machine has to give an electrical output 1·4 times. If one machine takes the normal load as a motor the other will be considerably underloaded, and will have to have its fields put in parallel or a higher voltage on them. For small motors—up to 2 h.p.—a modification of the Prony brake, in which the torque is produced between a copper disc rotated by the motor and an electro-magnet, is very useful. The electromagnet has poles embracing the wheel, and is supported on knife-edges. A balance is first obtained with the wheel at rest, then when the machine is run up and the magnet excited a further balance is obtained by sliding a weight, which is on the apparatus when balanced stationary, along a graduated bar.

$$\text{H.P.} = \frac{w \times L \times N}{33{,}000},$$

where $w$ = sliding weight in pounds;
L = twice the distance moved in feet;
N = revolutions per minute.

The wasted energy is easily dissipated in the air owing to the comparatively large surface of the brake wheel. Very small motors may be conveniently tested by means of a grooved pulley, round which is a turn of string. One end of this has a weight attached to it, and the other end is moved round, so that more or less string touches the pulley till there is no pull showing on a spring balance attached to it.

$$\text{H.P.} = \frac{\text{weight} \times \text{revs. per minute} \times \pi \times \text{pulley diameter}}{33{,}000}.$$

For motors above 2 h.p. the best arrangement is a rope brake, the pulley of which is arranged for water cooling. The rope is slung with one turn, but any number of ropes may be put in parallel, according to the weights which may be necessary. The top of the rope is supported on a spring balance, and the other end has a pan on which the weights are supported. When not actually being used the spring balance should have the weight taken off it, so that if the motor is suddenly shut down the balance will not be damaged. The range of the balance should be about 20 per cent. of the total weight.

Then if $w_0$ = weights in pan;
$w_1$ = weight of pan + that part of the rope not on the pulley;
$w_2$ = back pull on scale;
D = diameter of pulley;
$d$ = diameter of rope;
N = revolutions per minute;

$$\text{H.P.} = \frac{(w_0 + w_1 - w_2)(D + d) \times \pi \times N}{33{,}000}.$$

For general purposes this may be considered as the most convenient method. The brake pulley must have flanges at either end (inside) so as to hold the water. Care should be taken to have a plentiful supply of water and to keep the rope off that part of the pulley to which the water has not free access. This refers to the part where the arms or plate joins the rim. There are a number of tips on the

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use of this brake, but to refer to them would make this article too long. If the efficiency of a shunt motor, and consequently the current output, is known, it may be belted to another machine which is connected to the power supply mains. This is simply run in parallel with the supply and the load regulated on its shunt in the ordinary way. This will economise from 50 to 70 per cent. of the power required according to the combined efficiency of the machines used.—K. M. E.

The answers to Question No. 652 will be found on p. 278.

## COAL-CUTTING MACHINES.

We have before us a copy of the 1904 issue of Messrs. Mavor and Coulson's "Red Book," describing Pickquick coal-cutting machines fitted with direct-current and three-phase motors, several makers, who have produced motors of special design for coal-cutting machines. When the system of electric supply is open to choice, direct current should be selected, as it is the best adapted for driving coal-cutters. When the adoption of alternating current is determined by other considerations, a low periodicity, not exceeding 30 cycles per second, should, if possible, be used. The limitations in respect of diameter, speed of rotation, and complete enclosure of coal-cutter motors are incompatible with the best design in alternating-current motors for higher periodicities. The application of alternating-current motors to the larger sizes of bar coal-cutters for use in thick and medium seams presents little difficulty when the periodicity does not exceed 30 cycles per second, but for the small-size machines the use of alternating current is impracticable. Where the supply is alternating it is, therefore, necessary to interpose rotary converters, or motor-generators, in order to transform to direct current for the small machines. By the inclusion of such practical and useful information as the foregoing the value of the publication under notice is greatly enhanced.

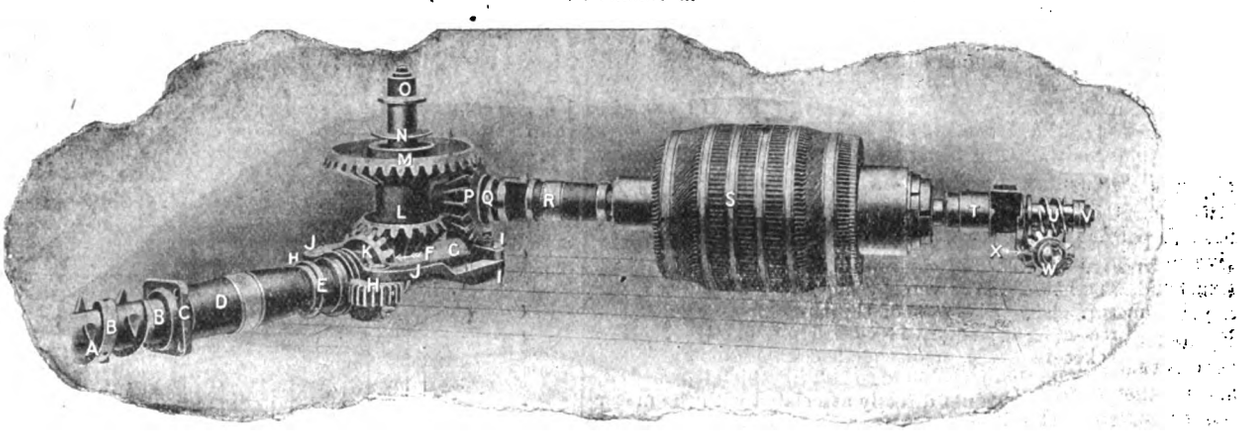


FIG. 1.—The Working Parts of a Pickquick Electric Bar Coal Cutter.

etc. As the "Foreword" aptly states: The question now to be determined by many colliery managers is not whether coal-cutting machines shall be adopted, but what type of coal-cutter shall be selected? The book under notice is designed to set forth the special, and in several respects unique, advantages claimed for the Pickquick long-wall coal-cutters. The technical aspect of the case is dealt with in a way which will be found both instructive and entertaining by mining engineers, and we have the economies effected by machine mining summarised as follows: (1) the cost of holing is reduced by the large increase of output per man employed; (2) a large output is obtained from a relatively small face, and the extent and cost of maintenance of roads is reduced; (3) the cost of timbering is reduced, and

The construction of the Pickquick coal-cutter is, of course, fully described and illustrated. It consists essentially of five parts—viz.: (1) cutter bar, (2) gear head, (3) motor, (4) switch box, (5) hauling gear. Referring to Fig. 1, the cutter bar, B, is of mild steel, and is machined out of the solid. The spiral thread formed on the bar acts as a worm conveyor, bringing the cuttings out from the holing, giving freedom to the cutting picks, A, and leaving space for the coal to drop. On the inner end of the bar a renewable thrust collar, block E, of forged, machine-cut, and case-hardened steel is fitted, and through this a reciprocating motion is imparted to the bar. The gear head completely encloses the main gearing. A pinion, P, on the motorshaft drives the double bevel wheel, which in turn drives the cutter-

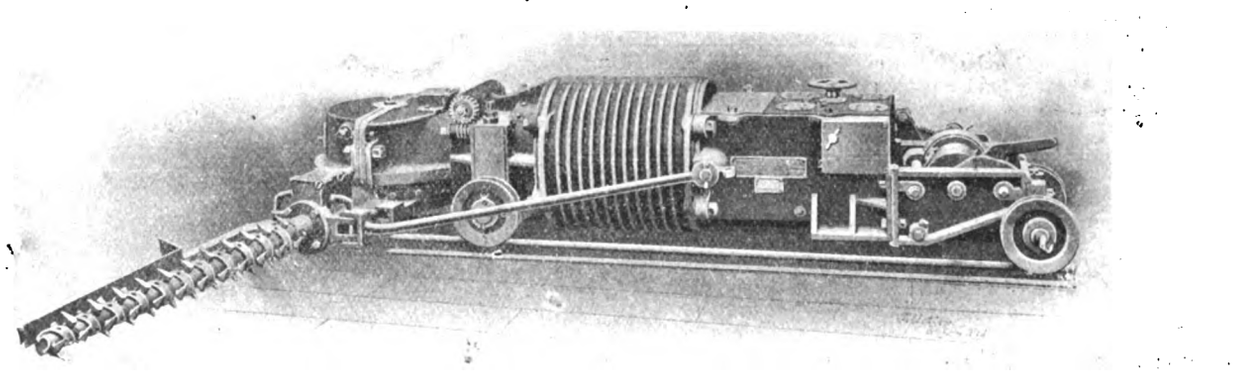

FIG. 2.—A Pickquick Electric Bar Coal Cutter, with Alternating-Current Motor—adjusted for undercutting.

the straight and rapid advance of the face facilitates the breaking away of the coal; (4) the use of explosives is almost invariably reduced, and is frequently abolished, by machine holing; (5) the percentage of slack is reduced, and the sale price of the coal is substantially increased; (6) greater safety to the miner. The machine does the most dangerous and laborious part of the miner's work, and the systematic timbering imposed by machine holing reduces falls at the face, and diminishes the number of accidents and compensation claims. The ratio of accidents to tonnage output has proved to be much lower with machine-cut than with hand-holed coal.

We are reminded that the driving of a coal-cutter is probably the most severe duty to which an electric motor can be applied, but the exacting conditions have been fully recognised and met by bar pinion. This pinion is not keyed rigidly to the bar, but is fitted with a feather projecting into the bore. The feather engages in a long keyway in the bar, which being driven is thus free to reciprocate along its own axis. A rack in the lower part of the gear case, worked by a pinion, provides for turning the lower part of the gear head with the cutter bar in a horizontal plane for cutting in. A worm fixed on the socket of the motor shell (see Fig. 2) gearing with the wormwheel, provides for tilting the bar in a vertical plane. The reciprocating motion is obtained from a worm upon the boss of the bar-driving pinion, gearing with two small wheels, each of which drives a toggle by means of an eccentric pin. The toggles impart a to-and-fro movement to the thrust block, and with it the cutter bar. The combined rotary and reciprocating movement thus

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imparted to the bar gives a chipping and shearing action, which effectually prevents the bar from clogging and the cutters from working into grooves. The direct-current motor is of the four-pole completely enclosed type, with two shunt-wound magnet coils. The motor shell has incorporated with it the socket into which the spigot of the gear head enters, and also the hand gear, which by means of a worm engaging the rack on the gear-head spigot elevates or depresses the point of the bar. The pole-pieces, with their exciting coils, are readily detachable from the sides of the shell, so exposing the armature for inspection. The latter is of the slotted-drum type. The core is built upon a cast-iron hub fitted with cylindrical ends to support the end windings, and provided with an extension to carry the commutator independently of the shaft. The brush gear is attached to the switch box, the brushes themselves being so arranged that they are easily removed for inspection, and the compensation for wear is automatic. A screw, with external handle, is provided to admit of any necessary brush adjustment without opening the motor. The starting switch and resistance are enclosed in a flame-tight cast-iron box bolted to the end of the motor shell. The resistance coils are wound upon formers enclosed in a chamber behind the switch ; in the same casting a tool box is provided for the few tools which it is necessary to carry. In the switch-box casting, and accessible through the tool box, is a chamber into which a renewable worm (shown at U in Fig. 1) on the end of the armature shaft projects. This worm gives motion to a cross shaft which passes through the side of the box, and carries outside a disc with pin (adjustable radially) which operates a connecting rod, and by it the ratchet of the haulage gear, which is bolted to the end of the switch box. A view of Pickquick bar coal-cutter adjusted for undercutting is shown in Fig. 2. This machine differs from the one just described, in that it is driven by means of an alternating-current motor. This motor is of the three-phase type, and, like the direct-current motor, is completely enclosed. The gear-head socket in the case of the three-phase motor is cast of steel independently of the motor shell to which it is bolted, but for the rest the parts not directly associated with the motor are identical for both direct-current and alternating-current machines.

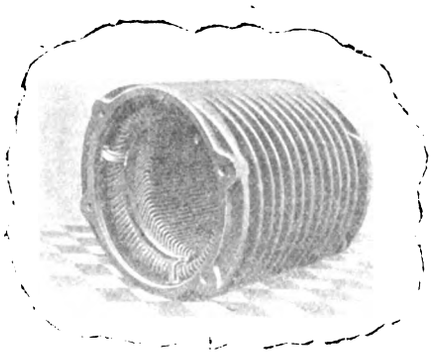


FIG. 3.—Stator Core of an Alternating-Current Motor for a Pickquick Electric Bar Coal Cutter.

The stator core (Fig. 3), with the conductors embedded in its slots, is contained in a cylindrical cast-steel shell with ribs cast upon it to assist the radiation of heat. The windings of the core are securely held in place by rings, which prevent the possibility of relative movement of the parts. There is no opening in the stator shell, and its ends are closed by faced joints with the gear-head socket and auto-starter box respectively.

The rotor is of the closed-circuit or squirrel-cage type without slip-rings. The core discs are built up on a cast-iron hub, and the conductors, consisting of round copper bars, are, with their insulation, completely embedded in the slots of the core. The ends of the core conductors are short-circuited by having copper rings cast round them. This method, besides providing the electrical contact, makes a perfectly rigid mechanical connection, and firmly holds the conductors in position. The shaft, from which the rotor is easily removed, is supported by bearings of exceptional length carried as close to the rotor as possible.

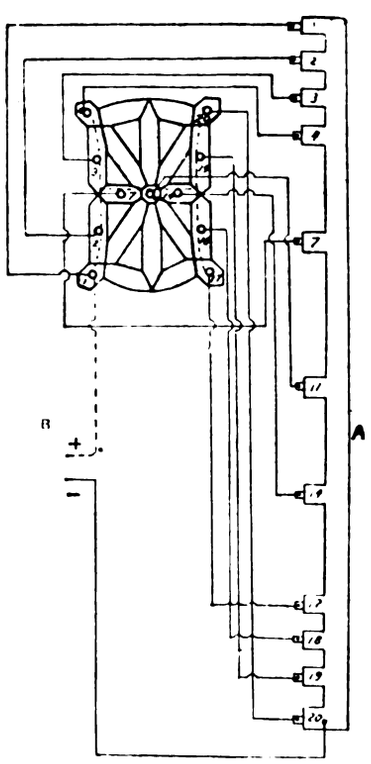
The auto-starter is contained in a close cast-iron box. The coils are fixed at the bottom of the box, and over them the controller type switch, which is operated by an external insulated handle. The dimensions of the auto-starter coils and switch are such that immersion in oil is avoided.

Readers who desire further information about Pickquick coal-cutters could not do better than apply to Messrs. Mavor and Coulson, Limited, 47, King-street, Mile End, Glasgow, for a copy of their "Red Book," which, in addition to the above, contains data and general information bearing on the important question of coal-cutting by machinery of an extremely useful character. We are glad to note that the sales of these machines are increasing very rapidly. Those for 1903 included, we understand, nearly 40 per cent. of repeat orders. What further testimonial is needed ?

## TRADE NOTICES AND NOVELTIES.

### The Talking Sign.

The British Electric Sign Company, Dashwood House, last Friday exhibited opposite the Grand Café de l'Europe their new and effective advertising device, which consists of the manipulation of 21 fixed ordinary electric light bulbs, each of which is placed into a separate reflecting trough or compartment of a square frame in such a manner that they are capable of forming any and every letter of the alphabet or required figure. These frames are truly called monograms. Connected with each bulb is a wire, which is run to the bottom of the monogram, and is carried off to a room somewhere adjacent to the "sign" or series of monograms—in this case 17—where there are a number of commutators. There is one commutator to every monogram, so that in the case in point there will be 17 commutators. They are about 1ft. long and 8in. high, and are mounted on a slate base 4in. wide. Three brass discs are fastened to the shaft of the commutator, one at each end and one in the middle, and these are slotted in 40 places, equidistant apart, for the reception of flat pieces of metal called letter-bars, and answering exactly the same purpose as ordinary printers' type. Each bar represents a different letter, and each letter-bar having projections coming from different places along the edge. Above the commutators is a slate top, on the underside of which are 20 phosphor-bronze flat springs, and above these springs 20 contact posts, which are connected with the 20 wires coming from the monogram. When a letter-bar is inserted in the commutator the teeth on it press up the springs, and complete the circuit by touching the contact posts. It will be seen, therefore,




that each letter-bar—for the teeth on each are different—connects up certain bulbs, and so makes the different letters. The commutators rotate at regular intervals by means of a motor attached to an intermittent locking gear, and if it is desired to stop them at one line of the message, all that has to be done is to switch off the motor, when that particular line remains on the sign till the motor is switched on again. The lines in the commutators can be changed very readily and quickly, and a boy can manage the whole sign, as once it is started it requires absolutely no attention whatever. Not the least important point about the sign is that the words can be read at an angle remarkably clearly, and that the light, owing to the reflectors which line the cells, is seen at a great distance. Our illustration shows a letter-bar with the teeth necessary to form the letter H in the monogram. About 40 different lines of news were flashed out on the wall of buildings opposite the Café de l'Europe, thus illustrating clearly the great value of this neat method of advertising, for newspaper offices, shops, theatres, etc., where a quick change of matter is often required.

### Electric Time Service.

In the course of an article describing the electrical equipment of a new factory we referred last week to an installation of electric clocks which provides uniform time in the various departments. These clocks were supplied by the Synchronome Company, 32 34, Clerkenwell-road, London, E.C., and the

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following is a brief description of the system of working: An electrically-driven pendulum is used to control any number of dials. The pendulum is operated by two wheels, and each dial by one. There is little explanation needed of the accompanying diagram, which shows the arrangement of the controlling device. The weighted lever, A, as it falls turns the wheels, B and C, and keeps the pendulum, D, swinging. When it reaches the armature, E, the circuit of the battery, F, is closed, and the electromagnet, G, replaces the weight by throwing it up on to the next tooth of the ratchet, B.

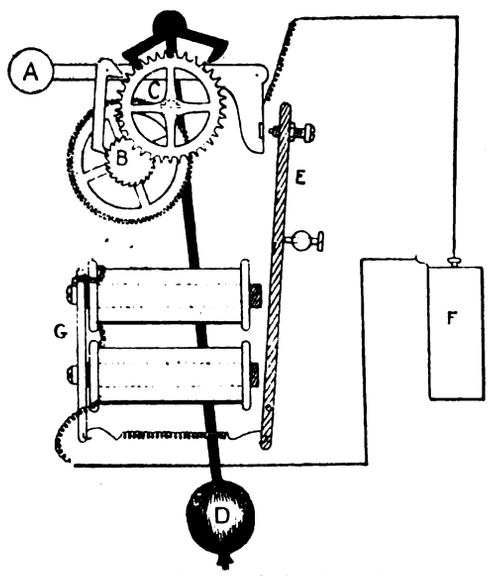
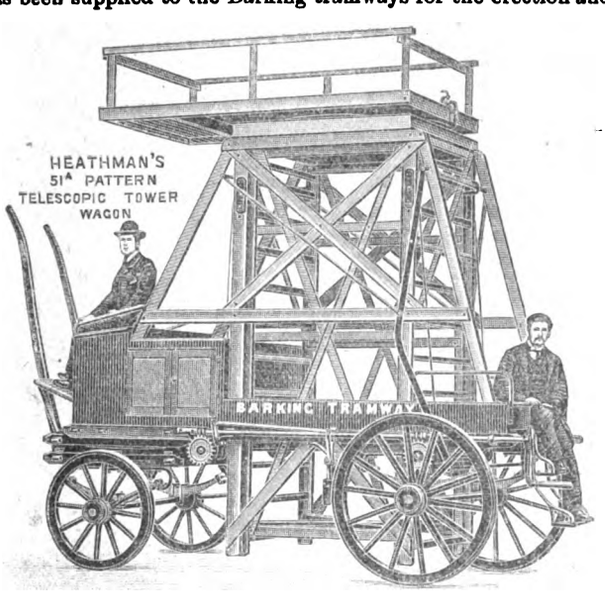



Diagram of Automatic Timed Switch.

The electrical contact, occurring at each half minute precisely, is the only contact in the system, and it is a very perfect one; a severe rubbing and thrusting action of the surfaces being obtained at every operation. It is so designed that at each operation it transmits to all the dials sufficient current to propel them, each of the indicator dials being provided with an electromagnet, through which the clockwork attached is actuated by the impulses received from the controlling device. The whole arrangement is exceedingly simple. It remains to add that the system has already been widely adopted, but having regard to the obvious advantages which it offers it has certainly not yet met with all the attention which it deserves, and this applies especially to manufacturers.

## A New Tower Wagon.

The illustration shows Heathman's latest improvement, which has been supplied to the Barking tramways for the erection and




maintenance of overhead trolley wires. It will be noticed, amongst other improved features, that the tower is set lower down than usual, which gives a reduced height when closed. There is also an improved locking arrangement, which by the movement of one lever operates the locks at all four corners to secure the rising section in the unforeseen event of a rope breaking, although as there is a homogeneous steel-wire rope at each corner, and each is independent of the other, such a mishap is not very likely to occur. The revolving platform can be locked by the mere turn of a screw in any position. The winding arrangements are operated at the back, so as to be quite clear of side traffic, and the hind axle is made longer so as to give wider bearing surface upon the road to secure increased stability against turning over in high winds. Another improved feature is the larger box for storage of tools and materials, and also that one man can raise and lower the sliding section even when three or four men are upon the platform with their tools and material. The whole appears to be extremely well put together, of solid construction, and yet reasonably light in weight. In fact, one horse can draw it at a good speed to the scene of action. The works of the makers are, we are given to understand, about to be very considerably enlarged, and their buildings at Parson's Green, Fulham, S.W., added to, as, in consequence of the great satisfaction which their manufactures give, orders are so numerous that increased accommodation has come to be a necessity.

## "Excello" Arcs.

We have recently received from the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., some figures which show their "Excello" intense flame arc lamp in a very favourable light. Four of these lamps in series are compared with 12 enclosed arc lamps connected two in series, the former showing an economy in current consumption of over 71 per cent., and an increase of effective illumination of over 60 per cent.—certainly very commendable results. We understand that "Excello" arcs were used on the occasion of the Union Jack Club Ice Carnival held last week, in connection with which the presence of Royalty, of course, made it imperative to have everything of the very best.

## Telegraph and Telephone Apparatus, etc.

We have received from Messrs. P. Walters and Co., Kensal Town Telegraph Works, Kensal-road, London, W., a copy of their new catalogue dealing with telegraph and telephone instruments of all kinds, line material, railway block and signalling apparatus, batteries, linesmen's tools, etc. This catalogue is well printed, and contains many excellent illustrations. In fact, we have no hesitation in commending it to the notice of readers who may be concerned with the class of apparatus in question.

## Price-List.

From Messrs. W. F. Dennis and Co., 49, Queen Victoria-street, London, E.C., we have a copy of the fourth edition of their "Fredennis" price-list, which they are just issuing to the trade. We note that the firm have made several additions to their stock, from which they can effect prompt delivery. Among the goods listed are the following: bright drawn-steel rods, copper and bronze wires, covered wires of various kinds, flexible cords for arc lamps, telephone instruments, etc.

## Publications, Catalogues, etc.

TWENTIETH-CENTURY VENTILATION.—A short catechism published by James Keith and Blackman Company, Limited, 27, Farringdon-street, E.C., with a view of popularising the appreciation of fresh air indoors, and the knowledge of ventilating properly.

G. BRAULIK, 217 and 218, Upper Thames-street, London. "Eclipse" electricity meters (list E.M.) for continuous and alternating current (two and three wire).—We are asked to say on application a copy will be forwarded to any station engineer or contractor who is not already in possession of same.

ARTHUR CORT AND CO., 277, Camberwell New-road, London. Red, grey, or black insulating hard or flexible vulcanised fibre, in sheets, tubes, rods, washers, valves, etc., for electrical, mechanical, railways, tramways, carriage builders, and general engineering purposes; genuine balata, guttapercha, and cotton belts; guttapercha sheet, tube, cord, belts, tissue, etc.; Chatterton compound.

JOSEPH KAYE AND SONS, LIMITED, Hunslet, Leeds.—Kaye's latest improvements in oilcans.

## APPOINTMENTS VACANT.

**Car-Shed Foreman**, Rotherham tramways. Salary, 40s. per week. Applications to Mr. H. Hampton Copnall, town clerk, Town Hall, by Feb. 13.

**Assistant Electrical Engineer**, Bradford. Salary, £250 per annum. Applications by Feb. 18. See advertisement.

**Assistant Clerk**, Woolwich Electricity Department. Salary, £100 per annum. Applications by Feb. 23. Particulars from Mr. J. B. Mitchell, electrical engineer, White Hart-road, Plumstead.

**Assistants** (2), Stalybridge, Hyde, and Mossley Tramway Board. To supervise erection of plant and act as shift engineers. Applications by Feb. 17 to the Chairman of the Generating Station Committee.

**Electrical Engineer**, Holyhead Electricity and Refuse Destructor Works. Particulars from Mr. C. E. Moreton Prichard, Urban District Office. Applications by Feb. 22.

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## TRANSATLANTIC ENGINEERING SCHOOLS.

The lengthy paper of Dr. Walmsley presented to the Institution contains a vast amount of interesting detail in regard to the educational methods and training adopted in the States. It is too often forgotten that the educational system of this country was initiated centuries ago, and that the problem before us is to continually change the existing system so as to fulfil the requirements of to-day. On the other hand, the educational system of America is comparatively new, and it was possible to organise it at the start so as to comply with modern needs. Before entering into the subject of Dr. Walmsley's paper, we must emphatically protest against "the outcry that we are being beaten in our great staple industry of mechanical engineering." Prof. Walmsley does not discuss this statement, but merely gives it as a fact well known. The outcry exists, but it has come from those who do not know, and is disputed and contradicted by those who do know. The keen competition which exists has no more to do with educational systems, or lack of systems, than it has to do with the Government of Timbuctoo. The foundation of American success was laid by importing good men from England, Scotland, Germany, and Sweden. These men were trained in the lands they left, and were among the best so trained—men who knew their own capability, but were too cramped in their own country to be able to show their worth. They went where such men were wanted, where there was room for them, and they adapted themselves to their surroundings, and have made their mark. Could anything further have been expected? The conditions were there, the men were there, and success was certain. We do not think these facts will be disputed, but they are too often forgotten, and the remaining business men and engineers of this country are spoken of as effete, behind the times, ignorant of their work, and uneducated. The educational problem of Great Britain, as we have said, differs from that of a younger nation. We have to change with the times; they commenced with the times. There is no reason why we should not carefully and thoroughly examine into the various systems adopted by the younger nations, and utilise in our changes all that seems necessary to keep us abreast of modern requirements. Throughout the whole examination, however, the conditions under which we live should be kept in mind. Far too much is made of German, French, and American methods. In the remote past we have created, but in the past quarter of a century educationally we have copied—and in no single instance has the copying been successful. As a writer in the *Times* put it, the educational changes have nearly all been made in Germany. A large part of the moral of Dr. Walmsley's conclusions, and all similar conclusions, depends upon the answer to the question, what class or classes of men do you want to train? The largest class consists of workmen, and here a long school with an after college course is tabooed. Foremen form another large class, and should be recruited from the workmen. If a college man would go for a few years cheek by jowl with the workmen, being as one of them, he would make an immeasurably superior foreman to one without that training taken from the workman class. For still higher grades there is no doubt about the value of college education, and it is here that the moral comes out strongest. To take Dr. Walmsley's points somewhat in order. The resources of the schools are described. They consist, as here, of private gifts, endowments, etc., and a State grant of public land. The latter can only be given when there are State lands to give, and cannot apply to any extent in old countries. The equipment of many of the American institutions is very complete, but, again, con-

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ditions frequently determine what the equipment must be. The mere multiplication of machinery is valuable only if it can be put to good use, and in this it must be remembered that the American institution laboratories are not only educational establishments, but the teachers and professors pose as consulting experts, carry out tests, and give reports of the ordinary professional kind for professional fees. Do we want more of that kind of thing here, or ought we to pay the professor enough to insist that his whole time should be devoted to his professorial duties? In our opinion he should be an experimentalist for educational purposes, and not for professional consulting purposes or for patent office purposes. The American argument, with which Dr. Walmsley seems to agree, is that the mere educational pay is insufficient, and that the man will not keep himself fully conversant with the latest practice unless he acts as a consultant as well as a teacher. With this we entirely disagree. If he desires, the teacher can keep himself just as much abreast of the times without as with consulting practice. A very large portion of this interesting paper deals with details, such as finance, age and method of entrance, timetables, examinations, etc.—information necessary for comparison, but not needing comment. More to the purpose are the conclusions drawn by the author. We are in entire accord with him when he states that the debates of the last two years "have at least served one good purpose in arousing the attention of the country to some of our most glaring educational defects, especially in the direction of secondary education." The weakest link in our educational chain is secondary education. Thirty years or so ago the present writer took an active part in initiating and for some years carrying on the crusade for bettering secondary education. Between elementary and higher schools secondary education was then almost entirely in the hands of private adventure schools. Anybody could start and run such a school, but the education imparted therein was an unknown quantity. This class of school is going and the requirements of professional training have assisted the going. Dr. Walmsley entreats employers to assist the development of proper establishments by giving posts to trained men, by pecuniary assistance, and educating parents and guardians as to what the training should be. One important factor in any appeal to employers is that the training should be in the direction they require, and not in the direction the schools think they should require.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### THE LATE MR. McMILLAN.

SIR,—Having just returned from abroad, I was deeply shocked when I heard for the first time on Friday last of the death of the secretary of the Institution, Mr. McMillan. All who had the privilege of knowing him will agree with me that he was one who never considered any amount of time or labour too much for any work he had to do for the Institution, either as secretary, adviser, or friend. He was always working for others and left no time to consider himself, and he often overtaxed his somewhat delicate constitution in consequence. From enquiry, I learn that he has been unable to make much provision for his wife and young family, and I would venture to ask, through the medium of the electrical Press, that a McMillan memorial fund be opened, and that each of the leading electrical journals should provide a column for subscribers, so that the many members, associates, and students of the Institution may have an opportunity of contributing; and as these things are twice done if done quickly, the list should be kept open for a limited time, say one month, only. Possibly similar proposals have already been made in other quarters, but in any event I am sure it has only to be known to the 5,000 members of the Electrical Institution that funds are required to meet with a hearty reponse from all. I remember well when our former respected secretary, Mr. Frank Webb, retired, that on that occasion I acted as honorary treasurer in connection with a fund raised in recognition of Mr. Webb's valued past services to the Institution. The response was hearty and unanimous, and we are all pleased to know what a comfort and reward that contribution has been to Mr. Webb, and now with our younger dear dead friend, Mr. McMillan, we can only get the indirect consciousness to ourselves that we have done a kind action to one who can, alas! now never thank us, but it rests with us to see that suitable provision is made for his children. I shall be glad to volunteer my services in connection with a small special committee of gentlemen to help the matter forward, and have pleasure in subscribing one guinea to each paper opening its columns for subscription. I trust that you will see your way to help in this matter, and thank you in anticipation.—Yours, etc,

HENRY EDMUNDS.

71, Upper Tulse-hill, S.W., Feb. 7, 1904.

[We think that every member will welcome the suggestion of Mr. Edmunds, but it being further suggested that the Institution itself will form a committee for the same object, it would be best to amalgamate forces and send all contributions to the Institution direct.—ED. *E. E.*]

### COMPARATIVE COSTS.

SIR,—My attention has been called to the table of the comparative cost of working hydraulic and electric lifts contained in Mr. Bowden's paper on "Electrical Transmission of Power as an Aid to Greater Economy in Works and Factories" in your last issue. I think I recognise that table as a cutting from a lift-maker's pamphlet issued a year or two ago. Mr. Bowden's comment is that the result in the table may be relied on. I wish to call attention to the fact that the rates used for the hydraulic power are in no case taken at the equivalent of 2½d. per unit for the electric current, and that at equal rates of charge and with equally good machines of each class, the cost of working hydraulic lifts will in the majority of cases be less than with electric power. In a discussion that took place on Mr. Ravenshaw's paper on electric lifts at the Institution of Civil Engineers I showed, I think, conclusively that an ordinary lift such as those referred to in the table took more energy to work electrically at the most economical load than the hydraulic energy required for the full load. The table has been constructed for trade purposes, and ignores the fact that all public hydraulic supplies are given under a sliding scale of charges, and it is, therefore, quite unreliable as a statement of the relative efficiency of the two systems.—Yours etc,

E. B. ELLINGTON.

Palace-chambers, Westminster, S.W., Feb. 4, 1904.

### REVERSE-CURRENT RELEASES.

SIR,—I am interested in Mr. Andrews's remarks in your issue of Jan. 29, referring to the difficulties experienced in the design of reverse-current releases. From experience gained in some of the largest power installations in the States, I can fully endorse Mr. Andrews's remarks as to the difficulty of designing discriminating cut-outs to meet the severe conditions met with in practice. It is generally overlooked that reverse-current devices are designed to meet emergency conditions. Emergency conditions are generally accompanied by large phase changes and drop of volts, thus annulling any adjustment dependent upon maintenance of volts or of certain phase relations. Logic would indicate under the circumstances the adoption of a device independent of voltage and of the phase relations between voltage and current.—Yours etc.,

E. B. WEDMORE.

41, Murray-road, Rugby, Jan. 29, 1904.

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## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion held two sittings under the presidency of Sir David Barbour, on Thursday and Friday last week respectively.

**Mr. C. S. Meik, M.I.C.E.**, said he had prepared his evidence in conjunction with Mr. Walter Beer. The London traffic problem might be divided into two heads—relief of congestion of vehicular traffic and the transport of passengers between the outskirts and the central business area and through that area. The improvement of vehicular communication could only be effected by means of new streets, and the provision of two great arterial thoroughfares, running respectively from north to south and east to west, was of the first importance. New thoroughfares were preferable to widenings. He handed in plans of the proposed thoroughfares, one of which would commence in the vicinity of Enfield and terminate between Croydon and Wallington, being carried over the Thames by a bridge between Blackfriars and Waterloo. The other would run from east to west, starting in the vicinity of Osterly Park and terminating to the east of Barking. Those arteries would connect the large railway termini. The thoroughfares, he explained, would have accommodation for fast motor traffic, tram traffic, and also for a suspended railway. Cross roads, which he called "first-class roads," would also have to be constructed. The width of the "main avenues" would be 160ft., and that of cross roads 100ft. In connection with the scheme was a proposal to construct an embankment on the south side of the Thames, between Blackfriars and Waterloo bridges; it would have two decks, the lower being used by the wharves. Speaking of the cost of construction in the case of the various types of railway, witness showed that the cost of a suspended railway would be considerably less than that of a shallow subway or a tube. He put the figure at £75,000 per mile for the suspended railway, £250,000 for the shallow subway, and £350,000 for the tube. He also submitted estimates of the cost of the "main avenues." The cost of acquiring the property in the case of the north to south avenue he put at £31,343,000; recoupment would amount to £36,789,000. The works would cost £10,020,000; the net cost of the property would therefore be £4,574,000. The figures for the east to west route were: cost of property, £39,843,000; recoupment, £33,801,000; works, £10,695,000; net cost, £16,737,000. The total cost for the two routes would be: property, £71,186,000; recoupment, £70,590,000; works, £20,715,000; total net cost, £21,311,000. To those figures had to be added the cost of whatever type of railway was adopted. Witness gave details, estimates of the cost of the construction of the necessary works and of the earning power of the proposed railways and tramways, and showed that the latter would be sufficient to pay interest and sinking fund on the total expenditure for works, and also on the remaining expenditure on land, after the deduction of recoupment.

**Sir Ralph Littler, K.C.**, chairman of the Middlesex County Council, said that the Council had had numerous complaints as to the width of such of the main roads as were traversed by the tramways of the London United Tramways, Limited, and he considered that a series of through main roads should be constructed through the country, at national expense, to provide for the necessary through traffic. After very careful consideration, the County Council of Middlesex had come to the conclusion that the Light Railway Commissioners were not a satisfactory tribunal to deal with applications in Middlesex, and in his opinion it would be better if all schemes were referred to Parliament. No tribunal could, in his opinion, give that satisfaction which Parliament did, and there were grave complaints in Scotland as to the procedure there. The provisions of the Lands Clauses Act, which came into operation under the Light Railway Act, inflicted unnecessary hardships on promoters. Further, it was no more expensive to bring a scheme before Parliament than before the Light Railway Commissioners, and counsel and witnesses generally required a special fee to attend before the Commissioners. So far, Middlesex and the London County Council had adopted no scheme for the interchange of traffic between the two counties.

In reply to Sir David Barbour, the witness said he thought it advisable everywhere that the county council should be the tramway authority and the only authority to buy up tramways.

**Mr. J. Edward Waller, M.I.E.E**, considered that the construction of tramways must play a considerable part in solving the problem of London traffic. A double line of tramways should only be run in a street having a minimum width of 30ft., or a single line of tramway in a street having a minimum width of 22ft. Facilities might be given for the tramway traffic by the stringent exclusion, as far as practicable, of all heavy through vehicular traffic, as much of the congestion in the London streets was due to vans and wagons travelling slowly. He considered that railway companies might be required to locate their collecting centres in side streets, while as a considerable parcel traffic might be dealt with by tramways, it would reduce the number of the collecting vans of the railway companies and the parcel delivering companies. He did not consider that tube railways could serve the travelling population in the same way that tramways could, and the enormous capital involved in tube railway construction was against their extensive development. In his opinion a comprehensive system of tramways could be constructed in London without adding to the congestion of the streets. Such a system, when developed, would naturally remove the great bulk of the omnibus traffic, and in some degree the cab traffic also, and during development it should be possible to divert this traffic to a great extent from the streets in which the tramways were located. Any disjointed system owned and worked by separate companies would fail to give the necessary relief to the traffic, and his opinion was that the only satisfactory way to deal with the matter would be to allow road authorities or companies to promote tramway undertakings, regard being had when sanctioning such undertakings to their suitability as forming part of a general scheme for the Metropolis. He did not consider it a practical suggestion that either the Board or some independent body should initiate a scheme of tramways for London. Witness then dealt at some length with the present mode of procedure in tramway promotion. He thought that relief should be given to both local authorities and to company promoters. As regarded both parties, there should be no absolute frontagers' veto; as regarded local authorities, there should be no ratepayers' veto; and as regarded company promoters, there should be no road authority veto. The only satisfactory way to deal with the tramway legislative problem, whether applied to London or the whole of the country, was the creation of a special tramway or street traffic board, probably forming a Government department. He advocated that a Board of Trade should have absolute legislative powers, but subject to a right of appeal to Parliament with the sanction of the Board, such sanction being granted in all cases where, in the opinion of the Board, the interests of the opponents were of such magnitude that the proposals of the promoters ought to be submitted to the Legislature.

The Commission adjourned.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 12.

**Institution of Civil Engineers** (Students' Section).—At 8 p.m. Paper: "The Electricity and Destructor Station at Plumstead," by Mr. T. S. Nash.

**Automobile Show.**—At Crystal Palace, Feb. 12-24.

SATURDAY, FEB. 13.

**Institution of Electrical Engineers.**—Glasgow Section: at 7.30 p.m. at Edinburgh, extra meeting. Paper: "New Methods of Electrical Winding Gear for Collieries and Allied Purposes," by Mr. Geoge. Visit in the afternoon to new works of Messrs. Bruce Peebles and Co. Students' Section: At 3 p.m., visit to the G.P.O. Central Telephone Exchange.

**Junior Institution of Engineers.**—At 6.30 for 7 p.m., anniversary dinner, Hotel Cecil.

MONDAY, FEB. 15.

**Society of Arts.**—At 8 p.m., Cantor lecture: "Oils and Fats," by Mr. J. Lewkowitsch, P.H.D. (Lecture IV.).

TUESDAY, FEB. 16.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Paper: "The Forms of Turbines Most Suitable for Low Falls," by Mr. A. Steiger.

**Institution of Electrical Engineers** (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Manchester Tramways Equipment—Line and Rolling-Stock," by Mr. J. M. McElroy.

WEDNESDAY, FEB. 17.

**Society of Arts.**—At 8 p.m., ordinary meeting. Paper: "Garden Cities in their Relation to Industries and Agriculture," by Mr. A. R. Sennett.

**Institution of Electrical Engineers.**—Birmingham Section: ordinary meeting. Paper: "Notes on Steam-Engine and Dynamo Testing," by Mr. R. Morcom. Students' Section: at 7.30 p.m., ordinary meeting. Paper: "The Testing of Alternating-Current Machinery," by Mr. R. J. Kaula.

**Chemical Society.**—At 5.30 p.m., ordinary meeting.

THURSDAY, FEB. 18.

**Institution of Electrical Engineers** (Leeds Section).—At 7.30 p.m., ordinary meeting. Discussion of Paper: "Alternators in Parallel," by Mr. H. Bohle.

FRIDAY, FEB. 19.

**Institution of Mechanical Engineers.**—At 8 p.m., annual general meeting. Discussion on "Heat Treatment of Steel." Paper: "The Motion of Gases in Pipes, and the Use of Gauges to Determine the Delivery," by Mr. R. L. Threlfall, F.R.S.

**Royal Institution.**—At 9 p.m., discourse by Mr. H. Brereton Baker: "Some Unexplained Experiments."

SATURDAY, FEB. 20.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "Physics."

**Glasgow Scientific Society.**—At 7.30 p.m., ordinary meeting. Paper: "Modern Conceptions of Matter," by Mr. Angus MacLean, B.Sc.

**Northampton Institute.**—Distribution of prizes by Lord Kelvin.

**Junior Institution of Engineers.**—At 2 p.m., visit to the Colonial Consignment and Distributing Company's Frozen Meat Store, Lambeth.

**General Electric Company.**—At 6 for 6.30 p.m., annual dinner, Trocadero Restaurant.

## NEW COMPANIES REGISTERED.

**Buchholtz Reversible Turbine Syndicate, Limited (79,891).**—Capital, £100,000. Object: to adopt an agreement with Messrs. G. F. Griffin and R. S. Simpson (for the syndicate) for the acquisition of patent rights in connection with the Buchholtz reversible turbine or rotary motor, etc.

**Brown and Barlow, Limited.**—Capital, £2,000. Object: to carry on the business of carburetter manufacturers, electrical engineers, etc. Registered office: 16 and 17, Loveday-street, Birmingham.

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# LEGAL INTELLIGENCE.

## ST. PANCRAS ELECTRIC LIGHT WORKS.

The case of Colwell and others *v.* the St. Pancras Borough Council came before Mr. Justice Joyce in the Chancery Division on Wednesday, Thursday, Friday, and Monday last. Mr. Hughes, K.C., and Mr. Beaumont appeared for the plaintiffs, and Mr. Bousfield, Mr. Younger, K.C., and Mr. Martin for the defendants.

**Mr. Hughes,** in opening the plaintiffs' case, said that the action was brought to restrain an alleged nuisance caused to the plaintiffs by the defendants in the working and use of their electric generating station and dust destructor at Camden Town. The main nuisance, and the most important part of the case, was the alleged vibration. In addition to that, however, there was nuisance from the noise from the engines, and from the dust and smoke from the use of the dust destructor. The properties of the plaintiffs and defendants were situated close to the electricity works at Camden Town.

**His Lordship** asked if the defendants had statutory powers for the nuisance?

**Mr. Hughes** said they had not. The Borough Council undertook the lighting themselves and the supply of electrical power in St. Pancras. The property of the plaintiffs was five houses in Great College-street. The plaintiffs were the leaseholders and occupiers, the defendants being the freeholders. The defendants had bought up the various interests of the other houses running along Great College-street. Continuing, the learned counsel said that the defendants' scheme was not as it sometimes was where an electrical generating station was worked in conjunction with a dust destructor, the heat of the dust being used to generate electricity, but there was one shaft between the two, and that was common to both. He did not think that the two undertakings were worked together except to that extent. The defendants' electrical generating station had been in operation for some years, or at least a certain part of it had. In May, 1902, having found it necessary to very much increase their output, defendants determined to put in three large engines of 750 i.h.p. The engines running the continuous-current dynamos did not run in step, and in consequence there was a certain periodic increase and decrease in the vibration. In May, 1902, the new plant began working, but not at full load. At this time the plaintiffs, occupying these houses, began to find at various hours a very great increase in the vibration, and complaints began which ultimately culminated in the action. The defendants asked at various periods for time in order to get the plant into working order, but ultimately this action was brought. The defendants, in their defence, said that the engines were at present defective in balance, and consequently did not run smoothly, but that this defect could be remedied if time were given for that purpose.

Evidence was given on behalf of the plaintiffs by **Colonel R. E. B. Crompton, C.B.,** managing director of Crompton and Co., Limited, electrical engineers. He said he was instructed last October in connection with this case, and made an examination and inspection of the premises for the purpose of this action early in January. On Friday, Jan. 8, which was, he supposed, the time of maximum load, he went into 116, Great College-street. He noticed distinct vibration, which undoubtedly was caused by reciprocating machinery. It had a distinct beat, which was easily recognised. He also went into Nos. 108 and 112. He noticed vibration there. He afterwards went to the generating station, and asked that the engine might be shut down. This was done, and it had a remarkable effect. It reduced the amount of vibration that was observable in the premises to an extent that nobody could possibly doubt or deny.

Cross-examined: There were many rooms where there was no perceptible vibration. The houses in Great College-street were lightish buildings and a bit loose-jointed. The district was one where the traffic was heavy, but there was no trace of vibration set up by the passing of tramcars or wagons.

**Mr. Jas. Johnson Bourne, A.M.I C.E.,** gave corroborative evidence.

**Mr. G. W. Colwell,** one of the plaintiffs, and the leaseholder of 116, Great College-street, gave evidence of the vibration being a serious nuisance. The destructor was also a nuisance, causing dust, smoke, and smell.

Evidence as to the nuisance was also given by **Mr. Malcolm Wheeler, M.R.C.S.,** in practice at 59, Great College-street; **Mr. A. Baldwin, F.R C.S.,** of 6, Manchester-square; **Mr. Edmund Evans,** a surveyor; **Mr. G. West,** a railway clerk; **Mr. A. E. Pritchard,** a music-hall entertainer; and by several other residents in the neighbourhood.

At the close of the plaintiffs' case, **Mr. Beaumont,** in dealing with the evidence given on behalf of the plaintiffs, said, with regard to vibration and the length of time which elapsed before the action was commenced, that the nuisance which was caused before the defendants put in their heavy machinery was very slight. The real nuisance occurred when the heavy machinery was installed. He did not for one moment suggest that the defendants had not tried to minimise the nuisance, but they had not succeeded in the least degree when the action was commenced, nor at the present time, but it was certainly less than it formerly was. He (counsel), without binding himself, said he felt that if the defendants removed the new engines put in, the plaintiffs would not have much cause to complain.

**Mr. Bousfield** then proceeded to open the defendants' case. He said that there were two or three separate causes of action, or alleged causes of action. As to the electric lighting plant, it might be of importance to him to establish that as regarded the old plant there was nothing of which any reasonable person could complain. They had got the fact that the old plant was at work in 1895, and had been working ever since. It was an extremely strong observation to make with regard to the old plant to say that nobody ever really complained about it. As to the three new engines, he admitted that there was vibration at times between May and December, which a reasonable person had the right to complain of if the vibration had been of anything more than a temporary character. He should submit that a public body doing its best to discharge its statutory duty with reasonable skill was entitled to a certain amount of grace, and if, notwithstanding the amount of skill and experience the body could bring to bear upon it, there was a temporary nuisance, it was not a case for an injunction. He would also submit that on and from Jan. 8 there was nothing which any reasonable person could complain about. As soon as complaints were made defendants set to work to balance the engines much more closely, and that work had been going on ever since. The great authority on this point as to the balancing of engines was Prof. Dalby, and defendants had put themselves in his hands. Defendants thought, and had every reason to hope, that everything would be remedied if the engineers had time in which to complete their experiments.

**Major Philip Cardew,** examined by Mr. Bousfield, said he had attended at the defendants' station with reference to the complaints at various times when the electric light plant was running. There was no difficulty in synchronising the engines so that they ran to balance one another. From what he saw there was very little vibration. The engines were running quietly, but there was a slight noise from the escape of steam. On Jan. 11 defendants had more plant running, consisting of three large alternators. The load was not very large at that time, but the machinery was running at full speed. In his view, excepting in the room where the piano was, and in Miss Colwell's bedroom, there was no vibration of which any reasonable person could complain. He had been told what had been done by the defendants up to the present, and in his view those who were responsible for the undertaking had done and were doing all that reasonable skill could do to remedy the vibration. He had no doubt that the engines would ultimately be brought into perfect balance. He quite agreed with what Prof. Dalby was doing in the matter. He thought the vibration could be perfectly cured.

**Prof. Dalby,** examined by Mr. Bousfield, said he had devoted particular attention to the subject of the balancing of engines. In these engines there was a very considerable amount of balancing obtained by the disposition of the cranks and the moving parts. There was still, however, an unbalanced residue. Experience showed that such engines showed no vibration in certain conditions. It was necessary to get rid of the unbalanced residue. He proposed to do this by adding balancing weights on the machinery. He had not the slightest doubt that he could cure the vibration in this case.

**Mr. Justice Joyce** delivered judgment. He said it was virtually admitted—and in truth it could not be denied—that by reason of the vibration caused by the defendants' works at various times, and from time to time between the months of May and December, the plaintiffs' had a right to complain of the annoyance to which they had been subjected. He was of opinion that the amount of the annoyance caused had been a material interference with the comfort of the plaintiffs. In this particular case the annoyance had not been temporary and occasional personal inconvenience, but in his opinion was such as was calculated to work material injury to the property of the plaintiffs, and beyond all question was most serious and likely to depreciate the value of the plaintiffs' property. In this particular case there was a clause in the order which authorised the work, that nothing in the order should exonerate the undertakers from any indictment or other proceedings for nuisance in the event of any nuisance being occasioned by them. He was inclined to say that after the construction of their works, if not before the owners, particularly under an order like this, were not entitled to carry them on at all unless and until they could do so without occasioning a nuisance to the neighbouring owners of property. In his opinion there must be an injunction, not distinguishing in any way between the old machinery and the new, restraining the defendants from carrying on these works in such a way, as by vibration, noise, or otherwise, to occasion a nuisance or injury to the plaintiffs during the continuance of their lease; and there must be an enquiry as to damages. This order would be without prejudice to any question in reference to any nuisance or annoyance that might be caused by the working of the dust destructor after March 30 next, and the defendants must pay the costs of the action.

**Mr. Younger** asked that the injunction might be suspended for six months.

**Mr. Hughes** thought three months, with liberty to apply, was sufficient.

**Mr. Justice Joyce** suspended the operation of the injunction for six months, saying there was to be no nuisance and vibration between 12 p.m. and 7 a.m., and after May 1 between 11 p.m. and 7 a.m. The enquiry as to damages would be directed to the separate interests of the plaintiffs.

## GEIPEL'S PATENT FOR STEAM-TRAPS.

In the Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on Monday, judgment was delivered on the appeal of Wm. Geipel from an order of Mr. Justice Buckley directing a patent, No. 7,860, granted to him in 1893 for steam-traps to be revoked unless certain disclaimers were made. The facts of the case appeared in our issue for the 29th ult.

**Lord Justice Stirling** read the judgment of the Court. He said the appeal was from an order of Mr. Justice Buckley upon a petition for the revocation of the patent by which he directed that the patent should be revoked unless within three months, or such further term as the Court should allow, the patentee should obtain leave to disclaim two figures in the complete specification. The present appeal related to only so much of the order as referred to one of them, the patentee admitting that as regarded the other, the decision of the Court below was well founded. The ground upon which it was sought to revoke the patent was that there was discon-

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formity between the provisional and complete specifications. The patent related to improvements in steam-traps, which were devices for draining condensed water from steam-pipes or other receptacles for steam. The valves were made so as to act automatically. As the water fell it caused the metal to expand or contract by the variation of temperature, so that when water formed the valve opened. Before the date of the patent in question this had been accomplished in various ways. Their Lordships in the result held that there was no disconformity between the provisional and complete specifications, the figure in the complete specification being merely a development of the figure found in the provisional specification. The appeal was accordingly allowed.

It was agreed that the Court should apportion the costs to be borne by either party.

## FERRANTI LIMITED.

In the Winding-up Court on Tuesday the petition was heard of Estler Bros., creditors, for the winding-up of the above company, the ground alleged being that the company was insolvent.

**Mr. Buckmaster,** for the petitioners, said that the petitioners were creditors for £827. The company was incorporated in July, 1901, with a capital of £400,000 in £1 shares, divided equally in preference and ordinary shares. One hundred and twenty thousand preference and 100,000 ordinary had been issued and credited as fully paid. The objects of the company were to acquire the business of another company called De Ferranti, and to carry on the business of electrical engineers and for the supply of electricity. In December, 1901, they had issued £100,000 in first mortgage debentures, which were secured by a trust deed of that date, and on the terms of which hung a great deal of this matter. They continued to carry on business until December, 1903. Tate and Whittaker were appointed receivers of the undertaking at the instance of the debenture-holders, and the receivers and managers carried on the business. When the receivers and managers entered they prepared a circular and balance-sheet stating the position of the company. The liabilities showed the shares issued and the first mortgage debentures. The net result was that £413 597 was shown as assets, and the amount of secured creditors £100,000. Under these circumstances the petitioners could not get paid. It did not appear that the company had filed any affidavits in answer to the petition at all, but the debenture-holders, through Tate and Whittaker, had put in an affidavit in answer. The matter had stood over from time to time, pending the settlement of a scheme, but nothing had come of it, and now they heard of a determination by the directors to effect a voluntary liquidation of the company. The position was this: that if the petitioners were to be paid, there must be some form of liquidation. There was very good reason why there should not be voluntary liquidation, because, under the terms of the trust deeds, if there were a voluntary liquidation they got a bonus of 10 per cent. on their debentures. If it were compulsory they would only get 5 per cent.

**Mr. George Henderson,** for creditors for £14,000, supported the petition. After hearing counsel for the company, the petition was ordered to stand over.

## LIBEL ACTION BY AN ELECTRICAL ENGINEER.

At the Manchester Assizes Mr. Edwin Philpott Crowther, an electrical engineer, of Manchester, sought to recover damages for libel from Charles A. Copinger, also an electrical engineer, carrying on business as Copinger and Co. in Manchester. It was stated that the defendant had been apprenticed to the plaintiff, and that he had remained in his employ until 1901. At the end of 1900 the plaintiff's business, which had been conducted under the style of Crowther and Co., was converted into a limited liability company, and became known as Crowther and Company's Electrical Industries, Limited. Early in 1902 the concern went into liquidation, and later the defendant purchased the stock and goodwill from the liquidator. The plaintiff since 1902 has acted as the manager of a business established by his wife, and also carried on under the style of Crowther and Co., electrical engineers. The libel complained of was contained in a letter which was written by the defendant to Mr. H. K. Kempton, of Buxton, who was a customer of the plaintiff's. In this letter it was stated that "Mr. Crowther, the managing director," had absconded when the Electrical Industries Company went into liquidation, and also that the defendant, since taking over the business, had endeavoured "to carry it on on an honest basis." The plaintiff, in his evidence, emphatically denied that he had absconded, or that he had conducted his business in a dishonest manner. Eventually the jury stopped the case, and judgment was entered for the defendant.

## ABERYSTWYTH TELEPHONES.

At the Aberystwyth County Court Judge William Evans heard a case in which the plaintiff was the Postmaster-General and the defendants Messrs. J. and J. Gibson, newspaper proprietors, Aberystwyth. The claim was for £3 rent of telephone exchange line, and the defendants put in a counter-claim for £3 damages for breach of contract, and for the recission of the agreement entered into with the Postmaster-General.

From the evidence it appeared that defendants signed an agreement that they would pay an annual sum of £3 for three years for the use of the apparatus placed in their office last August, the trunk line having been extended from Newtown. The defendants called up London on Aug. 10, but there was a delay of two hours, and apparently this was the only occasion on which they used the apparatus. The Post Office authorities claimed from the defendants 5s. for two calls to London on Aug. 10, but the defendants said there was only one call, and the 2s. 6d. tendered was subsequently accepted by the Post Office. The defendants were not permitted, in consequence of the refusal to pay, to use the apparatus at their office, though the Post Office allowed them to receive calls. A long correspondence took place between the defendants and the Postmaster-General, the former stating that the apparatus was useless to newspaper men, and they declined to pay the rent. The Postmaster-General explained that there was no delay between Aberystwyth and Shrewsbury, but that delay was occasioned through congestion between Shrewsbury and Birmingham, that improvements would be made by which it was hoped there would be acceleration, and that the exchanges in Mid-Wales were receiving special attention. After this explanation the Postmaster-General hoped the defendants would reconsider their decision, but they declined. Evidence was called to show that the telephone was in good working order on the day it was used by the defendants, though it would be admitted that complaints had been made by another firm about the delay in getting through.

**Mr. Jones** put in the conditions, showing that the trunk line was for use when available, and that the Postmaster-General was not liable for any interruption or delay in the service.

Judgment was given for the plaintiff.

## ELECTRIC TRAMWAYS CONSTRUCTION AND MAINTENANCE, LIMITED.

In the Chancery Division on Tuesday Mr. Justice Bryne heard the petition of Alldays, Limited, for the winding up of the above company, but on being called, counsel for the petitioner asked leave to withdraw it. He said his clients had been substituted for other petitioners, and terms had been come to between them and the company.

**Mr. Whinney,** for creditors who supported the petition, and who had not been settled with, asked that they might be substituted as petitioners.

**His Lordship** thought Mr. Whinney's clients were entitled to an order, which he made accordingly, and gave leave to make the necessary amendments to the petition.

## POST OFFICE TELEPHONE CONTRACTS.

In the City of London Court on Tuesday the Postmaster-General sued Lindsay Bendix and Co., of Leadenhall-street, for £4. 15s. 2d., charges due under a telephone contract. The defendants signed one of the General Post Office telephone contracts agreeing to pay £5 a year for the telephone and 30s. for a year's calls. They had paid those sums, but they were now sued for a proportion of the next year's fees because they had not given any notice to determine the contract, as required by one of the clauses.

**Mr. Bendix,** one of the defendants, said he did not see that clause, which was on the back of the contract, when he signed it. He thought he was only agreeing to take the telephone for one year, and then there would be an end of it. He had no idea he had to give notice to determine.

**Judge Lumley Smith, K.C.,** said there was no doubt that the defendants were bound by the contract, but he did not like the conditions being on the back. The contract was subject to the conditions "endorsed thereon," and, of course, that meant on the back. He thought in future when the Postmaster-General's canvassers called to get signatures to agreements the customer had better be required to sign both sides of the contract, or the words "see back" should be put on the front of the contract. He gave judgment for the Postmaster-General for the amount claimed and the costs.

## CUTTING TELEGRAPH WIRES.

At Worship-street on Saturday three labourers were charged on remand with being concerned together in stealing and receiving a large quantity of copper wire the property of the Postmaster-General.

**Mr. Arnold,** who attended to prosecute on behalf of the Post Office, said the authorities did not desire to bring the case under the Post Office Acts, but, if the prisoners were satisfied, would leave the matter to be dealt with by the magistrate under the police charge.

One of the accused, when called on, however said that he was innocent of all knowledge of the wire being stolen.

At the Clerkenwell Sessions on Wednesday the prisoners were found guilty. Geo. Walker was sent to hard labour for 18 months, Albert Joyce for 14 months, and George Hibbard for six months.

# COMPANIES' MEETINGS AND REPORTS

## ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at the offices, Carnaby-street, Golden-square, Colonel Eustace J. A. Balfour presiding.

The **Chairman,** in moving the adoption of the report (which appeared in our last issue), said that for the seventh year the Board were enabled to recommend a distribution of 14½ per cent. on the ordinary shares. The past 12 months unquestionably witnessed a want of elasticity in West-end trade, combined with a remarkable absence of fogs, and these two facts together had caused their returns, for the first time in the Company's history, to mark time instead of advancing. The best proof, however, that this was but a temporary pause was found in the fact that the six weeks of 1904 which had already elapsed had brought about a satisfactory growth in their sales, and gave every prospect of a largely increased business in the future. Upwards of 6,662,000 units were generated at the Company's stations within the district of supply, and 1,118.000 units were

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purchased from the Central Electric Supply Company,' Limited. The cost of the former was normal, the economies to which he referred last year having been maintained, but the average cost of the electricity sold by the Company had been increased by 0·4d. per unit. This was directly due to the charge of 3d. per unit which had had to be paid for the supply drawn from the Central Company. From the calculations of the joint engineers of the two contributory companies to the Central Company, it appeared that the charge for energy required to cover that company's expenses for the current year would hardly, if at all, exceed 2d. per unit, and there was every prospect that with the growth in the output the charge would soon be reduced to that at which this Company could generate at their own internal stations. The existence of that external source of supply had been of the greatest benefit to them in several respects. All requirements for the extension of their business could be drawn from the Central Company's undertaking, of which they had a joint control with the Westminster Electric Supply Corporation. The Central Company's works and plant were of the most modern description, and had been in successful operation throughout the past year. These works covered only one-sixth part of the total freehold site owned by that company and available for extension, so that the necessary supply for the future business of this Company was assured, without their having to have recourse to Parliament for further powers. As a company they were in a sound and stable position, and the apparent setback in the accounts, due to their connection with the Central Company, was temporary only, and in no wise differed from the position which they would have been in had they by themselves undertaken their own extensions. The association of the St. James's and Westminster Companies in a joint undertaking of this nature was one that must naturally conduce to the mutual advantage of both, by securing the economy of a huge bulk supply and the strength of a combination in dealing with matters of common interest.

**Mr. Walter Leaf** seconded the motion, which was unanimously carried.

## BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The annual general meeting of the shareholders in this Company was held on Friday at Hamilton House, Mr. George Westinghouse presiding.

The **Chairman**, in moving the adoption of the report, expressed regret at the great delay in holding the meeting. The most potent factor in delaying the completion of their plant was the phenomenal activity in business which began in America in the year this Company was registered. This activity caused great delay in the delivery of the material and machinery required to complete their plant. The delay amounted to fully one year, so that shipments of their own product in moderate amount only began during the present fiscal year. It was not expected that the production of their works would reach a normal condition even this year. The American Westinghouse companies had in consequence of this delay furnished a large amount of apparatus, and had made a special allowance, or deduction, of £60,000 as an offset to the manufacturing profit which should have resulted from an earlier completion of the works. This allowance had contributed to the profit required to pay the interim and final dividends on the preference shares for the year ended July 31 last. The dividend for the present year must depend upon the final results as shown by their accountants, and it was not contemplated to pay an interim dividend. As to the frequent calls for further capital, the management had wisely—as he believed events would show—deemed it of the highest importance to secure a large amount of business in order fully to utilise the manufacturing facilities which had been provided. To that end a large selling staff had been created, and local offices had been established at several important centres. The report indicated the degree of success which had attended the efforts to secure new business. The orders in hand not executed on the 31st ult. amounted to £1,608,256. Another question which might be asked was, Have your works, in view of existing general conditions, been planned upon too large a scale? He unhesitatingly replied in the negative, and he based this opinion on the development of the electrical business in the United States. The Company's works at present could give employment to about 7,000 operatives, and the buildings had been so planned that extensions which would greatly increase their output could be made for a comparatively small expenditure of capital. The Company's trade with the Colonies was rapidly growing, and the directors believed that there was likely to be an increasingly active demand for electrical apparatus from the British Colonies all over the world. It must also be remembered that they had furnished apparatus for several large orders for the execution of contracts in the territory of other Westinghouse companies—notably on the Continent of Europe and in South America—and a number of important negotiations were now pending. From the beginning of their operations it had been apparent to the directors that "a head or chief executive" for the Company should be found. He had devoted much thought and investigation to this matter, and he should that day propose to the meeting the election as one of the directors of Mr. William I. Buchanan, who would arrive in London about the 20th inst., and to the Board he would propose his appointment as the deputy chairman and managing director of the Company. Mr. Buchanan—who would, with himself, represent the American companies' interests in the British company—had had an exceptional experience in the management of important affairs, and under that gentleman he was satisfied that their business would have that constant supervision and direction which were so essential for complete success—a supervision which it would be impossible for him himself to continue to give to the same extent as heretofore, in view of his larger interests in America. The American Westinghouse companies, in return for ordinary shares (which would not receive any dividend until after the preference shares had first had a dividend of 6 per cent.) had already rendered a service or given a value in excess of the par value of these ordinary shares. They had, with other American friends, already paid for about 30 per cent. of the outstanding preference shares, and he was now authorised by the directors of the Westinghouse Electric and Manufacturing Company to take so many of the 100,000 new preference shares at par as might not be taken by the other shareholders The shareholders of the American companies went without dividends for several years, but the result, as measured by present values and dividends, had fully justified their patience. Of the railways in this country which were referred to at the meeting last year as having taken steps to use electricity for the working of some of their trains, only one—the Mersey—had so far put its new service into operation. In the United States the results from the use of electricity upon railways exceeded the most confident predictions. In view of developments it might not prove to be a matter of regret that the time already taken for the work in progress by the several railway companies had greatly exceeded expectations. In this connection the passing last session of the Railways (Electrical Power) Act was of the utmost importance. It was with much satisfaction that he was able in connection with this subject to refer to a development by the American Westinghouse Company of the very highest importance—namely, the perfection of a simple and practical alternating-current motor whereby single-phase alternating currents could be so utilised as to dispense with much complicated machinery, and, by reason of the decreased cost, make more probable the extensive use of electricity by the great railways. He felt safe in saying that no single step of greater importance in connection with the electrification of railways had ever been made. The single-phase alternating-current railway system had been made possible by chief engineer Benjamin G. Lamme, of the American Westinghouse Company, which had all its plans ready to supply the new form of motors, and had already sent forward the particulars needed by the British company's officials to begin their manufacture at once. The Company were making the manufacture of steam-turbines a special feature. In the construction of gas-engines at their works great progress had already been made. He retained an unabated belief in the prospects of the business, and the Board were confident that in due time the shareholders would reap their reward, as in the case of the American companies.

**Mr. J. H. Lukach** seconded the motion.

A discussion followed, in the course of which disappointment was expressed at the financial results of the Company's working, and complaint was made of the fact that the last issue of £5 preference shares was made at a premium of 10s., their present price being only £4. 2s. 6d., including the dividend of 3s. a share. In the circumstances the proposed further increase of capital was questioned.

The motion was then adopted.

## GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The half-yearly meeting of the shareholders was held at Hamilton House, Victoria-embankment, Sir Henry Fowler, M.P., presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), stated that the Company had been hard at work during the past half-year, and the amount expended on capital account during that period had been £1,175,504. The engineers' reports were appended to that of the directors, and they gave a very full account of the progress of the works on the three sections of the railway—from Finsbury Park to Holborn, from Holborn to South Kensington, and from South Kensington to Earl's Court. The Company had now acquired all the station sites, which, the shareholders might be aware, were the points from which the various works underground proceeded. The contractors were doing their best to complete the works, and the engineers were perfectly satisfied with the progress that was being made. The outlay on capital account to Dec. 31 last was £2,075 330. and the estimated expenditure for the present half-year was £900,000. The rent due from the Underground Electric Railways Company of London, Limited, under the terms of the agreement for lease dated Jan. 13, 1903, up to Dec. 31 last, permitted of a dividend at the rate of 4 per cent. per annum, and the directors recommended the payment of such dividend. At the last half-yearly meeting the dividend declared covered the period of practically seven months up to July 31, and the dividend now recommended would be for the five months to the end of last year. In future the dividends would be paid regularly at the expiration of each half-year.

**Lord Farrer** seconded the motion, which was carried unanimously.

A special general meeting was held afterwards, at which resolutions were passed creating the additional capital of £250,000 authorised by the Company's Various Powers Act of 1903—25,000 new ordinary shares of £10 each—and empowering the directors, subject to the provision of the Company's special Acts, to issue all or any of these shares "at such time or times, at such prices, and on such terms, and in such manner" as they might think fit.

## LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of the proprietors of this railway was held on Tuesday at Liverpool, Sir William Forwood presiding.

The report of the directors stated that the gross revenue receipts amount to £44,145. 4s. 3d., and the working expenses to £33,210. 8s. 2d. The number of passengers carried during the past half-year was as follows: first class, 766,160; second class (including tramways), 3,670,404; workmen (special return tickets), 1,459,939—total, 5,896,503. The traffic, both on the railway and tramway, continues to show a satisfactory increase. The working expenses have been considerably augmented by the cost of relaying a portion of the permanent way, a part of which has been charged to revenue, and the balance (£1,000) to renewal fund. The agreement with the Lancashire and

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Yorkshire Railway is now signed, and it is hoped the work will be completed before the end of the year. The revenue account shows that the receipts from passenger traffic and miscellaneous receipts and interest amounted to £44,145. 4s. 3d., and the working expenses to £33,210. 8s. 2d., which, after deducting interest on mortgage debentures (£3,800), and adding balance brought forward (£3,747. 5s. 10d.), left £10 882 1s. 11d. available for dividend. Out of this balance the directors recommend the declaration of dividends at the following rates (less income tax): 5 per cent. per annum on preference shares, £3,000; 1½ per cent. per annum on ordinary shares, £3.750; leaving a balance of £4,132. 1s. 11d. to be carried forward to next half-year.

The **Chairman** said the report might be deemed fairly satisfactory, although it was not by any means as good as the one for the corresponding half of 1902. It showed a gratifying increase in traffic, but he regretted to say that expenses considerably increased; they had to spend £2,092 extra to earn £2,951 of additional traffics. Their connection with the Lancashire and Yorkshire Railway at Seaforth would give them a good deal of additional traffic. The new issue of preference shares had been allotted to the extent of £6,000.

The report was adopted.

Several shareholders complained of the smallness of the dividend of 1½ per cent. per annum, and advocated new blood on the directorate.

The **Chairman** said nobody was more sorry than the directors that the ordinary dividend was not better. It was only fair, however, to say that the directors did work the Company up to a 5 per cent. basis, but they suffered severely by the competition of the Corporation electric cars along the dock system. They were gradually recovering, and the directors were looking out for new connections.

## NERNST ELECTRIC LIGHT.

At the last general meeting of this Company a resolution was passed that it was desirable that the capital should be reduced to £100,000 in ordinary shares of £1 each in one class, and that the preference shareholders should receive as nearly as may be £75,000 and the ordinary shareholders £25,000 of such capital, and that the directors were requested to take such steps as they might be advised were necessary for the reduction of the capital on the basis of the resolution. The directors now announce that they have very carefully considered the matter, and have taken advice as to the necessary formalities. With regard to the figures suggested at the general meeting, it is not possible, they state, having regard to the present distribution of the share capital, to make an adjustment corresponding precisely with the figures indicated at the general meeting, but if one-half of the preference shares and eight-ninths of the ordinary shares are surrendered, so that the holders of preference shares will remain with one share for every two they hold, and the holders of ordinary shares will remain with one share for every nine they hold (all shares in the future ranking *pari passu*), the capital will be reduced to £90 000, of which the present holders of preference shares will have £70 000 and the present holders of ordinary shares £20,000, and a scheme of arrangement has been prepared on this basis. There are technical difficulties in carrying out what is suggested, but the Board is advised that if the arrangements proposed are approved by the body of shareholders generally, there will be little practical difficulty in obtaining the sanction of the Court, but that if there be any serious opposition inside the Company the application to the Court may fail. Under these circumstances, before taking the step of convening meetings for carrying the scheme through, the directors feel that they should, by first submitting the proposed scheme to the shareholders, ascertain whether it is one which meets with the approval of not only those who were present at the annual general meeting, but of the body of shareholders at large.

## WHITECHAPEL AND BOW RAILWAY.

Presiding at the half-yearly general meeting of the proprietors of this railway, **Mr. H. Doughty Browne** said the service, as far as the Tilbury Railway was concerned, was carried on under great difficulties, and would not occupy its rightful position until the work of doubling part of that line was complete. That would probably be in a year's time. It was hoped that the work of "electrification" would be carried out simultaneously by the District Company and the Tilbury Company. Up to the present time the Company had been unable to get any through service in connection with the Metropolitan Railway. When the Company's line was made the theory was that there would be almost as valuable traffic to be received from the north branch as from the south branch over the Metropolitan District. Of course there were difficulties in the way of that, and it required some negotiation to carry out the idea. The Board had the matter before them, and they would not lose any opportunity that offered of carrying it out. It ought to result in a very considerable accession of traffic.

## TYNESIDE TRAMWAYS.

The half-yearly meeting of the shareholders in this Company was held at Newcastle, Lord Armstrong presiding.

The **Chairman** said he was pleased to record a substantial progress. During the last six months the Company had carried a quarter of a million more passengers than during the previous six months, and this brought the total revenue for the year up to £16,882. During the period the receipts per car mile had increased, while their expenses would compare favourably per car mile with other centres, being lower than Liverpool and Newcastle, and the same as Sunderland. Extra cars were on order, which he hoped would increase the receipts from holiday traffic in the summer. He regretted that the negotiations with Newcastle Corporation for running powers had broken down, but now they had applied to Parliament, and expected that it would be recognised that such running powers would be for the welfare of the district served by their Company and of Newcastle. The directors proposed to issue £40,000 of debentures at 5 per cent. in order to provide the funds for extensions. The Chairman said it had that day been decided to let the contract for the extension of the lines to Gosforth Park, and it was hoped it would be remunerative.

A dividend was agreed to for the half-year at the rate of 2½ per cent. per annum.

An extraordinary meeting of the Company was subsequently held, when the Bill which is now before Parliament was approved.

## GIANT'S CAUSEWAY ELECTRIC RAILWAY AND TRAMWAY.

The annual meeting of the proprietors of this railway and tramway was held at the offices, Portrush, on the 1st inst., Dr. Anthony Traill presiding.

The directors' report contained the following: Your directors have again to report an increase, though a small one, in the receipts as compared with the previous year—namely, from £3 356. 17s. 10d. to £3,376. 17s. 1d. This has arisen from an increase in the number of passengers carried during the year from 107,268 to 108.154. The credit balance, or net profits, on the year's working was £1.241. 14s. 8d., against £1,263. 2s. in 1902 and £1,059. 14s. 11d. in 1901. The number of miles run by electricity have been 22,954 as against 24,196 in 1902, and the number of miles run by steam have been 7,560, making the total number of miles run last year 30,514 as against 32,008 in 1902, and 30,973 in 1901. The season was one of the wettest which has occurred since the opening of the line, and the results of the year's working may be considered very satisfactory under the circumstances, showing an actual increase of £19. 19s. 3d. in the total receipts, with a slight reduction of £21. 7s. 4d. in the net profits. This has arisen, as stated last year, from the successful working of the new overhead electric system, which provides greater power, and, therefore, more rapid means of transit than did the old system. These results of the overhead electric system are altogether satisfactory, and show steady progress in the net receipts of the Company, notwithstanding the large outlay in keeping the line and rolling-stock up to the usual high standard of repair and efficiency. The Company have been unfortunate in the matter of law costs and compensation during the year. The balance on revenue account, £1,241. 14s. 8d., has enabled your directors to pay 4 per cent. on £13,750 debenture stock, and 4 per cent. on the mortgage for £10,000 borrowed for the construction of the Causeway extension, and £139. 2s. 8d. interest on temporary loans.

The report was adopted.

## PERSONAL.

The Croydon Council desiring to express their high appreciation of the services rendered by Mr. J. Gray Scott during the time he had held the position of borough electrical engineer, and in view of the arduous work he had performed, more particularly in consequence of and following the fire, have made him a grant of 50 guineas.

The heads of departments and employés of Messrs. Mavor and Coulson, Limited, last Friday presented Mr. George Stevenson with a complete Shakspere in 40 volumes, handsomely bound in russia leather, and also a silver-mounted cigarette case. Mr. Stevenson leaves Messrs. Mavor and Coulson to take up the post of chief electrical engineer to the Carron Iron Company. A most enjoyable smoking concert was held, during which the presentation was made by Mr. G. C. Anderson, chief of the estimating department, on behalf of the employés and staff, Mr. Stevenson replying in a very neat speech.

Mr. H. Holt has resigned his position as the manager of the plant and motor department at Messrs. Verity's, Limited, London, and taken up a similar position with the Rhodes Electrical Manufacturing Company at 70, Bishopsgate-street Within, London, E C.

Mr. J. Guildford Halliwell, for 2½ years motor inspector and lately in charge of the repair shop of the Bradford Corporation electricity department, who is taking up a similar position at York, was presented with a travelling portmanteau, suitably inscribed, by the staff.

Mr. Henry W. Clothier, whose association with high-tension switchgear designs is well known, has resigned his position as manager of the estimating department of Messrs. Ferranti Limited, in order to take up the improvement and development of the business of Messrs. Walker and Hodgetts, Limited, of Salford. Mr. Clothier joined Messrs. Ferranti Limited when their works were situated at Charterhouse-square, in the year 1894, and has the record of having designed the first oil-break switch that was put to commercial use in this country. Mr. Hodgetts will in future devote his attention to the management of the works and to the design of motors and dynamos. It is now the intention of the firm to inaugurate a special department for the manufacture of switchgears for use in central stations, collieries, etc.

Mr. W. Wyld has resigned his position as electrical engineer at Doncaster, having been appointed to the position of tramways manager at Birkenhead.

The Bootle Council have agreed upon the following increases of salary: Mr. J. B. Hudson (deputy electrical engineer) from £130 to £150 per annum, and Mr. Hort (switchboard attendant) from £100 to £110 per annum.

Mr. Day has been appointed as tramways manager and Mr. Howard as traffic manager at Bolton.

The Newport (Mon.) Electricity and Tramways Committee have increased the salary of Mr. L. de R. du Verge, the deputy borough electrical engineer and tramways manager, from £175 to £200.

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## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cuenia (Spain).**—The Municipality require tenders for the public lighting for 15 years, 5,000 c.p. Tenders by 26th inst. Particulars from the above.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Punta Arenas, Chile (Straits of Magellanstrasse).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Port Elizabeth.**—The Municipality invite tenders for the supply of telephone material. Specifications, etc., from Davis and Soper, 54, St. Mary-axe, London, E.C. Tenders by Feb. 22.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for the year ending March 31, 1905. Tenders by 4 p.m. on March 2 to the Town Clerk. See advertisement.

**Newport.**—The Tramways Committee invite tenders for 10 electric tramcars and a motor trolley wagon. Particulars from Mr. H. C. Bishop, M.I.E.E., tramways manager. Tenders by Feb. 22.

**St. Annes-on-Sea.**—The Urban District Council invite tenders for a steam dynamo. Specifications from Mr. J. H. Clothier, Electricity Works. Tenders by noon on 27th inst. See advertisement.

**Stockton-on-Tees.**—The Corporation invite tenders for articles and stores for the year ending March 31, 1905. All information may be obtained of the Electric Light Engineer. Tenders by 16th inst.

**Wiring.**—Tenders are invited for wiring buildings for direct connection with the fire brigades at Glasgow and Sheffield, for the May-Oatway Fire Appliances. Tenders by 17th inst. See advertisement.

**Preston.**—The Corporation invite tenders for laying complete a system of feeder mains on the drawn-in system. Specifications from Mr. W. H. Tittensor, 25, Barrow-road, Preston. Tenders by 15th inst.

**Swindon.**—The Corporation invite tenders for wiring school for electric lighting. Specifications, etc., from Mr. J. G. Griffin, Electricity Works. Tenders by Feb. 15. See advertisement in last issue.

**Radcliffe (Lancs.).**—The Urban District Council invite tenders for station lighting and wiring to motors, testing instruments and accessories. Specifications, etc., may be obtained from the Clerk. Tenders by 20th inst.

**Islington.**—The Council invite tenders for supply of electrical stores, etc., for one year. Particulars may be obtained at the Town Hall, Upper-street, N., on and after the 15th inst. Tenders by noon on 25th inst.

**Greenock.**—The Corporation invite tenders for one 400-kw. steam-driven traction and lighting generator. Specifications from Mr. J. A. Robertson, Hunter-place, Greenock. Tenders by Feb. 25. See advertisement.

**Kilmarnock.**—The Corporation invite tenders for the various plant in connection with electric lighting and tramways. Specifications, etc., can be obtained from the Town Clerk. Tenders by 29th inst. See advertisement.

**Sunderland.**—The Corporation invite tenders for the supply of travelling crane and storage battery. Specifications, etc., from Mr. John F. C. Snell, M.I.C.E., Town Hall. Tenders by Feb. 26. See advertisement in former issue.

**Manchester.**—The Rivers Committee invite tenders for the supply of various articles for 12 months from April 1, including electrical goods. Specifications from Secretary, Rivers Department, Town Hall. Tenders by 10 a.m. on 29th inst.

**Islington.**—The Lighting Committee invite proposals for the carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals by Feb. 17. See advertisement in last issue.

**Hammersmith.**—Tenders are invited for the supply of electricity meters, house service boxes, and fuse boxes for the ensuing 12 months. Specifications from Mr. G. G. Bell, 57, Fulham Palace-road. Tenders by 6 p.m. on Feb. 24. See advertisement.

**Gainsborough.**—The Urban District Council invite tenders for telephone instruments, fire alarms, and connecting overhead wires. Specification from Mr. R. W. Fraser, electrical engineer to the Council. Tenders by March 16. See advertisement.

**Salford.**—The Tramways Committee invite tenders for 12 months' supply (ending March 31, 1905) of various stores. Particulars may be obtained from the Tramway General Offices, 32, Blackfriars-street, Salford. Tenders by 3 p.m. on 26th inst.

**Rathmines.**—The Urban District Council invite tenders for the supply of various electrical stores for the 12 months ending March 31, 1905. Specifications from Mr. F. P. Fawcett, clerk to the Council. Tenders by 20th inst. See advertisement.

**Ealing.**—The Corporation invite tenders for a 750-kw. steam alternator, central surface condenser, etc. Specification from Mr. J. Douglas Knight, M.I.E.E., Electricity Works, South Ealing, W. Tenders by 25th inst. See advertisement.

**Blackburn.**—The Electricity Committee invite tenders for supply of various stores for the year ending March 25, 1905. Specifications, etc., from Mr. A. S. Giles, Electricity Works, Jubilee-street, Blackburn. Tenders by Feb. 29. See advertisement.

**Sheffield.**—The Tramways Committee invite tenders for the supply of general stores for 12 months, including electrical supplies. Forms of tender from Mr. A. R. Fearnley, Tramways Department, Town Hall, Sheffield. Tenders by 10 a.m. on 22nd inst.

**Camberwell.**—The Baths Sub-Committee invite tenders for a new engine and dynamo, etc. Specifications can be obtained from borough engineer, Mr. W. Oxtoby, Town Hall, Camberwell, S.E. Tenders by 6 p.m. on Feb. 16. See advertisement in last issue.

**Hanley.**—The Corporation invite tenders for the supply, delivery, and erection of alternators, condensing plant, superheaters, etc. Specifications from Mr. C. A. Cowell, Electricity Works, Park-road. Tenders by Feb. 22. See advertisement in former issue.

**Edinburgh.**—The Corporation invite tenders for engine and dynamo for electricity supply station at M'Donald-road. Specifications, etc., from the Electrical Engineer, Dewar-place Station. Tenders by Feb. 22. See advertisement in former issue.

**Battersea.**—The Borough Council invite tenders for a 750-kw. steam dynamo, electric pumps, etc. Specifications from Mr. H. R. Forbes Mackay, Electricity Department, Lombard-road, S.W. Tenders by Feb. 15. See advertisement in former issue.

**Bury.**—The Tramways Committee invite tenders for the purchase of old tramway rails, fishplates, tiebars, points, crossings, nuts, and bolts from about seven miles of track. Particulars from Mr. A. W. Bradley, borough engineer, Bury. Tenders by 24th inst.

**Kirkcaldy (Scotland).**—The Corporation invite tenders for the wiring complete of the Pathhead Halls, including fittings. Specifications, etc., can be obtained from Mr. O. F. Francis, Electricity Works, Victoria-road. Tenders to the Town Clerk by noon on Feb. 15.

**Stourbridge.**—The Urban District Council invite tenders for engines and dynamos, watertube boiler, balancer booster, overhead hand crane, storage battery. Specifications from Electrical Engineer, Town Hall. Tenders by 12 noon on Feb. 26. See advertisement.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Whitehaven.**—The Town Council invite tenders for the supply of various stores during the year ending March 31, 1905, including electric fittings and glow lamps. Forms of tender from the Borough Engineer, Town Hall, Whitehaven. Tenders by 10 a.m. on 23rd inst.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr. J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Birkenhead.**—The Corporation invites tenders for various stores and materials required at the electricity works during year ending March 31, 1905. Particulars may be had on application to Mr. William Bates, A.M.I.C.E., Craven-street Generating Station. Tenders by 5 p.m. on 15th inst.

**Halifax.**—The Corporation invite tenders for the supply of engine-room stores and ironmongery and wrought-iron goods required during the 12 months ending March 31, 1905. Forms of tender may be obtained from the Borough Electrical Engineer, Foundry-street, Halifax. Tenders by 12 noon on Feb. 26.

**Coventry.**—The New General Traction Company, Limited, invite tenders for the construction of about three miles of new tramways and the reconstruction of 5¼ miles of tramways. Specifications, etc., may be obtained from Mr. I. E. Winslow, engineer, 30, Bishopsgate-street Within, E.C. Tenders to the Engineer by March 5, at 1 p.m.

**Aston Manor.**—The Corporation invite tenders for one 750-kw. continuous-current dynamo coupled direct to a vertical cross-compound engine, speed not to exceed 100 revolutions per minute. Specifications from the Electrical Engineer, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on Feb. 22. See advertisement.

**Manchester Ship Canal.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection of 25 electric hoists and 10 electric fixed cranes for transit sheds. Specification, etc., can be obtained from Mr. W. H. Hunter, M.I.C.E., chief engineer, 41, Spring-gardens, Manchester. Tenders by March 1.

**Battersea.**—The Borough Council invite tenders for the supply of the following materials for the electricity department for one year from March 31: coal, oil and engine-room stores, carbons for arc lamps, electricity meters. Forms of tender from the Electrical Engineer, Electric Light Station, Lombard-road, London, S.W. Tenders by 12 noon on 22nd inst.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**Cambuslang (Scotland).**—The Lanark County Council invite tenders for providing and erecting engines, dynamos, switchboards, lamps, main and distributing cables, and other works necessary to provide a complete system of electrical supply within the lighting district. Specifications, etc., from Messrs. Hunter and Jack, 101, St. Vincent-street, Glasgow. Tenders by 10 a.m. on 29th inst.

**Greenwich.**—The London County Council invite tenders for the supply and delivery of five tubular fuel economisers, of 320 tubes each, complete with scraper gear, and five motors with starting gear, for erection of the plant in the station at Greenwich, and dampers and frames for flues and chimney openings. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders before 10 a.m. on Feb. 16.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction

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of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Islington.**—Tenders are invited for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors and pilot cable, with feeding, junction, and service boxes Specifications, etc., from the Borough Electrical Engineer, 50, Eden-grove, Holloway, N. Tenders by Feb 24. See advertisement in former issue.

## RESULTS OF TENDERS.

**Hampstead.**—The tender of Messrs. Babcock and Wilcox, at £3,879, for supplying and fixing three superheaters has been accepted.

**Harrogate.**—The tender of J. and R. Richie, Middlesbrough, for the supply of 60 tons of cast-iron pipes, at £4. 12s 6d. a ton, delivered at Harrogate Station, has been accepted.

**Swansea.**—The Harbour Trust have accepted the tender of Messrs. Chance Bros., of Birmingham, to supply the installation, at a cost of £100 (1,200 c.p.), for the Mumbles lighthouse.

**London.**—The Underground Electric Railways Company, Limited, have placed a contract for electric lifts for the whole of the Yerkes system of tube railways with the Otis Elevator Company, Limited. The works amount to about £350,000.

**Wimbledon.** The Urban District Council have accepted the tender of the Paterson Engineering Company, Limited, for a water-softener and filter, softened water storage tank, etc., in connection with the extension of their electricity works, at £1,153.

**London.**—The Underground Electric Railway Company have accepted the tender of the Westinghouse Brake Company for the signalling equipment of 15 miles of double track, and the tender of the British Thomson-Houston Company, Limited, for the motors to be used on the trains.

**Lowestoft.**—The Town Council have received the following tenders for the provision of electrically driven plant: Blake, Knowles, and Co., £907; Reavell and Co., Ipswich, £750; R. W. Blackwell and Co., £1,114; British Westinghouse Company, £730; Hughes and Lancaster, £1,057; Ingersoll-Sargent Drill Company, £726 (accepted).

**Egremont (Cheshire).**—The Wallasey Urban District Council have accepted the following tender for supply and delivery only of about 7,100 yards concentric armoured cables, together with joint boxes and section boxes: British Insulated and Helsby Cables, Prescot, concentric cable (·3) 7s. per yard, tee junction boxes 23s. each, straight-through boxes 18s. 6d., compound for joint-boxes 84s. per cwt., section boxes £22 each.

**Kirkcaldy.**—The Corporation have received the following tenders for seven motorcars for their tramways:

| | | | |
|---|---|---|---|
| British Thomson-Houston Company, Rugby* | £4,125 | 13 | 0 |
| Brush Electrical Engineering Company, Loughborough | 4,055 | 0 | 0 |
| Witting, Eborall, and Co., London | 3,939 | 0 | 0 |
| Dick, Kerr, and Co., London | 4,131 | 15 | 0 |
| British Westinghouse Company, Manchester | 3,762 | 0 | 0 |

* Tender accepted minus spares.

**Leyton.**—The Urban District Council have received the following tenders for hot-water heating apparatus and electric lighting at Norlington-road school:

Hot-water heating apparatus.

| | | | |
|---|---|---|---|
| Allin and Sons, Cambridge | £461 | 0 | 0 |
| G. and E. Bradley, London | 367 | 10 | 0 |
| Brightside Foundry Company, Sheffield | 343 | 0 | 0 |
| Crittall and Co., London | 343 | 17 | 6 |
| J. Defries and Co., Houndsditch | 404 | 14 | 0 |
| General Ironfoundry Company, London | 348 | 0 | 0 |
| Haden and Sons, London | 458 | 0 | 0 |
| J. T. Halsey, Stratford | 331 | 15 | 6 |
| J. and W. Jeal, London | 318 | 0 | 0 |
| Lancashire Heating Company, Manchester (accepted) | 318 | 0 | 0 |
| R. H. and J. Pearson, Notting Hill | 387 | 0 | 0 |
| Tamplin and Makovski, Redhill | 355 | 0 | 0 |
| Troup, Curtis, and Co., Custom House | 355 | 5 | 3 |
| Werner, Pfleiderer, and Perkins, London | 350 | 11 | 2 |

Electric lighting.

| | | | |
|---|---|---|---|
| Allin and Sons | 651 | 6 | 1 |
| Barton and Co., Walthamstow | 868 | 2 | 9 |
| J. Defries and Son | 811 | 6 | 0 |
| Durrell and Co., City | 1,160 | 12 | 6 |
| Empire Electrical Company, Walthamstow | 830 | 13 | 6 |
| Haden and Sons | 1,073 | 15 | 10 |
| J. T. Halsey | 762 | 0 | 0 |
| Headland and Headland, Leyton | 876 | 14 | 0 |
| Jackson Bros., Plaistow | 813 | 5 | 0 |
| Lightwell Electric Company, Forest Gate | 976 | 13 | 0 |
| Nunn, Watts, and Co., City | 699 | 8 | 6 |
| R. H. and J. Pearson | 779 | 10 | 0 |
| W. Simmons, Stratford | 759 | 0 | 0 |
| Tamplin and Makovski | 860 | 0 | 0 |
| Troup, Curtis, and Co. | 711 | 13 | 0 |
| Troy and Co., London | 1,125 | 0 | 0 |
| Vulcan Electric Company, Stratford | 700 | 0 | 0 |
| Weston and Sons, City | 649 | 1 | 0 |
| J. A. Woods, Westminster | 1,600 | 3 | 0 |
| W. R. Woodward, Forest Gate | 741 | 2 | 6 |

The consideration of the tenders was deferred until the next meeting on March 1.

**Croydon.**—The Corporation have accepted the tender of Messrs. Dorman, Long, and Co., at £2,905. 11s. 1d., for the smith and ironfounder's work required in extensions at their electricity works. The Electricity Committee have recommended for acceptance the tender of the Alphons Custodis Chimney Construction Company, at £3,823, for chimney shaft at the electricity works; and the tender of Messrs. Mellowes and Co. for glazing the roofs with patent glazing.

# BUSINESS NOTES.

## TRACTION.

**Pemberton.**—Sanction has been obtained to a loan of £16,155 for tramway purposes.

**Bristol.**—The Town Council are in favour of the tramways company's proposed extensions.

**Cheadle.**—The High-street section of the electric tramways was opened for traffic last week-end.

**Paisley.**—It is expected that the Paisley-Johnstone tramway will be opened for traffic during April.

**Glasgow.**—The Town Council at their last meeting decided to make no change in the present ½d. fares.

**Leeds.**—The "split-turn" system of duties for tramwaymen was introduced this week on several routes.

**Llandilo.**—The District Council have decided to support the scheme for a light railway from Llandilo to Lampeter.

**Coventry.**—The tramways company propose to proceed with the relaying of the tramway to Bedworth almost immediately.

**Nelson.**—Consideration of the question of equipping two more cars with top covers has been adjourned to the end of the year.

**Colchester.**—St. Botolph's-street is to be paved with wood blocks in lieu of granite in connection with the tramway scheme.

**Calcutta.**—We understand that an important extension of the electric tramway system is contemplated in the near future.

**Wolverhampton.**—The Local Government Board have sanctioned a loan of £16,514 by the Corporation for tramway purposes.

**Whitley Upper.**—At the next meeting of the District Council a proposal will be brought up for a light railway for the district.

**Sunderland.**—Although the tramway accounts are not yet available, it is believed that they show a profit of about £5,000 for the year.

**Batley.**—The Council have agreed to pay £50 to the borough surveyor for services connected with the construction of tramways.

**Standish.**—Application is to be made by the District Council for a loan to widen Wigan-road in connection with the tramway scheme.

**Burton.**—The tramways have just completed the first six months working, during which period they carried 2,019,878 passengers and took in fares £9,120.

**Burnley.**—The last branch line of the Corporation electric tramways was opened for traffic at the close of last week. It comprises the Manchester-road and Todmorden-road sections.

**Rochdale.**—The Tramways Committee have granted the request of the tramway men, who asked them to place the whole of the staff on short time rather than dismiss a number of the men.

**Bengal-Nagpur Railway.**—According to *Indian Engineering*, electrical developments on this system necessitate the engagement of an assistant electrical engineer, who will be particularly required for Kharagpur.

**Belfast.**—On Monday a special meeting of the Town Council confirmed the promotion in the present session of a Bill to acquire the undertaking of the Street Tramways Company and contiguous lines, and to adopt electric traction.

**Coatbridge.**—On Friday Colonel Yorke and Mr. A. P. Trotter, of the Board of Trade, inspected the tramways between Coatbridge and Airdrie, and on Monday the lines were opened for public traffic. It is the intention to have a Sunday service.

**Invercargill (N.Z.).**—Messrs. Noyes Bros., of Melbourne and Sydney, have received the order for the design and construction of a complete system of electric tramways for Invercargill, New Zealand. The work is to be proceeded with at once.

**Southport-Liverpool Railway.**—The first trip of an electric train between Southport and Liverpool, over the entire length of the line, was made early on Sunday morning. No date is yet given by the company for the probable opening of the line.

**Ashton and Stalybridge.**—Arbitration proceedings have been opened in London in connection with the purchase of the tramways in Ashton-under-Lyne and Stalybridge by the two corporations from the Manchester Carriage and Tramways Company.

**Newport (Mon.).**—The Ratepayers' Association is opposing the scheme for a single line up Stow-hill, contending that a double line should be laid in accordance with the Act. The Council have applied for a loan of £60,500 for the purpose of the tramway.

**St. Marylebone.**—At the Borough Council meeting on Thursday last week a recommendation that they should adhere to their previous resolutions against the London County Council's projected electric tramways along Tottenham Court-road and Edgware-road was rejected.

**Lowestoft.**—The Tramways Committee report that the total receipts from July 21, 1903, to Jan. 16, 1904, amounted to £5,917. 7s. 10d.; passengers carried, 1,305,000; total mileage run, 128,469 miles; average receipts per day, £33. 4s. 10d.; average receipts per car mile, 10·68d.

**Tramway and Railway Competition.**—At the half-yearly meeting of the Lancashire and Yorkshire Railway Company on Wednesday

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Sir George Armytage regretted the circumstances which had reduced the dividend. Passenger receipts had been affected by tramway competition.

**Hope and Castleton Light Railway.**—The Light Railway Commissioners on Wednesday held an enquiry into the application of a syndicate for powers to lay a light railway 2¼ miles long from Hope *via* Bradwell to Castleton. The Commissioners promised to recommend the granting of an order.

**Streatham.**—The projected extension of the tramway from the present terminus, opposite the library, to the county boundary at Norbury has been abandoned owing to the Wandsworth Borough Council's objection to the diversion of the line along Gleneldon-road. The scheme will no doubt be revived next year.

**Thornaby.**—At the last Corporation meeting it was reported in connection with the new Bill that the tramway company had agreed to pay an annual sum of £200 per mile of tram route in the borough from July 16 next, and subject to this and other details being incorporated in the Bill it was decided not to oppose it.

**Hong Kong.**—*Indian Engineering* says that progress on the tramways undertaking is not all that one would expect from the Far Eastern Settlement. The lines are still to be laid, and the overhead wires are being slowly erected, while the engines for the power-house have not yet arrived. They are on their way out, and the cars are due later on.

**Baker-street and Waterloo Railway Co.**—The directors report that the capital expenditure during the past half-year amounted to £204,175. The estimated expenditure for the current half-year is £300,000. A Bill has been deposited to authorise this company to acquire additional lands, raise further capital, and for other purposes.

**Walsall.**—The Tramways Committee recommend that, with a view to facilitate the traffic between Walsall and the Pleck, the overhead equipment between Milton-street and Prince-street, the Pleck, be reconstructed at an estimated cost of £320, and that a tender be obtained from Messrs. R. W. Blackwell and Co. for carrying out the work.

**Shoreditch.**—The Borough Council have unanimously decided not to agree to the proposed underground conduit system of electrical traction for the tramways along the main thoroughfares of the borough unless a double track is laid down throughout, and the necessary improvement and widenings are carried out by the London County Council at their cost.

**Halifax.**—An electric car is to be equipped by way of experiment with Moseley's patent wind guard. The Tramways Traffic and Construction Sub-Committee have been requested to consider the desirability of running single-deck cars on certain routes. The Town Council have decided to make an application to borrow £10,000 to provide additional generating plant for tramway purposes.

**Margam.**—At the last meeting of the District Council a letter was read stating that a syndicate had been formed to apply to Parliament for power to construct an electrical tramway from Taibach to Aberavon, and asking that the Council approve the project. The Dolter Electric Traction Company enquired if the Council would entertain the idea of disposing of their electric lighting order. Both questions were referred to Mr. Prusmann, Swansea, for his opinion.

**Dean Forest.**—An ambitious scheme was unfolded before a public assembly in Cinderford town hall on Thursday last week for promoting a light railway in the district. The scheme is to build a three-rail track from Severn Bridge, Lydney, to Cinderford, a distance of 12 miles. The narrow gauge is for passengers and the broader one for minerals. The motive power is to be electricity, provided by means of a turbine plant on the Severn, and worked by the in-rolling tide.

**Newcastle.**—A repeat order has been placed by the Corporation with the British Westinghouse Electric and Manufacturing Company, Limited, for Westinghouse magnetic brake equipments. This order covers 30 additional cars, the trucks of which are the Brill 21 E type, with 6ft. 6in. wheel base, 30in. wheels, and standard gauge. The poll of the ratepayers on the question of proposed extensions of the tramways has resulted in a majority in favour of the proposals.

**Finsbury.**—With regard to the proposed electric tramways in St. John-street and other thoroughfares of the borough, the Works Committee recommended the Council at their last meeting not to press for wood paving being laid close to the rails, seeing that, under present circumstances, this would interfere with the current; but there was a stipulation that if experiments showed that this difficulty could at any time be got over, there should be laid the more silent paving.

**Darlington.**—At the last meeting of the Town Council the Tramways Committee reported that they had visited Woodlands-road in order to inspect the method at present adopted for lighting that street, and recommended that the borough surveyor prepare a plan showing the position of the centre poles in Woodlands-road and Northgate and the existing lamp-posts, and also an estimate of the comparative costs of increasing the light either by means of gas or arc lamps.

**Lincoln.**—The Electricity Works Committee have considered plans for the electrification of the tramways, and have instructed their engineer to provide for the span system of overhead constructionf rom High Bridge to Alfred-street, and the centre-pole system from that point to Hamilton-road, and from the latter point to the Bracebridge terminus the span system. A sub-committee appointed to visit other towns to inspect the cars in use have reported to the committee, who have approved of their report.

**Stockholm (Sweden).**—The electric tramways now under construction are to be ready for use early this year. The tenders accepted for the new lines were sent in by Swedish and German contractors in combination. The American bidders were unsuccessful in securing the contracts. The amount to be expended in the work is about £159,000. Several other cities in Sweden—Gefle, Malmo, Norrköping, Sundsvall, and others—are contemplating changing their street railway lines, from horse power to electric power.

**Gildersome.**—At the meeting of the District Council on Monday, a letter was read from the British Electric Traction Company giving notice that they intended making an application to the Board of Trade to prolong the time limit for the completion of the railways authorised by the Morley and District Light Railways Order, 1901, until March 4, 1906. It was resolved that the Council forward a letter to the company objecting to the postponement.

**Lambeth.**—At the last meeting of the Town Council a resolution was carried instructing the General Purposes Committee to consider the expediency of obtaining parliamentary powers to purchase and work the London and Southern Tramways Company's undertaking. It will be remembered that the London County Council have decided not to purchase this undertaking, owing to the refusal of the Lambeth Council to contribute one-third of the cost of the street widenings involved in the electrification scheme.

**Campbeltown.**—It is announced that an important development is about to take place in connection with the sailings of the turbine steamers to Campbeltown. This is the laying of an electric light railway to Machranish, which in recent years has become a favourite resort with the tourist. The preliminary arrangements are so far advanced that a representative of the syndicate which has the scheme in hand will, it is understood, in the course of a few days meet and confer with the Town Council on the matter.

**Taff Vale Railway.**—Speaking at the half-yearly meeting of this railway, the chairman said powers had been taken to electrify the railway, but the directors found, on going closely into the question, that if motorcars with separate power were to be introduced electricity was not in it with steam, the prime cost being very much higher and also the cost of working and maintenance. They had, therefore, tried the experiment with steam, and the car between Penarth and Cardiff had proved to be a very great success, passenger traffic having largely increased.

**London Tube Railways.**—It has been decided to postpone the introduction of the Bill to authorise the construction of the North-Eastern "tube" pending the report of the Royal Commission, which means that the scheme will not be proceeded with this session. The favourable reception accorded by the Parliamentary Committee, the Royal Commission, and the public to the proposal for a "tube" from the City to Hammersmith by way of Piccadilly has led to its being revived, and the Bill will be redeposited in time for its consideration next session.

**Woolwich Tube Scheme.**—The promoters of the Bill for constructing an electric railway under the Thames from North to South Woolwich have deposited the estimates of the cost of the proposed scheme. The total cost of the railway and works is estimated at £233,276. It is proposed to construct a single line nearly seven furlongs in length with stations at both ends only. To provide the necessary funds it is proposed to form a company with a share capital of £240,000, and power to borrow £80,000 for the equipment of the line when completed.

**Barrow.**—A further service of electric tramways was inaugurated at Barrow-in-Furness on Saturday. The tramways are under the control of the British Electric Traction Company, who have obtained a concession from the Corporation on a 21 years' lease, the Corporation having the right to purchase the trams at every period of seven years at a valuation. The new routes opened are from the town hall to Furness Abbey terminus, and from the town hall to Roose Station. Two other routes are in process of construction, one from the town hall to Ramsden Dock, and the other from the town hall to Walney Ferry.

**Torquay.**—Under their agreement with the Dolter Electric Traction Company the Town Council are to supply current for working the tramways when constructed. The minimum payment for this service is to be £100 a month, or £1,200 a year, which is estimated to yield a profit to the Council of £120 per annum. At the last meeting of the Town Council the electricity undertaking came in for some criticism, and it was suggested that expert advice should be obtained with regard to it. Eventually the committee's report was referred back with a view to reducing the expenditure, if possible, without impairing efficiency.

**Queensland.**—According to an Australasian contemporary, attention has been called to the fact that the regulations recently issued by the Post and Telegraph Department dealing with the interference with telephone and telegraph lines by electric tramways, etc., may seriously interfere with the railways. About Brisbane the railway stations are lighted with electricity, and so are the tunnels, and it is believed that if the Post and Telegraph Department's regulations applied fully the cables would have to be pulled down and others substituted. In the same way, if electric traction was established on the railways the two things would clash.

**Blackburn.**—At the last meeting of the Town Council a councillor asked for an explanation of the cause of the loss on the tramways. He found that for the last month there was an increase in the mileage of 12,133, and a decrease in the passengers carried of 5,625. Alderman Thompson, in reply, said he supposed the falling off in the tram traffic was because there were not sufficient people prepared to ride and pay the fares. They could not be made to use the trams. Another councillor, however, suggested that while people could not be made to use the trams, they might be induced to do so. That had been done in other towns.

**Paris.**—The two parties in the tramway strike have at length agreed to accept the offices of a third mediator, in the person of M. Pierre Baudin, formerly Minister of Public Works, who on Wednesday met Messrs. Lax and Moreau, representing respectively the company and the men. After a long discussion the three arbitrators decided that they were incompetent to deal with the question of hours. Ultimately they sent the company an intimation to allow the men to start work within 24 hours on the system which obtained before the present

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dispute arose, this arrangement to continue until the Prefect of Police has revised the regulations.

**Stockport.**—A special meeting of the Tramways Committee was held last Friday for the purpose of appointing a tramways manager at a salary of £300 per year and a clerk to commence at £100 per year. In respect of the former position the committee interviewed six candidates. In the voting Mr. A. T. Eardley was recommended for the position by a unanimous vote. Mr. Eardley, who is 32 years of age, at present holds the position of committee clerk to the Corporation. On the matter coming up for confirmation at the Town Council meeting, however, the appointment was rejected. Mr. Preston, of Rochdale, was appointed to the post of clerk.

**Morley.**—At the last meeting of the Town Council a letter was read from the British Electric Traction Company stating that the directors regret that at present they are unable to fix a date for the commencement of the light railways in Morley and district. The other lines which have been constructed in Yorkshire have not proved at all remunerative, and it is not possible, therefore, in the present depressed condition of the money market to raise capital upon sufficiently favourable terms to justify proceeding with the undertaking at present. The directors, however, hope that it will not be long before financial conditions improve so as to justify them proceeding with the lines.

**Swansea.**—The Tramways Committee reported to the Town Council at their last meeting (1) on the proposed double line of tramways through Oxford-street, and that they have decided to ask the Board of Trade to approve of it; (2) the paving of Wardfield-street and Bryn-road and the side street; (3) the construction of the Brynhyfryd section of the line; (4) the lowering of the Harbour-road under the Great Western Railway bridge. The report was adopted. It was suggested that the heat from the dust destructor should be used to raise steam for producing electrical energy to work the Brynhyfryd and other sections of trams. The consideration of the proposal was adjourned until the next meeting.

**Worcester.**—The conversion of the city tramways to electric traction has been so far completed after eight months' work that a public service was inaugurated on Saturday over the St. John's, Barbourne, Shrub Hill, and Rainbow Hill sections. Colonel Donop and Mr. A. P. Trotter inspected the system on Saturday morning, and expressed their entire approval. The chairman of the Electricity Committee of the Corporation (Mr. A. H. Parker) entertained a large number of guests at the Hylton-road station, which has been erected primarily for supplying power to the trams, and switched on the current. A trial trip was then made by the Mayor (Mr. J. S. Cook) and other members of the Corporation, and the public service inaugurated.

**Additional Traffic Returns.**—Anglo-Argentine, £1,952 increase; Barcelona Ensanche y Gracia, £58 increase; Barcelona, £114 decrease; Brisbane, £305 decrease (month of January, £10,425, decrease £224), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £337 increase (month of January, £14,055, increase £962); Calcutta, £496 decrease; Cape Town (month of January), receipts £18,213, expenditure £8 305; Isle of Thanet Electric, £5 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of January), receipts £45,400, expenses £29,000; Perth Electric, £184 increase (for the year 1903: receipts £62,097, expenses £34,871); Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**Batley Accident.**—Major Druitt, in his report on the derailment of an electric car at Batley on Jan. 16, resulting in injury to the driver and five passengers, attributes the entire blame to the driver, Bowers, who, according to Major Druitt, drove the car at an excessive speed on approaching the curve near Mr. M. Oldroyd's house. Bowers alleged that when he applied the Westinghouse brake it had not the slightest effect, but Major Druitt says the brake was found to be in good order after the accident. There is an appreciable interval of time between the moment of applying the Westinghouse slipper brake and the braking effect being felt, and Major Druitt thinks it most probable that Bower, feeling no immediate effect on the car, jumped to the conclusion that the brake had failed, and at once took it off, intending to stop the car by another method. He had no time, however, and in his hurry performed the wrong motions.

**East Cheshire.**—A company has been formed, under the title of the East Cheshire Light Railways Syndicate, with the object of obtaining powers to construct a system of light railways, some seven miles in length, commencing at the borough of Stalybridge and running to Mottram, Hollingworth, and Glossop, with a branch from Mottram to Broadbottom and a further branch from Hollingworth to Tintwistle. If the powers are granted, the scheme will virtually form a junction of light railway systems connecting the Manchester, Ashton-under-Lyne, Oldham, Stalybridge, Mossley, Dukinfield, Denton, Hyde, and Stockport electric tramways with the Glossop and Hadfield electric tramways. A generating station is to be erected on the centre of the system at Mottram, near the highway. Powers are also sought, should it be thought advisable, to take electrical energy from the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board or from the Glossop Tramways Company.

**Tramway Statistics.**—According to a return issued by the Board of Trade, during the 12 months ended June 30 last there were 1,772 miles of light railways and tramways open for public traffic, and of these 1,258 miles were worked by electricity. During the preceding year there were 1,481 miles open, and in 1878 there were only 269 miles available. The number of horses used on tramways in the year under review was 20,005, compared with 38,777 in 1898, and the number of locomotive engines 334, against 589 in 1898—figures which speak with striking emphasis of the advance made in the utilisation of electricity as a motive power during the last six years. In 1878, the first year of which details are given, there were 1,124 cars, which carried 146,001,223 passengers, while in 1903 there were 8,951 cars, with a total number of passengers carried of 1,681,984,655. The net receipts last year were over 2½ millions, compared with under a quarter of a million in 1878. Of the total mileage 1,067 miles, or nearly two-thirds belonged to local authorities.

**Bury, Rochdale, and Oldham.**—Another conference of local authorities interested in the acquisition of the Bury, Rochdale, and Oldham Steam Tramway Company's undertaking has been held. It was reported that all the authorities except Whitefield had agreed to the terms offered by the tramway company in the draft agreement, and that Whitefield would come in provided they could have the same terms as the other authorities. To this, however, the company object, holding that Whitefield failed to give the necessary notice at the proper time, and that the matter must be referred to the arbitrator to decide whether and what Whitefield must pay the compensation for the seven years during which they are entitled to retain possession of the lines. After some conversation it was resolved to ask the contracting authorities to seal the agreement as early as possible, and it was also decided to ask the Board of Trade to appoint an arbitrator at once, and to instruct him to make an inspection of the lines as speedily as possible. The outcome of this will be that as soon as the lines have been inspected the work of reconstruction will be commenced.

**North Metropolitan Tramways.**—Speaking at the half-yearly meeting of the North Metropolitan Tramways Company on Monday Mr. George Richardson said the decreases in the number of cars run, miles opened, miles run, passengers carried, and in traffic receipts were due to the severance by the transfer of the lines, etc., to the Metropolitan Electric Tramways Company and the West Ham Corporation, for both of whom this company had been and still was working the lines. With reference to the attitude of the London County Council as to the electrification of the lines leased to the company—the lines always referred to by the Council and in the newspapers as the Council's northern tramways—it was quite true that the company had demurred to the introduction of the conduit system, but it was not fair to suggest that it had done more than that, or that it had refused to co-operate or assist the Council in the matter. The directors had in no way changed their views that the overhead system of traction could be more rapidly and economically established than was possible with the conduit system, with the minimum amount of disturbance and inconvenience to the public.

**New Issue.**—Subscriptions are invited for an issue of £500,000 5 per cent. deferred ordinary "B" shares of £10 each, fully paid, in the Great Northern and City Railway Company, at the price of £6. 10s. per share. The company, which has an authorised share capital of £2,010,000, has issued £1,500 000 of it, and, in addition, there is £504,216 of 4 per cent. debenture stock. After providing for the interest on the debenture stock, the net earnings of the company are divisible as follows: (*a*) a dividend on any preference shares which may be issued in the future; (*b*) a dividend at the rate of 4 per cent. on the "A" shares; (*c*) a dividend up to 5 per cent. on the "B" shares. Any profits remaining thereafter are divisible *pro rata* between the "A" and "B" shares, and the "A" and "B" shares have equal voting rights. The present issue is offered by and on behalf of the contractors for the line, S. Pearson and Son, Limited. It is estimated that, after discharging debenture interest and the 4 per cent. dividend on the "A" shares, a balance of over £28,000 will remain available for the "B" shares, equal to a distribution of over 3½ per cent. on that security, or 5 per cent. on the price at which the shares are now offered. The lists close to-day (Friday).

**Sydney (N.S.W.).**—It has been more than once stated by the Railway Commissioners that their inability to extend the electric tramway system to certain suburbs of Sydney is due to the fact that the power-house at Ultimo was working up to full pressure. Indeed, it has been stated that the "load" at present carried by the electric installation at the head station is far too great, and that it would be in the interest of the public if there was a greater margin of power than exists at the present time. In order to meet the great and growing public demand for electric traction the Railway Commissioners some months ago called for tenders for the supply and erection of additional machinery at the Ultimo power-house. Forty-one offers were received, and were submitted to the careful examination of the electrical engineers of the tramway service. The Commissioners, after careful consideration, recently decided to accept the tender of Messrs. James Howden and Co., of Glasgow, submitted through their local agents, Messrs. W. and A. M'Arthur, Limited. The tender provides for the installation of a steam-turbine plant manufactured by Messrs. C. A. Parsons and Co., Limited, of Newcastle-on-Tyne. It is to be provided with Babcock and Wilcox water-tube boilers and automatic stokers. The cost of the additional power will be about £48,000, and it is expected the plant will be in running order in about 12 months.—*N.S.W. Railway Budget.*

**London County Council.**—The Highways Committee of the London County Council propose to purchase spare car-ploughs for the rolling-stock for the New Cross and Greenwich line. The estimated cost is £1 500. The number of cars ordered from Messrs. Dick, Kerr, and Co. for the Kennington-to-Streatham section is 80, and arrangements are being made to have these equipped with lifeguards. The committee proposed to engage clerks of works to supervise the erection of car-sheds, sub-stations, etc., and are authorised to spend £27 weekly for 12 months for that purpose. Work will soon be commenced on the erection of a sub-station for the electrical working of the eastern portion of the Council's northern tramways. A sum of £5,000 has been voted for the purchase of a site for the building. There was a spirited passage-at-arms when Mr. Benn was "peppered" with questions from the Moderate benches on the subject of recent collapses in the system. Mr. John Burns, M.P., however, brought the matter to a head by raising similar points in connection with the London United Tramway system, and in reply to the whole series of queries Mr. Benn made an interesting statement. With regard to the recent stoppages, Mr. Benn stated that a new plough had been tested

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with most satisfactory results, and he hoped all difficulties would soon be overcome. The system of employment adopted by the Council represented a sum of £35,000, and, as to accidents, the Council had been more fortunate than any other electrical undertaking in London. The new lifeguard also was working most successfully.

**Camberwell.**—At the last meeting of the Borough Council the following letter was received from the clerk to the London County Council: "The attention of the Council has been directed to the inconvenience which arises in regard to the working of the electrical tramways owing to the accumulation of mud in the track conduits. This difficulty would be obviated to a considerable extent if arrangements could be made for the mud, etc., in the roadway on either side of the tramway conduits to be swept to the sides of the carriage-way. By this means the accumulation of refuse in the conduits would be greatly lessened, and the Council would be enabled to exercise such control over the cleansing of the tramway works as would ensure a quicker and more regular service on the lines affected. I am directed to ask the Council of the metropolitan borough of Camberwell to be so good as to take the matter into consideration with a view to steps being taken for the sweeping of the roads referred to being carried out in the manner suggested. The Council is confident that the Borough Council will co-operate with it in taking measures to render the tramway service as efficient in every way as possible, and it will be glad to learn that the Borough Council will assist it in the direction indicated." It was decided to inform the County Council that the Borough Council are assisting the County Council as far as possible in this matter, but desire to point out that it is absolutely impossible to cleanse the centre of the roadway without brushing across the conduit slot. The Council decided to adhere to their decision to make a one-third contribution towards the cost of street-widenings in connection with the proposed tramways to Forest Hill.

**Exeter.**—The Electric Traction Committee have received a report from the city surveyor and electrical engineer on the first cost of construction and the working expenses of the conduit system of electric traction, also on the first cost and working expenses of the conduit and trolley systems combined as applied to the tramway scheme. The total reduced single length being within 5¼ chains of 12 miles, they have adopted this figure in their calculations. The estimated extra cost of the various lengths of conduit system, substituted for the trolley system, in each case is as follows: Scheme 1—conduit system, £8,175; trolley system, £2,736—excess of conduit over trolley, £5,440. Scheme 2—conduit system, £13,172; trolley system, £4,065—excess of conduit over trolley, £9,107. Scheme 3—conduit system, £16,791; trolley system, £5,329—excess of conduit over trolley, £11,462. The estimated annual charge on the three schemes are: Scheme 1, total extra annual cost, £614; Scheme 2, £915; Scheme 3, £1,050. In other words, the additional annual cost under Scheme 1, the cheapest of the three schemes, will amount to a sum equal to more than one-third of the total management expenses under the trolley system, and the other schemes more in proportion. The committee recommend that the tramways to be laid by the Corporation be equipped on the overhead trolley system throughout; that the city engineer and surveyor and the electrical engineer be instructed to at once prepare plans, etc., for the two sections it is desired to construct, with a view of tenders being invited; also to prepare a report as to the best size and type of car to be adopted, and that they be empowered, if thought desirable, to visit the works of the makers of standard cars.

**Rugby and District Light Railway.**—Sir Herbert Jekyll has held an enquiry into the objections against the confirmation of an order authorising the construction of light railways in the urban and rural districts of Rugby. Mr. Robert Green (engineer) said he thought the cost per mile, taking the whole cost, including equipment, would be about £13,000. His estimate was £62 340 plus £17,660 for cost of widenings and extra expenses. Mr. Shillitoe said he appeared as a ratepayer representing business men. They thought that the company in 21 years, or at any rate some period less than 35 years, would amply recoup themselves for all their outlay, and it would be greatly to the advantage of Rugby that the Council should have the option of purchasing. He had a petition from between 400 and 500 ratepayers. Sir Herbert Jekyll doubted whether the Board would be disposed to go behind the agreement which had been come to between the local authorities and the promoters in a matter of this kind. On behalf of the Rugby Gas Company an attempt was made to obtain the addition of a proviso to the clause relating to water-mains as follows: "To admit of any new service pipe which the owners may desire to lay down in connection with any such main being laid horizontally with the same." It was argued for the company that it was very important that the service pipes should be laid horizontally, because if a bend of any kind should take place in the pipe water was likely to accumulate, which would cause a stoppage and interfere with the gas supply. This, it will be seen, is a development of the case of the Ilford Council and the gas company, where the Courts held that it was a reasonable requirement that the Council, in constructing their tramways, should do so in such a manner that the new service pipes to the gas-mains might be laid horizontally. Sir Herbert Jekyll said the point would be considered, but he did not consider the Board would think there was much in it.

**District Railway.**—The Underground Electric Railways Company of London, Limited, have placed the contract for the signalling equipment of the 15 miles of double track of the Metropolitan District Railway with the Westinghouse Brake Company. The signals for this installation will be worked automatically on the Westinghouse electro-pneumatic system, and are about 200 in number, the service in the tunnels being arranged for trains running at intervals of about 1¼ minutes. A new form of combined signal motor and arm will be employed. These motors, together with train stops, relays, and other special apparatus, are now being manufactured by the Westinghouse Brake Company, Limited, at their works at 82, York-road, King's Cross, N. This system of automatic signalling has already been in service for some months on the Ealing and Harrow branch of the Metropolitan District Railway. The Underground Electric Railways Company have also placed a contract for electric lifts for the whole of the Yerkes system of tube railways with the Otis Elevator Company, Limited, of London. The works amount in value to about £350,000—the largest contract for passenger lifts which has ever been placed in this country or abroad. The lifts will be electrically operated from the Chelsea generating station, from which electric power will be furnished for the three railways comprising the system—namely, the Baker-street and Waterloo, the Charing Cross, Euston, and Hampstead, and the Great Northern, Piccadilly, and Brompton Railways. The underground stations will be fitted in most cases with four and in some cases with six lifts each. The lift machinery will be of the Otis type, and precautions will be taken to ensure the security of the public by the adoption of special safety appliances and of non-flammable material throughout the mechanism and its accessories. The tender of the British Thomson-Houston Company, Limited, of Rugby, has been accepted for the motors to be used on the trains. In connection with this it is interesting to recall that the Sprague Thomson-Houston system of multiple-unit control was a short time since decided upon for the trains of the District Railway, the contract being awarded to the British Thomson-Houston Company after extensive competitive trial and thorough examination into the merits of the various systems. This follows the example set by the Central London Railway, Great Northern and City Railway, and the North-Eastern Railway at Newcastle.

**North-Eastern Railway.**—According to the *Yorkshire Post*, it is expected that the work of electrifying the suburban lines of the North-Eastern Railway in the neighbourhood of Newcastle will be finished by Easter, and it is possible that a portion of them may be in use before them. The actual road-bed work has been completed in the most populous part of the system for a week or two, and the most important trials are expected to take place on the 14th inst. Delay in the use of the lines is caused by the station alterations for the conversion of the three-phase electric current, and the completion of the new power station of the Newcastle Electric Supply Company, who are to supply current. The three-phase current will be supplied at 5,500 volts and at a periodicity of 40 cycles per second, and will be transformed into continuous current for the working line. Thirty-seven miles in all, or 82 miles of single track, are being converted, enclosing a populous oblong piece of land between Newcastle and the sea, while one tongue will run westward as a light railway to the village of Ponteland, eight miles from Newcastle. The whole of the electrical equipment of the track has been carried out by the British Thomson-Houston Company, of Rugby. The conductor rails are of special high-conductivity steel, weighing 80lb. per yard. These rails are 19¼in. from the gauge line, and are outside the running rail. The return is secured by bonding the track rails with a special fishplate, designed by Mr. Charles Harrison, engineer to the line. The plant for the new power-house at Wallsend is being supplied by Messrs. C. A. Parsons and Co., and the installation includes one 2 000-kw. turbo-alternator with exciter, and two 3,500-kw. turbo-alternators with exciters. The turbines will be of the regulation Parsons type. The speed is 1,200 revolutions per minute, and the larger sets are capable of an overload output of 5,000 kw. for two hours. The rolling stock is being built at the N.E.R. works at York, and includes motor coaches and trailer coaches from the designs of Mr. Wilson Worsdell, the locomotive superintendent. The cars are of the open-corridor type, lighted and heated by electricity, and painted to standard N E R colours. Each coach is carried on two four-wheel bogie trucks supplied by the Thomson-Houston Company, and constructed by the Brush Electrical Engineering Company to Mr. Worsdell's specification. The collector shoes are carried by an oak beam on either side of the truck. Each coach is equipped with two 150-h.p. motors carried on one bogie truck. The train unit is to consist of two motor coaches with trailer between. The motor coaches have drivers' compartments at one end, but a few also have controllers in the vestibule at the other end. The Sprague-Thomson-Houston multiple-unit control system is used throughout. The ordinary stopping train will take 23 minutes for the journey from Newcastle to Tynemouth, travelling at 22 miles an hour including stops, instead of 38 minutes as now, while the express will take 15 minutes instead of 20 minutes. The Quayside branch for goods is being treated separately, and will be worked by two electric locomotives capable of hauling a train of 150 tons up a gradient of 1 in 27 at from nine to ten miles per hour. The Wolseley Company, of Birmingham, have for a considerable time been engaged upon the construction of a petrol-driven motor train for the North-Eastern Railway Company. The first of the cars was dispatched some time ago, and has just had its trial trip. It was tested over 60 miles of the ordinary track, and came out of the ordeal most successfully. The journey was accomplished without a hitch of any description, and in addition the car was found to do its work upon a most economical basis. The consumption of petrol worked out at the low rate of one pint per horse-power per hour. A speed of 40 miles was often attained, and on the whole journey, including four stoppages, the average showed a speed of 30 miles an hour. A gradient of some magnitude was climbed with the greatest ease. The coach, which weighs 35 tons, resembles an ordinary long passenger carriage. Current is generated by an 80-h.p. motor driving a dynamo. The new cars are intended to be used on the suburban lines at Newcastle.

## LIGHTING AND GENERAL.

**Colchester.**—The Electric Light Committee have decided to extend the mains to Mile End Village at a cost of £410.

**Margam.**—The enquiry into an application by the Council to borrow £15,000 for electric lighting has been adjourned.

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**Bridgend.**—The Urban Council have resolved to take steps to provide a transformer sub-station at Oldcastle at a cost of £250.

**Smithfield Market.**—The market was plunged in darkness on Tuesday night owing to the bursting of a steam-pipe.

**Exmouth.**—The Electric Supply Corporation propose to start work soon in connection with the electric lighting of the town.

**Merthyr.**—The Urban District Council have approved a scheme for street lighting, which includes the erection of a number of arc lamps.

**Bognor.**—The Board of Trade have extended the period for revoking the Urban District Council's electric lighting order for another six months.

**Sunderland.**—The yearly estimates of the Electricity and Lighting Committee shows an estimated profit of £400 on the coming year's working.

**Beckenham (Kent).**—With regard to the fire in the electric light and battery works it is reported that the buildings have been entirely destroyed.

**Dorchester.**—The Town Council are taking steps to negotiate with companies desirous of obtaining a transfer of the Council's electric lighting order.

**Luton.**—The total number of 8-c.p. lamps or equivalent is now 7374; total number of 8-c.p. lamps connected, 9,665; and the maximum demand to date, 470 amperes.

**Fulham.**—The Borough Council have agreed to a notice from the Brompton and Kensington Electricity Supply Company of intention to lay mains along a portion of Redcliffe-square.

**South London Electric Supply Co.**—The directors announce that, subject to final audit, they recommend a dividend on the ordinary shares at the rate of 3 per cent. for the past year.

**Brighton Telephones.**—The manager has reported that by March 1 about 750 subscribers will have been connected to the Corporation system, and the rentals will be charged from that date.

**Coniston.**—A canvass is being made for customers who would be willing to take up lights provided an electric installation was laid down in the village. The Lighting Act is to be adopted.

**Hebburn.**—The District Council have decided to instruct the Northern Counties Electricity Supply Company to complete the lighting of the urban area by electricity as early as possible.

**Derby.**—It has been decided to grant to the National Telephone Company permission to place and maintain wires underground in such streets as may from time to time be approved by the Corporation.

**Barnet.**—A draft agreement between the Urban District Council and the North Metropolitan Electrical Power Distribution Company, under the Council's electric lighting order of 1900, has been approved.

**Swindon.**—The number of electric light consumers on Jan. 15 was 153 as against 141 in December. The number of street lamps connected to the electric light at that date was 115 as against 98 the previous month.

**Eccles.**—The Public Lighting and Electrical Supply Committee, having inspected the lighting in the vicinity of seven streets, have instructed the electrical engineer to prepare an estimate of the cost of improved lighting.

**Lowestoft.**—Additional street-lighting has been agreed to by means of 16-c.p. lamps fixed to the trolley standards, at a capital charge of £178. The annual charge for lighting (including repayment of capital and interest) will be £55.

**Walsall.**—The Guardians have decided to light their new buildings by electricity. Incandescent gas brackets have been put in as a test, but the committee which had had the lighting question in hand would not recommend gas for the new buildings.

**Malton.**—Callender's Cable and Construction Company began laying the cables for the purpose of lighting the streets, etc., by electricity on Tuesday morning, and they are pushing on the work vigorously by the aid of a large staff of men.

**Madrid.**—The Public Works Department require tenders for the construction and the working of an electric tramway from San Cristobal de la Laguna á Tacoronte, in the province of Canarias. The adjudication will take place on March 23, at 12 noon.

**Oswestry.**—The Town Council have accepted the tender of the electric light company for lighting and repairing the 12 arc lamps in the Cross Market at £36 per annum, and an agreement has been entered into with the company for seven years.

**Telegraph Construction and Maintenance Co.**—The directors propose paying a dividend of 10 per cent. (£1. 4s. per share), together with a bonus of 5 per cent. (12s. per share), in addition to the 5 per cent. already paid, making 20 per cent. for the year 1903.

**Bangor.**—The electrical engineer's (Mr. Price White) last report states that on Jan. 23 the works were supplying electricity to 8,628 8-c p. lamps. During the four weeks ended Jan. 23 there was an increase of 18 per cent. in the number of units of electricity sold.

**National Telephone Co.**—The directors recommend a dividend for the half-year ended Dec. 31 last at the rate of 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock, carrying £110,000 to reserve and about £10,500 forward.

**Morley.**—The borough electrical engineer in his last report stated that the output of electricity during the month ending Dec. 31 was 24,435 units, as compared with 17,129 units the same period of the previous year, being an increase of 6,306 units. The lamps connected to Jan. 22 numbered 11,262.

**Kensington and Knightsbridge Electric Lighting Co.**—The directors recommend a dividend for the half-year ended Dec. 31 at the rate of 10 per cent. per annum and a bonus of 2 per cent. for the year, making, with the interim dividend paid Aug. 1, 12 per cent. for the year, leaving a balance of £8,289 to be carried forward.

**Glastonbury.**—The Somerset County Council are opposing the application of the Town Council for a provisional order under the Electric Lighting Acts, but the Town Council, acting under the advice of their parliamentary agents, have decided not to assent to the insertion of the clauses required by the County Council.

**Municipal and County Club.**—At the house dinner of the Municipal and County Club, held on the 8th inst., Sir Francis J. S. Hopwood, K.C.B., C.M.G., Permanent Secretary of the Board of Trade, was the guest of the evening. Mr. Laurence Gomme, the president, occupied the chair. A most successful entertainment followed.

**Colyton (Devon).**—At a parish meeting last week it was decided to take steps to light the town by electricity, and a committee was appointed, consisting of Dr. Cosens, Rev. R. Turner, Dr. Evans, Messrs. J. I. Scarbrough, Follett, E. H. Cumming, Pitcher, Murley, Stokes, Baker, Strawbridge, and W. Board (secretary), to further consider the question.

**Bonnyrigg.**—At a meeting of the Town Council on Wednesday a ratepayers' petition was presented suggesting that some arrangement might be made, in view of the early introduction of electric lighting in the neighbouring burgh of Dalkeith, for an extension of the electrical system to Bonnyrigg. The matter was remitted to the Lighting Committee of the Council.

**Telegraph Rates to Egypt.**—A *Times* correspondent writes from Alexandria on Jan. 29: "It is announced that the telegraph rates between England and Egypt will be reduced to 1s. 5d., instead of 1s. 10d. and 1s. 7d., a word on and from July 1 next, at which date the revised rules and regulations adopted at the recent Telegraph Conference will come into force."

**Middlesbrough.**—It is stated that the Corporation, who received sanction to borrow £2,000 for street-lighting some months ago, have used that amount in other directions. Consequently the Local Government Board have declared that when the Council apply for another electric loan, they will deduct the £2,000 unless the thoroughfares have been illuminated with electricity.

**New Branches.**—Messrs. Sybry, Searls, and Co., Limited, Cannon Steelworks, Sheffield, suppliers of tool and mining steels, crucible steel castings, rock drills, etc., have opened a London office at 46, Queen Victoria-street, E.C. The Paterson Engineering Company, Limited, have opened an office at Amberley House, Norfolk-street, Strand, in connection with their business in the South of England.

**Ravensthorpe.**—The Yorkshire Electric Power Company last Thursday submitted to the Council a scale of charges for lighting and power. This varied from ½d. to 1½d. per unit. It was suggested that the Council might consider the question of taking current in bulk and distributing it. The clerk was instructed to bring the matter up again along with the company's Act of Parliament.

**India.**—A correspondent writes to *Indian Engineering* that the progressive Burma hill station of Thandaung is going in for lighting its school with electric light. The station is fortunate enough to have an engineer in charge of its sawmill who understands electricity, and there is any amount of water power available. Thandaung may possibly have its roads lighted by electricity even before Rangoon.

**Motor Sales.**—The British Westinghouse Electric and Manufacturing Company report recent sales of S.B. direct-current motors to the Great Northern Railway, Messrs. Babcock and Wilcox, the Newcastle and District Electric Lighting Company, the South Durham Steel and Iron Company, Messrs. E. Newell and Co., Messrs. Mills, English, and Co., and Messrs. Monks, Hall, and Co.

**Torquay.**—The Town Council have resumed the discussion of the recommendation of the Electric Lighting Committee to apply for sanction to borrow £42,500 for a new light and power station, transferring the present station from underneath the Bath Saloons to Upton Valley, the estimated cost of the station buildings and chimney shaft being £14,500 and of boilers and machinery £28,000.

**Rand Central Electric Works.**—The following cablegram from Johannesburg, notifying the result of working for the month of January, 1904, appears in the *Financial Times*: "Kilowatt-hours generated 776,940, yielding a gross revenue of about £7,000." (Office note—For the corresponding period of last year the result was: kilowatt-hours generated 677,860, yielding a gross revenue of £5,078.)

**Bootle.**—A report on results of enquiries made at 200 principal electric supply undertakings as to their system of charging for the supply of electricity has been submitted, but the matter stands deferred for the present. Several manufacturers are prepared to enter into hire-purchase supply of electric motors if the Corporation will collect and transmit without any responsibility the purchase money to the manufacturer.

**Yorkshire Electric Power Co.**—The directors report that since the first ordinary meeting of the company, held in September last, the erection of the station at Thornhill has made progress, the structure of the engine-house in particular being pushed forward. A scale of charges for current has been settled, and negotiations with various local authorities, colliery proprietors, and others for the supply of power are proceeding.

**Stock Exchange.**—The Stock Exchange Committee has appointed Feb. 17 special settling day for Auckland Electric Tramways Company's £200,000 5 per cent. first mortgage debenture stock, and have also ordered the said securities to be quoted in the official list. The committee have been asked to allow to be quoted Electric Construction Company's further issue of £12,500 4 per cent. perpetual first mortgage debenture stock.

**Measures Bros., Limited.**—In the report, to be submitted at the fifth annual meeting on Friday, the directors again report an improve-

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ment in the profits over those of the previous year. They report that the purchase of the business of Messrs. H. and G. Measures has been carried out, and the amalgamation completely effected. It is proposed to pay on the ordinary shares a dividend of 5 per cent. per annum for the half-year ending Dec. 31.

**Buxton.**—Mr. W. J. Leeming in his last report on the progress of the electrical undertaking states that there are now 18,943 8-c.p. lamps connected, and also eight motors making a total of 45 h.p. Applications for 100 8-c.p. lamps and 17 motors of a total of 49½ h.p. are in hand. The units sold for the quarter ended Dec. 31, 1903, were 53,745, as compared with the corresponding quarter, 1902, 38,467; the total increase being 15,278.

**Doncaster.**—The borough electrical engineer in his last report stated that the number of applications received since the November meeting to the present date was 10, being equivalent to 364 8-c.p. lamps. Number of consumers on books, 326; number of 8-c.p. lamps applied for, 25,519; number of consumers awaiting connection, 8; number of consumers connected, 318; number of 8-c.p. lamps awaiting connection, 698; number of 8-c.p. lamps connected, 24,821.

**Camberwell.**—A notice from the County of London and Brush Provincial Electric Lighting Company, Limited, of its intention to lay electrical conduits along the east side of Flodden-road and the east side of Denmark-road from Knatchbull-road to Camberwell Station-road, also along the south side of Camberwell Station-road from Denmark-road to the mineral-water works, one 2in. high-tension pipe and one 2in. low-tension pipe, has been agreed to.

**Venice.**—A recent consular report refers to an electrical supply company which has for the last two years been exploiting the water power of the Celina River for electrical purposes. It is mentioned that while it would pay manufacturers to introduce many electrical appliances for which there is an increasing demand, that personal efforts—*i.e.*, travellers—are required, as the Venetian merchant pays little attention to catalogues, even when printed in Italian.

**Widnes.**—The Council's electricity supply order of 1901 is to be transferred to the Mersey Electric Supply Company, Limited. The Corporation are to have in addition statutory powers of purchase, the option to acquire the undertaking for an amount actually expended, after deducting amount (if any) required to put same in repair, with the following additions: at the end of 14 years, 20 per cent.; 21 years, 10 per cent.; 28 years, 5 per cent.; and 35 years, 2½ per cent.

**Hampstead.**—Owing to the increase in the number of lights connected in High-road, Kilburn, it has become necessary to supplement the distributors between these points, the present mains being overloaded, and 50 yards of triple-concentric cable is to be laid from the sub-station at an estimated cost of £41. The Lighting Committee are prepared to provide penny-in-the-slot electric meters if any applications were received, but so far no applications have been received.

**Councils' Wiring.**—A conference is being convened with the view of urging the London County Council to make another application to Parliament for powers to enable metropolitan borough councils supplying electrical energy to expend money on the wiring and fitting of consumers' premises as well as to make charges therefor. The opponents to the former measure have intimated their intention not to renew their opposition in the event of the powers mentioned being again applied for.

**Worksop.**—The Urban District Council have received the following statement with regard to the electric light undertaking for the years 1902 and 1903: For year ending Dec. 31, 1902—income, £1,260. 3s. 1d.; expenditure on revenue account. £1,014. 18s. 7d. For year ending Dec. 31, 1903—income, £2,190; expenditure on revenue account. £1,299. 10s. 1d. Balance to credit—1902, £245. 4s. 6d.; 1903. £890. 9s. 11d. Amount paid for loans and interest—1902, £1,278. 3s.; 1903, £1,427. 7s. 3d.

**Swansea.**—The number of users of electric light on the books is now 483. It is proposed to supply electric light at the Bath and West of England Show. The Postmaster-General has replied on the subject of intercommunication with the National Company's system to the effect that the number of subscribers to the Corporation telephones being more than a quarter of the subscribers to the National Company, the Corporation would be permitted mutual intercommunication in accordance with the order of September, 1899.

**Underground Telegraphs.**—In the House of Commons on Tuesday, Lord Stanley, questioned by Sir J. Leng, said the line of pipes for the underground telegraph cable was now laid continuously from London to Carlisle, and a section of 19 miles was being laid over the Beattock Summit. By the end of the financial year a double line would also be laid from Manchester to Leeds. A permanent cable would be ready for use as far as Warrington, and it might be possible to employ temporary cables between Manchester and Leeds.

**Southport.**—The electrical engineer has been empowered to engage a temporary draughtman to bring up to date the plans of the mains, service cables, etc. He has also presented a report on the working and maintenance of the electric fire-alarm bells in the firemen's houses, and the head constable is to test the alarms at least once a week. The Chairman, Vice-Chairman, Councillors Austin, Ingham, and Thorp have been appointed a sub-committee to report on the exits and fire appliances at the whole of the public buildings, churches, chapels, etc., in the borough.

**Dundee.**—At the last Town Council meeting Mr. Speed referred to the breakdown in the electric light supply a week ago, and said they should have a report regarding it, as the citizens were entitled to some explanation. The Lord Provost said the engineer told him that the reason of the breakdown was that the old wires were overloaded, and while they were removing and relaying cables extra current was put through, with the result that one of the cables gave out. It was purely an accident, and was not likely to happen again. The subject then dropped.

**Radcliffe.**—The Lancashire Electric Power Company have obtained a site on the banks of the River Irwell, in Radcliffe, with railway siding accommodation. Tenders for the buildings have been let, and the work of erection is progressing rapidly. The plant is due for delivery in the autumn, by which time the buildings are to be ready, and the company should be in a position to supply electric power at the beginning of next year. Negotiations are in progress with a number of local authorities who are anxious to have a supply of electricity in bulk.

**Worthing.**—The electrical engineer states the recent failures in the arc lighting were in almost every case due to the action of the damp in corroding the moving parts of the lamp mechanism and causing them to stick. In the ordinary course arc lamps will do their work for three years with no more than the ordinary daily attention; the exceptional weather, however, had necessitated a general overhaul at the end of the second year. Already about a third of the lamps have been taken to pieces and readjusted, and that work is being steadily persevered with.

**Glasgow.**—The Electricity Committee have been empowered to order three turbine engines for the electricity power stations. The deputation which was sent to Newcastle returned with the opinion that there was no doubt that the turbine engines were destined to take the place of the ordinary steam-engines. Their cost, they said, was very much less than the ordinary steam-engines, and the consumption of fuel was less. It was, however, the saving in the capital expenses that had induced the committee to recommend the purchase of the three engines.

**Willesden.**—The Works and General Purposes Committee of the District Council on Tuesday reported that they were convinced that their electrical engineer, Mr. Ruthven Murray, in the course of the negotiations with the North Metropolitan Electric Supply Company, had acted in the best interests of the ratepayers, and that the interchange of courtesies between Mr. Murray and the consulting electrical engineer to the company had been misconstrued, although they were of opinion that the consent of the Electrical Committee should have been obtained before the interview took place.

**Schuler-Lahmeyer Motor.**—We are informed that the Lahmeyer Electrical Company, Limited, Bank-buildings, 109-111, New Oxford-street, W.C., have now made complete arrangements for the purchase of the patent Schuler single-phase alternating-current motor, the rights for which were recently held by Messrs. Ferranti, Limited. This motor has a very large starting torque, and is specially suitable for lift and crane work. The firm have for some time past held the Continental rights of this motor, and have already supplied a considerable number of these machines on the Continent.

**Cardiff.**—The Council have adopted a recommendation of the Electric Lighting Committee, that several streets in the borough in which electric mains are already laid should be lighted by electricity. The town had a narrow escape on Friday of being wholly cut off from communication with the outer world by telephone, owing to a fire which broke out at the Cardiff Docks Post Office, the exchange centre not only for the Post Office system, but for trunk calls over the National. The immediate arrival of the fire brigade saved the situation, and the damage was restricted to one cable, which was soon repaired.

**Ipswich.**—By the invitation of Mr. Herbert J. W. Jervis, chairman of the Corporation Electric Supply and Tramway Committee, the members of the Ipswich Scientific Society were enabled to pay a visit on Saturday afternoon to the electrical works in Constantine-road. Excellent arrangements were made by Mr. F. Ayton, chief engineer and manager, with whom and Mr. Frank Woolnough, hon. secretary of the society, there was hearty co-operation. The Mayor (Fred. Bennett, Esq.) and Mr. Jervis were present, and the members of the staff spared no pains to render the inspection both pleasant and instructive.

**Sowerby Bridge.**—Messrs. Miles Sykes and Son having asked the Council to allow the Halifax Corporation to supply them with electricity, the Council have replied that as they have obtained an electric lighting order, and expected shortly to be in a position to supply electrical current themselves, they could not give the permission asked for. The Electrical Sub-Committee are negotiating with the Yorkshire Electric Power Company with respect to the terms upon which they would supply the Council with electrical current. The Board of Trade have deferred consideration of the question of revoking the order until a year from Jan. 29.

**Chester-le-Street.**—At the last Rural District Council meeting a letter was read from the secretary of the Birtley Co-operative Society asking the Council to give their consent to the society approaching the Board of Trade for a provisional order under the Electric Lighting Acts, 1882, 1888, 1889, authorising a supply of electrical energy and power for public and private purposes for the township of Birtley, etc., over which the Rural District Council have jurisdiction and control. After discussion the application was withdrawn, it being intimated that the Highways Committee would be approached for permission to carry the society's wires through the roads.

**St. Marylebone.**—At a meeting on Feb. 4 the Mayor informed the Council that arrangements for the poll of the ratepayers next Monday had now been completed, and that the result would probably be known about midnight. The impression seemed to have got abroad that he was going to send round to the ratepayers a letter telling them to vote, but that was not his intention. Various motions, notice of which had been given by Mr. White, including "that the engagement of Mr. Arthur Wright, the electrical expert, be determined, and that the necessary notice be given him terminating his engagement," were adjourned till after Feb. 8. The result of the poll appears in another column.

**Bredbury and Romiley.**—The following recommendation will come before the next meeting of the District Council: "That inasmuch

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as the Board of Trade will revoke the electric lighting order unless certain works be carried out, and in view of the fact that considerable expense has already been incurred to prepare a further amended estimate and report on a scheme which would not involve the Council in a greater expenditure than must be met by a 1d. rate, that a further meeting be convened for the consideration of same, and in the meantime the views of the inhabitants within the compulsory area be taken whether they would be prepared to take electricity if the Council erected a station on a small scale."

**London County Council.**—At Tuesday's meeting the Fire Brigade Committee recommended (*a*) that the arrangement with Messrs. F. J. Coleby and Co. for the maintenance of electric bells in fire stations be terminated as from March 31, 1904; (*b*) that the offer of the General Post Office to maintain, in consideration of payment at the rate of 5*s.* per bell per year, the whole of the electric bell apparatus in fire brigade stations, such payment to include the provision and fixing of new bell apparatus in new stations, and additional bells at existing stations, be accepted, the agreement to hold good for three years from April 1, 1904, and to be continued thereafter from year to year until determined by three months' notice on either side.

**Metropolitan Asylums Board.**—At Saturday's meeting the Works Committee, as the result of consultations between Messrs. Treadwell and Martin and Mr. Hatch, submitted an amended plan of the laundry buildings and boiler-house at the Southern Hospital, together with plans showing a disinfector house, destructor house, coal stores, electrical power-house, and engineers' and artificers' shops, and an independent chimney shaft 120ft. high. The total cost of these buildings, which had been designed to meet the requirements of the engineer to the Board, the architects estimate at £14,995, or £3,069 (of which not more than £1,000 was allocated by them to the laundry) over and above the amount provided in the contract for the laundry, boiler-house, etc., as originally planned.

**Yarmouth.**—The borough surveyor and the electrical engineer on Tuesday submitted to the Electric Lighting Committee an estimate of the amounts likely to be required by the committee for the next half-year, and the present financial position of the undertaking. The year's work will be complete in two months, and there is every prospect of there being a profit over all expenses, including interest, sinking fund, etc., of £1,000, and with the balance of £378 left after paying £500 to relief of rates out of the last year's profits, they are of opinion that all contingencies would be met if £800 was contributed to the district fund account. The Council agreed that, assuming there was a net profit of £1,000 or upwards on the working for the year ending March 31 next, an allocation of £800 of such profits be applied to the relief of the district fund for the year commencing April 1 next.

**Plymouth.**—The report of the electrical engineer recommending the provision of additional plant at the electricity works has been approved, and a recommendation to apply for authority to borrow £20,000 to carry out the work will come before the next Council meeting. A return of the past nine months' working of the undertaking shows a net profit of £1,634 on the nine months' working. Two years ago the Council extended the buildings at the electricity works, and it is now only a question of providing additional machinery. The increase of the undertaking has been most rapid. In 1901 there was an increase of 4,222 8-c.p. lamps, in the following year there was an increase of 7,700, and last year a further increase of 11,071 lamps. With that rate of increase the margin of 5,000 lamps now left will soon be absorbed. The proposed extension is expected to yield a profit of £3,000 per annum.

**Crystal Palace Automobile Show.**—The official show of the Society of Motor Manufacturers and Traders, Limited, with which is incorporated the Crystal Palace and Motor Traders' Show, opens to-day. The whole of the resources of the Crystal Palace and the electric lighting company have been pressed into contribution. Over 130,000 square feet of space have already been allotted, but applications are still being received. In regard to the decoration of the stands, no fewer than 10,000 extra lights will be employed, and it has been found necessary for the society to lay down their own plant, the horse-power of the engines amounting in the aggregate to 750. Taking these in conjunction with the already brilliant lighting effects of the Crystal Palace, we can say without hesitation that the exhibition will be one of the most brilliant spectacles ever witnessed. With the exhibits we will deal in our next issue.

**Ealing.**—Attention having been drawn to complaints with regard to the pressure of the supply, the borough electrical engineer explained at the last Council meeting that to a large extent the cause was a series of accidents which had happened to the condensing plants on Jan 4 (when there was a 3 per cent. drop in pressure). The suction pipes of the condenser became choked up on two separate occasions within 10 minutes of each other, and some three hours elapsed after the removal of the obstruction before steam and electrical pressure could be re-established, owing to the drop in the boiler pressure which had taken place while the condensers were out of action. On the 10th ult. a piston rod snapped, and on the 14th ult. the breaking of a cross-head bolt put the condenser plant out of action. Every effort had been made to maintain the pressure of the supply; a series of tests was being made throughout the district in order to ascertain that the pressure was up to the standard.

**Whitby.**—Referring to the report in our last issue, we have obtained the following particulars in regard to supply records: Number of 8-c.p. lamps connected, 5 550; number of units sold, private supply 34,402, public supply 40,351—total, 74,753; units sold per 8 c.p. lamp, 13·40; maximum load on feeders, 80 kw.; load factor, 15·6; capacity of dynamos, 200 kw.; statutory maximum price per unit, 8d.; prices charged—private lighting, 8d.-2d., 6d., 5d.; public lighting, 3d.; power, heat, etc., 3d.; average price obtained—private supply 5·8d., public supply 4·1d.; population of area of supply, 11.755. The analysis of costs per unit is as follows: coal and other fuel, including cartage, £320. 6s. 11d. (1·02d. per unit); oil, waste, and engine-room stores, £31. 1s. 2½d. (·09d.); wages of workmen, £216 17s. 11d. (·70d.); repairs and maintenance, £284. 17s. 11d. (·91d.)—total works costs, £859. 3s. 1½d. (2·72d.); rents, rates, and taxes, £168. 1s. 4d. (·53d.); management expenses, including insurances, etc., £291. 14s. 10d. (·93d.)—total costs, £1,319. 0s. 1½d. (4·18d.); number of consumers, Dec. 31, 1902, 98 (Dec. 31, 1903, 144); number of public lamps lit by electricity, 36 (160).

**Dewsbury.**—At the last Council meeting the Mayor, in moving the minutes of the General Purposes Committee, referred to the minute dealing with the charges against the borough electrical engineer. He hoped and trusted that the result of the investigation would be a warning to anybody who recklessly and unduly made charges without any sense of responsibility against their officials. The matter was first mentioned to the chairman of the committee, and he was to be congratulated upon the way he took the matter up. They were all delighted and relieved at the result of the investigation, and Mr. Campion stood before them with his character untarnished. It was a proud position for him to occupy, and the fact that the investigation had resulted as it had was some gratification to him for the trouble and inconvenience he had been put to. Councillor L. A. Gledhill, who seconded, said it had been proved without a doubt that the note which was given to him was without any foundation. Alderman Oldroyd, as chairman of the Electricity Committee, said every member was satisfied with what had taken place, and they could only say that they regarded Mr. Campion all the more. He had not lost any of their respect, and they were all pleased. The minutes were approved.

**Longton.**—An application from the directors of the cottage hospital for the free charging by electricity of the batteries in connection with the X-ray apparatus recently presented to them has been granted for 12 months, providing the batteries are only used for patients of the hospital. The output of electricity for the past month was 14,330 units, being an increase as compared with last year of 3,105 units, or about 28 per cent. The report of the sub-committee appointed to consider the question of revising the charges for electric current used for motive power was presented last week. The recommendations are as follows: charges for current used for motive power—from 1 to 500 units per quarter, 2½d. per unit; from 500 to 1,000 units per quarter, 2¼d. per unit; from 1,000 to 1,500 units per quarter, 2d. per unit; from 1,500 and upwards units per quarter, 1¾d. per unit; also that a circular be issued setting forth the scale of charges, and that the same be circulated amongst manufacturers and others likely to be interested in the matter. A sub-committee, consisting of the Chairman, Vice-Chairman, Councillors Beswick, Bowers, Brewer, and Machin has been appointed to go into the question of free wiring as a probable source of new business for the department, and to report thereon to the Gas and Electricity Committee.

**Hereford.**—The Town Council have decided to apply for sanction to borrow £500 for the purchase of the following electrical plant: spare armature and case for No. 3 dynamo, £253; spare brush gear, No. 3 dynamo, £16. 10s.; spare armatures for circulating pump and economiser motor, £60; spare brush gear, No. 2 dynamo, £12. 10s.; spare switch brushes and studs, £6; earth-plate, etc., £12; meters (Ferranti), £80; meter boards, cut-outs, maximum demand indicators, service cable, troughing etc., £60. A return showing the output of current for the quarters ended Dec. 25, 1902 and 1903, has been submitted as follows: quarter ending Dec. 25 1902—units sold for lighting, 37,993; for power, 3 935—total units sold, 41,933; equivalent number of 8-c.p. lamps at beginning of quarter, 8,728; 8-c.p. lamps added, 621; equivalent number of 8-c.p. lamps at end of quarter, 9,349; number of arc lamps connected, 20; number of motors connected, 13; horse-power of motors connected, 42. Quarter ending Dec. 25, 1903—units sold for lighting, 44,069; for power, 5,505—total units sold, 49,574; equivalent number of 8 c.p. lamps at beginning of quarter, 9,895; 8-c.p. lamps added, 846; equivalent number of 8-c.p. lamps at end of quarter, 10,741; number of arc lamps connected, 22; number of motors connected, 15; horse-power of motors connected, 48.

**Kensington.**—The London County Council have sanctioned the borrowing of only £27,098 in respect of the erection of refuse furnaces at the Wood-lane depot, in place of the total estimated cost of these works—viz., £29,098. The balance of £2,000 was deducted in view of certain clauses contained in the contract for the construction of these furnaces, whereby payments at the rate of 50 per cent. only are to be made as the work proceeds, and the balance is spread over a period of three years after the completion thereof, during which period the contractors will be responsible for the proper maintenance of the works and machinery. The Borough Council Finance Committee last week intimated that the London County Council reaffirmed their decision as to sanctioning the borrowing of £27,098 only. The committee, however, is strongly of opinion that the entire cost of the work is a legitimate capital charge, and that the borrowing of the same should be sanctioned by the County Council, but it has come to the conclusion that the matter is not in itself of sufficient magnitude to warrant the Council in prosecuting an appeal to the Local Government Board on the point. It was recommended "That the London County Council be informed that this Council accept, under strong protest, their sanction to the raising of the sum of £27,098 for the works in question." The Council agreed.

**Acton.**—At a special meeting of the Council the Chairman said the position with regard to the dust destructor was that the Council had invited a number of firms to tender, and those firms had replied by asking a number of questions. After discussion it was decided to consider Mr. Trentham's (the electrical engineer) answers to the question, leaving out the questions applying to the combined scheme. The superintendence of the erection of the destructor is to be left with the surveyor. After settling the answers to questions from firms invited to tender it was agreed to ask for tenders at once, to authorise the chairman to open them, and to refer them to the surveyor for the latter to bring up a report on the tenders for a special meeting of the Council

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to be held on the 19th. Offers for the supply of electricity in bulk had been received from the North Metropolitan Electricity Supply Company and the Borough Council of Hammersmith, and their terms had been compared by Mr. Trentham with those of the Metropolitan Electricity Supply Company, which the Council had accepted, subject to a formal agreement. Mr. Trentham's statement showed that Hammersmith made the lowest offer. With capital charges the position was: lighting 3½ hours per day—Metropolitan Company, 4·687d. per unit; Hammersmith, 4·4; public lighting—Metropolitan Company, 2·34; Hammersmith, 2·32; power (nine hours per day)—Metropolitan Company, 4·2; Hammersmith, 3·54. Hammersmith do not charge anything for mains, therefore they come out cheaper on the whole. The Council accepted the terms of the Metropolitan Company.

**Tunstall.**—A special committee of the Urban District Council was held on Monday to consider the question of the supply of electricity for lighting, and a letter was received from the Burslem Corporation stating that a committee of that Council had decided to recommend the Council to enter into an agreement with the Tunstall District Council to supply electricity to Tunstall on the following terms: (1) the Tunstall Urban District Council to agree to take not less than 50,000 units per annum for a period of not less than seven years, the price to be as follows: 2d. per unit up to 100,000 units, 1½d. per unit for each unit over 100,000 and up to 200,000 units, 1d. per unit for each unit over 200,000; (2) if the Tunstall switchboard is fixed at the central station in Burslem, the extra charge for switchboard attendance at Burslem will be £75 per annum; (3) Mr. Bremner will be allowed to act as electrical adviser to the Tunstall Council and to supervise the laying down of electric mains in Tunstall on terms to be arranged by him with approval of the Burslem committee; (4) the question of Mr. Bremner, or the electrical engineer for the time being, acting as electrical engineer for Tunstall will be considered by the Burslem Council if the above terms are satisfactory to Tunstall. After discussion the following resolution was passed: "That provided Burslem is in a position from a legal point of view to carry out such an arrangement, this meeting is prepared to recommend the Council to enter into an approved agreement with the Burslem Corporation for supplying Tunstall with electricity in bulk on the terms contained in paragraph 1 of the letter of the town clerk of Jan. 28, 1904, the details of Clauses 2, 3, and 4 to be further considered and discussed with the Corporation of Burslem."

**Maidenhead.**—The Electric Lighting Committee, in a report submitted at the last meeting, stated that they had considered a communication from the Eton Rural District Council embodying observations upon and suggestions with regard to the draft provisional order containing the following paragraph: "That the maximum price (8d. per unit) appears to exceed that named at an interview with the Council, when their consent was obtained to the promotion of the order, and that the price should be amended in accordance with the statement then made." They had replied that the Corporation have no intention of departing from the rate of charge mentioned by the ex-mayor when he attended a meeting of the Council—viz., ½d. for every two-thirds of a mile from Maidenhead Bridge in addition to the rate current in the borough (now 5d.); and that the rate of 8d. was inserted in the present order to meet the most distant part in the new area; further, that the Corporation are advised that the Board of Trade prefer a fixed sum per unit rather than a sum at so much per mile covered, otherwise the latter method would have been substituted. Since the meeting of the committee formal objections have been lodged with the Board of Trade by the Eton Rural District Council, the Great Western Railway Company, Maidenhead Gas Company, Maidenhead Waterworks Company, Burnham, Dorney, and Hitcham Waterworks Company, Bucks County Council, and Thames Conservancy. The resident engineer, Mr. C. O. Milton, has submitted a report stating that the plant had run favourably over the heavy load of the Christmas season, no trouble at all having been experienced with the works. Since the last meeting six new applications had been received with a demand equivalent to 322 8 c.p. lamps, bringing the total lamps applied for up to 11,530. Six further services had been laid, and others were being put on at the rate of one per day.

**London Gazette.**—The creditors of the Hiram Maxim Lamp Company, Limited, are required on or before Feb. 26, 1904, to send particulars of their debts or claims, and the names and addresses of their solicitors, if any, to William Barclay Peat, the liquidator of the said company, *vice* W. F. Mills, Esq., deceased. The creditors of the Electric Traction Company, Limited, are required to send particulars of their debts or claims to William Barclay Peat, liquidator, 3, Lothbury, London, by March 11. The partnership between Robert Wilson, Francis Wilson, and George Langley, electrical engineers and manufacturers and agents of cycles and motorcars, 5, St. Peter's-street and 49, Bromham-road, Bedford, trading as Wilson Bros., has been dissolved. Robert Wilson and Francis Wilson will continue the business. The first meeting in the estate of Frank Moore, lately electrician, now out of business, lately of 35, Beechwood-view, Burley, carrying on business at 12, St. Paul's-street, Leeds, and now residing at 2, Russell-street, Carr-lane, Shipley, Yorks, will be held at 11 a.m. on Feb. 17 at the Official Receiver's Office, 22, Park-row, Leeds. The first meeting in the estate of Gilbert Jackson and David Smith, trading as Jackson and Smith, electrical engineers, 6, Annetwell-street, Carlisle, will be held at 3 p.m. on Feb. 22 at 34, Fisher-street, Carlisle. A receiving order has been made out in the estate of Charles Wallis, electrical engineer, 121, Cleethorpe-road, Great Grimsby. C. J. Dibb has been released from trusteeship in the estate of William Scholes, trading as Scholes and Son, electrical engineers and contractors, 49, Main-street, Failsworth, carrying on business at 85, Corporation-street, Manchester, and 10, Rochdale-road, Middleton, Lancaster. The Official Receiver has issued a statement in the estate of Gardner Bros. and Co., of Horninglow-street, Burton-on-Trent, electrical engineers, showing gross liabilities £2,860. 5s. 9d., £2,811. 19s. 2d. being expected to rank for dividend. There are 49 unsecured creditors. The debtor considers that the cause of his failure was bad trade, losses on contracts, and lack of capital.

**Burnley.**—A third refuse destructor has just been erected in Burnley. The first, a Beehive destructor, was laid down 20 years ago by Mr. J. E. Stafford and Mr. J. T. Pearson. The second was a Beaman and Deas, which is still standing. Messrs. Masterman Bros., Limited, have erected one of their Simplex types, which was opened on the 1st inst. This is not, however, quite new, as we are informed that over 9,000 tons of refuse have already been burned, and over 2,000,000 gallons of measured water and about 1,000,000 gallons of unmeasured water turned into steam at pressures up to 200lb. per square inch, so that its general capabilities have been tested. The cost of burning has averaged out on the whole of the 9,420 tons at 10·62d. per ton for labour only, which, of course, does not include carting, etc. The value of the Burnley refuse is estimated to be equal to about one-fifth of that of fairly good slack coal, so that every day the works are consuming an equivalent of 6½ to 7 tons of coal, and evaporating an average of over 800 gallons per hour, or, say, 400 i.h.p., calculated on 20lb. of steam. A guarantee has been given to the Electricity Committee that at least upwards of 600 gallons per hour shall be passed daily between 12 o'clock at noon and midnight, and also that by arrangement a supply will be given on Sundays and any other special days, whilst in case of emergency or necessity a very much higher amount can be guaranteed. Thus last Monday for 12 hours over 1,200 gallons of water were evaporated per hour, whilst the maximum of one hour in the middle of the afternoon over 1,500 was passed, and the lowest steam pressure of the whole of the time (12 hours) was 150lb. This shows that the guarantees can be kept well up. The coarser portions of the clinker are carted to the sewage works, and there used for the under bed or rougher screen of the filter-beds, whilst the finer portions go either to mortar mills, covering tips, making cinder paths, and the like. The mortar made from this ash sets more like cement than ordinary mortar. Mr. J. B. Massey, the sanitary inspector, has given the following results of analysis of several specimens of this clinker. Organic matter, 0.

| | Per cent. | | Per cent. |
|---|---|---|---|
| Silica | 40·6 | ..... | 55·3 |
| Lime | 11·2 | ..... | 5·5 |
| Alumina | 18·5 | ..... | 17·3 |
| Oxides of iron | 22·8 | ..... | 15·7 |
| Manganese, magnesia, alkali, etc. | 6 9 | ..... | 6·2 |
| | 100 0 | | 100·0 |

**Bournemouth Telephones.**—On Tuesday, the Town Council agreed to the proposals of the International Electric Company for the establishment of a telephone exchange in the Bournemouth telephone area under the license of the Post Office, subject to conditions as follows: (*a*) the Corporation should have the right at the end of five years from the date of the agreement, or at the end of every successive period of five years, to purchase the whole of the company's undertaking within the area, and the full benefit of the license, at the fair market value of the plant, etc., as a going concern (with nothing for goodwill), plus 20 per cent. for what would be in effect a compulsory purchase; (*b*) the Corporation, subject to the prior rights of the Postmaster-General, to be under obligation to purchase all such plant of the company as should immediately prior to such revocation, etc., be in use by the company for the purposes of the area upon terms of paying the fair market value at the date of purchase, without any addition for goodwill or compulsory purchase; (*c*) the company not to assign, subject, or otherwise dispose of the benefit of the license, or of the agreement with the Corporation, without the consent of the Corporation; (*d*) further clauses necessary to protect the company and the Corporation, but these are matters more of detail than of principle. In urging their proposals before the committee, the managing director referred to the very extensive works carried out by the company, and in reply to questions dealing with the stability of the company, said he was prepared to give any reasonable security for the company carrying through the work subject to their not being bound to do the work until about 400 subscribers are enrolled. The matter of intercommunication between subscribers on the company's system and on the National Company's system was discussed, and the committee took the view that if the number of subscribers was sufficient to justify the company embarking on the scheme, there need be little concern about obstacles being placed in the way of easy intercommunication. The principal telephone rates submitted were as follows: (1) For one instrument and one exclusive line, £6 per annum. (2) For one instrument and one toll line, £2. 10s. per annum, and 1d. a call originated by the subscriber. Subscribers to guarantee a minimum of 300 calls per annum. (3) For one instrument and one exclusive line, £3. 10s. per annum, and ½d. per call—300 calls per annum to be guaranteed. (4) Party lines—two instruments or two subscribers connected, £4. 10s. per annum each instrument; three instruments or three subscribers connected, £4 per annum each instrument; four instruments or four subscribers connected, £3. 10s. per annum each instrument. As regards Corporation instruments (in respect of which the Corporation is at present paying £216. 12s. per annum) a nominal rate of £1 each per annum would be charged.

**Tottenham.**—The report of the Electricity Committee presented at the last District Council meeting included the scheme submitted by the consulting engineers, Messrs. Hawtayne and Zeden, which recommended the Council to utilise the power of the refuse destructor. This would supply about 350 i.h.p., and would mean sufficient steam available for running a 200-kw. steam dynamo. The committee recommended that the Council put down a unit of this size, together with an additional similar unit to act as a stand-by. The top load of the plant would be reached during two hours out of the 24, and they considered it desirable that the Council should put down some additional boiler plant in connection with the refuse destructor boilers, so that the engine-house units might be increased from 200 kw. to 300 kw.

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In this way it was considered that the destructor could be better utilised. It would mean a very small coal bill, and would enable the Council to very considerably increase the number of their consumers, and consequently their revenue. The extra cost of the larger scheme was given as an addendum to the report, having stated that the refuse destructor could supply the power for a 200-kw. steam dynamo. The Council had decided to erect 129 arc lamps in the various streets, and these lamps would absorb about 70 kw., leaving 130 kw. for private supply. It was estimated that in the street-lighting area scheduled there would be about 8,000 8-c.p. lamps taken up, and of these not more than approximately 4,000 lamps would be on at one time. The provision of mains for the compulsory area was not a matter of public expense, but the provision of mains for the necessary lighting in the streets already named outside the compulsory area necessarily added a further considerable sum to the capital cost, as the cables laid in these streets would really have formed part of the distributing system if a larger scheme had been decided upon, but in this case a special system of both high and low tension mains has to be laid for supplying the arc lamps in the outlying districts. The cost of Scheme 1, running 200 kw., with one similar unit as a stand-by, would be £25,450, including proportional cost of site, shaft, generating plant, underground mains, meters, engineering and legal expenses, and extras for providing the necessary transformers, high and low tension mains, etc. By Scheme 2 an additional capital expenditure of £4,000 would be required to run 300-kw. units, together with additional boiler power to increase the generating plant, bringing up the total capital expenditure to £30,000. On this assumption the estimated revenue would be £5,422. 16s. per annum, from which, on deducting £3,113 for works cost and repairs, would leave a gross profit of £2,309. 16s. Allowing for interest and sinking fund at the rate of 6½ per cent. per annum on £25,450 as £1,654. 5s., there would be left a net profit of £655. 16s. It was pointed out that if the Council accept the North Metropolitan Company's offer for the supply of arc lamps, etc., a sum of approximately £4,000 would have to be added to the above-mentioned capital expenditure. The committee recommend the Council, in the event of the adoption of the scheme, they should make application to the Local Government Board for sanction to a loan of £30,000. After discussion, the matter was referred to the Council in committee.

## PROVISIONAL PATENTS, 1904

FEB. 1.

**2390. Improvement in magnetic compasses.** Alexander Hughes, 59, Fenchurch-street, London.

**2397. The renewable centre and self-lubricating trolley pulley for overhead electric tramcars and the like.** Robert Carnegie and Arthur Beevers, 32, St. Leonard's-road, Rotherham, Yorkshire.

**2420. Improvements in trolleys for electric cars.** William Allen Daggett, 18, Fulham-place, Paddington, London. (Complete specification.)

**2433. Improvements in means for regulating dynamos.** Henry Leitner and Richard Norman Lucas, Lynton, Dartnell Park, Byfleet, Surrey.

**2434. Improvements in secondary batteries.** Henry Leitner, Lynton, Dartnell Park, Byfleet, Surrey.

**2438. Improvements in automatic electrical switches.** Abraham Sanford Adler, 28, New Bridge-street, London. (Complete specification.)

**2449. Improvements in emergency brakes.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2450. Improvements in controlling electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**2451. Improvements in photometric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2452. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2453. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2454. Improvements in combined circuit breakers and starting rheostats.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2455. Improvements in control of alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2456. Improvements in machines for treating filaments for electric lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2457. Improvements in electric switches.** Gilbert Wright and Harry Maurice Acly, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 31, 1903, being date of application in United States.) (Complete specification.)

**2458. Improvements in brush holders for dynamo-electric machines.** Harry Maurice Acly, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 31, 1903, being date of application in United States.) (Complete specification.)

**2459. Improvements in compensating systems for alternating electric current generators.** Elmer Ellsworth Farmer Creighton, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 31, 1903, being date of application in United States.) (Complete specification.)

**2466. Improvements in clockwork electricity meters.** Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

**2467. Improvements in clockwork electricity meters.** Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

**2471. Improvements relating to the compound excitation of collector alternators.** Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 2, 1903, being date of application in France.) (Complete specification.)

**2486. Improvements in electric switches.** Louis Thurnauer, 4, South-street, Finsbury, London.

**2495. Improvements in or relating to electric gas or vapour lamps.** Max von Recklinghausen, Westinghouse-building, Norfolk-street, Strand, London.

**2497. Improvements in controllers for electric motors.** Mark Cummins, Westinghouse-building, Norfolk-street, Strand, London.

**2504. An improved contact shoe for electric railways.** Henry Rosenfeld, 53, Chancery-lane, London. (Complete specification.)

FEB. 2.

**2512. Improvements in electrical joint-boxes.** Wellington Ernest Grover, 26, Stanmore-road, Edgbaston, Birmingham.

**2558. A new or improved device for automatically switching off the electric current in an overhead trolley wire immediately a trolley wire breaks or is broken.** James Vernon Payne and Donald Poupart, 17, Avenue-road, Hammersmith, London.

**2589. Improvements in means for rectifying alternating current.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Feb. 2, 1903, being date of application in United States.) (Complete specification.)

**2581. Improvements in machines for making stems for incandescent lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2582. Improvements in synchronism indicators.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**2583. Improvements in and relating to insulation of electrical conductors.** Edward Bergtheil, 1, Queen Victoria-street, London.

**2602. Improvements in interchangeable electric display apparatus.** Deronda Levy, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 10, 1903, being date of application in United States.) (Complete specification.)

**2614. Improvements in terminals for electric batteries.** Henry George Prested, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEB. 3.

**2674. Improvements in and relating to electric generators.** Clement Talbot, Limited, 7, Southampton-buildings, Chancery-lane, London. (Adolphe Clement, France.)

**2676. Electric couplings for arc lamps and the like.** Oscar Schaefer, 49, Thurlby-road, West Norwood, London. (Hermann Bastians and Ottmar Wehrmann, Germany.)

**2707. Improvements in connection with electrostatic watt-meters.** Ernest Wilson, 64, St. John's-park, Blackheath, London.

**2715. Improvments in electric arc lamps.** The British Thomson-Houston Company, Limited, and Edwin Joseph Murphy, 83, Cannon-street, London.

**2717. A new or improved clutch for facilitating the drawing of electric cables and the like through pipes, conduits, and the like.** Arthur L. Smallpage, 9, Regent-street, London.

**2733. Improvements in the call system of telephonic installations.** Béla Gáti, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**2734. Method of and means for effecting multiple telegraphy.** Béla Gáti, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEB. 4.

**2743. Improvements in dynamometers.** William George Walker, 47, Victoria-street, Westminster, London.

**2751. Improvements in electricity meters.** Leonard James Aron, 104, Colmore-row, Birmingham.

**2752. Improvements in starting apparatus for use with and methods of controlling of continuous-current electro-motors.** Frederick Henry Royce and Ernest Alexander Claremont, Cooke-street, Hulme, Manchester.

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**2757. Improvements in secondary electric batteries.** Rankin Kennedy and Donald Ross Kennedy, 20, Oakwood-drive, Roundhay, Leeds.

**2766. Improvements in electric light fittings.** George Irving, Brougham-chambers, Nottingham.

**2767. Improvements in and relating to electrical switches.** Charles William Dunn Bourne, Old Market-chambers, Yorkshire-street, Rochdale.

**2800. Improvements in simultaneous telephony over telegraph lines, block signalling lines, and lines for the transmission of electrical power.** Enrico Canziani, 33, Chancery-lane, London. (Artruro Perego, Italy.)

**2801. Improvements in and connected with magneto-electric sparking devices.** Paul Schauer, 83, Cannon-street, London.

**2814. Screw-like rotary switch for electric resistance boxes, switchboards, and the like.** Nicolaas Gerhard von Huffel, 36, Chancery-lane, London.

FEB. 5.

**2849. An automatic switch for controlling electric motors.** Nathaniel David Phillips, 18, Stavordale-road, Highbury, London.

**2865. Improvements in printing telegraph receivers.** James Dundas White, 50, Clanricarde-gardens, London.

**2899. Improvements in electric signalling systems for railways.** Jacob Baker Struble, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 13, 1903, being date of application in United States.) (Complete specification.)

**2930. Improvements in electromotors of the induction type.** Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

**2939. Improvements in electrical igniting appliance for explosive engines.** Arthur Robert Bullock and Frank Roehl, 40, Chancery-lane, London. (Complete specification.)

FEB. 6.

**2948. Improvements in wattmeters.** William du Bois Duddell, 47, Hans-place, Chelsea, London.

**2958. Improvements in electrical controlling devices.** Arthur Edward Porte and Thomas Tomlinson, 61, Dawson-street, Dublin.

**3000. Improvements in controllers for electric motors and other apparatus.** George Laird and John Percival Todd, Westinghouse-building, Norfolk-street, Strand, London.

**3010. Improvements in electric traction on a road contact or like system.** Charles Josiah Ross and Burnett Charles Matthews, 36, Chancery-lane, London.

**3022. Improvements in or relating to connections or connecting pieces for electricity conductors.** Henry Hirsch, 46, Lincoln's-inn-fields, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 25, 1904.*

1903.

**2185. Electric operating mechanism for railway and tramway points.** Mackenzie. (Smith.)

**2256. Electric distribution systems.** Boult. (Osborn-Morgan Company.)

**2343. Combined electrical switches and electromagnetic cut-outs.** Bill and Abbott.

**2713. Telephonic transmitters.** Heys. (Hutchison Acoustic Company.)

**2857. Ears for trolley wires of electric tramways.** Close and Ramsey.

**2921. Devices for operating the points of electric railways and tramways.** Crawford.

**3102. Devices for indicating the stopping places on electric tramcars, applicable also for other purposes.** Boulton.

**3158. Method of and apparatus for making coils, particularly applicable for electrical apparatus.** Carolan. (General Electric Company.)

**3244. Electrical ignition apparatus applicable to internal-combustion engines.** Eckstein and Coates.

**3603. Luminous vapour electric lamps.** Hogan.

**5492. Apparatus for measuring electric resistances.** Evershed and Evershed and Vignoles, Limited.

**5646. Electric arc lamps.** Ewart.

**6415. Electric indicators.** Sadler.

**6495. Systems of electrical distribution.** Carolan. (General Electric Company.)

**7135. Devices for suspending overhead electric conductors.** Carolan. (General Electric Company.)

**7461. Electric circuit protecting devices.** Carolan. (General Electric Company.)

**7568. Fusible electric cut-outs.** Hetherington and British Electric Transformer Company (1903), Limited.

**7590. Electromagnetic mechanism for producing reciprocatory motion.** Mould.

**7783. Electrodes for arc lamps.** Edelmann.

**7790. Electric safety fuses.** Partridge.

**7827. Electric switch apparatus.** Pieper.

**8025. Swan electric lamp fitting with transversely arranged plug sleeves for connection with the spring terminals.** Schröder.

**8054. Brushes for electric machines.** McLean.

**15500. Electric cut-outs for alternating-current circuits.** Aktiengesellschaft Brown, Boveri, und Cie. (Date applied for under International Convention, Nov. 13, 1902.)

**16965. Electrical fire-alarm apparatus.** Robertson.

**22696. Electromagnetic meter for producing oscillatory movements, such as for massage and like purposes.** Whitney.

**23663. Telpherage.** Siemens Bros. and Co., Limited. (United Telpherage Company.)

**26255. Attachments to desk telephone instruments.** Childress and Sauls.

**26259. Apparatus or means for regulating or governing the speed of engines employed in driving electric current generators.** Johnson. (Elektricitäts-Aktiengesellschaft vorm. W. Lahmeyer und Co.)

**26378. Regulation of asynchronous, alternating, or three-phase current electric motors and rotary converters.** Johnson. (Elektricitäts-Aktiengesellschaft vorm. W. Lahmeyer und Co.)

**27131. Trolley poles used on electric tramcars and similar vehicles.** Wilkinson.

1904.

**226. Electric conductors for illuminating purposes, such as lamp pencils or filaments.** Ladoff and MacNaughton.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | Last price |
|---|---|---|
| **Commercial and Industrial.—** | £ | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 .. | ¼-⅜ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 .. | 5¼-5⅜ xd |
| —— 4½ per cent. Mortgage Debentures ..... | 100 .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 .. | 3¼-4 |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 .. | 93-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 .. | 104-108 |
| —— Ordinary ..... | 5 .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 .. | 1⅜-2¼ |
| —— 5 per cent. Debentures..... | 100 .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 .. | ½-1½ |
| —— 5 per cent. Debentures..... | 100 .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 .. | 1½-1⅝ |
| —— 7 per cent. Cumulative Pref..... | 2 .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 .. | 9¼-9⅝ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 .. | 12-13 |
| —— 4½ per cent. Preference ..... | 5 .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 .. | 18-19 |
| —— 4 per cent. Debentures..... | 100 .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 .. | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 .. | 101-104 |
| **Electric Lighting and Supply.—** | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 .. | ¾-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 .. | 114-117 |
| Bournemouth and Poole, Ordinary ..... | 10 .. | 12½-13½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 .. | 9½-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 .. | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 .. | 10¼-10⅜ |
| —— 7 per cent. Preference ..... | 5 .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 .. | 6-7 |
| —— Nos. 20,001-30,000 ..... | 5 .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 .. | 14½ |
| —— " £10 Ord. .... | 6 .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 .. | 8-9 |
| —— 4½ per cent. Cum. Pref. ..... | 5 .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 .. | 103-105 |
| Chelsea Electricity Supply ..... | 5 .. | 5¼-6¼ |
| —— 4½ per cent. Debentures ..... | 100 .. | 106-109 |
| City of London, Ordinary..... | 10 .. | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref..... | 10 .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.).. | 100 .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 .. | 8-9 |
| —— 6 per cent. Cum. Pref. ..... | 10 .. | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 .. | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb..... | 100 .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 .. | 3¼-4¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 .. | 5⅜-6¼ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 .. | 99-102 xd |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 .. | 7½-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 .. | 103-106 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9⅝-10¼ |
| London Electric, Ordinary | 5 | 1⅞-2¼ |
| —— 6 per cent. Pref. | 5 | 5¼-6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 95-98 |
| Metropolitan Ordinary | 10 | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 96 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 98 101 |
| —— Preference | 4 | 100 103 |
| Notting Hill Electric Lighting | 10 | 13-14 |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | 98-102 |
| Oxford Electric, Ordinary, 1-96 and -14,310 | 5 | 5⅛-6 |
| —— 4 per cent. Debenture Stock | 100 | 97-100 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | 98-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | 3½-3⅝ |
| —— 4 per cent. Debenture Stock | 100 | 86-90 |
| South London, Ordinary | | 3⅝-4¼ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | 14½-15½ |
| —— 7 per cent. Pref. | 5 | 8-9 |
| —— 3½ per cent. Deb. | 100 | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4⅜-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4⅝-5¼ |
| Westminster, Ordinary | 5 | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 6-6½ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 94-97 |
| —— 4 per cent. Pref. | 100 | 98-101 |
| —— " deferred | 100 | 91-94 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-115 |
| City and South London, Consolidated Ordinary | 100 | 50-53 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 126-129 |
| —— " " " '96 | 100 | 123-126 |
| —— " " " '01 | 100 | 120-125 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 91-94 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | 4⅜-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3⅞-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 79-82 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 103-105 p.c. |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | 10⅞-11⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | 11-11½ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3-3½ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 4⅜-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-107 |
| —— Prov. Cert., all paid | 100 | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 11½-11⅞ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | ⅛-¼ |
| New General Traction, Ordinary | 5 | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | 1½-2½ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | 88-93 |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | 10½-10⅞ |
| —— 5 per cent. Cum. Pref. | 10 | 11½-12½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8½-9½ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 102-104 |
| —— Deferred Stock | 100 | 78 81 |
| —— 6 per cent. Cum. First Pref. | 10 | 13½-14½ |
| —— 6 per cent. Cum. Second Pref. | 10 | 14-15 |
| —— 5 per cent. Non-Cum. Third Pref. | 5 | 5½-5⅝ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 96 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 100-102 |
| Oriental Telephone and Electric Company | 1 | ¼-1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 6 | 1,072 | 772 | + 300 | + 8,568h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 6 | 164 | 155 | + 9 | + 167 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 6 | 232 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 5 | 471 | 662 | + 109 | + 1,767 | 24 | 24 | March 25a | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,706 | 7·44 |
| Blackpool Corporation | ,, 4 | 296 | 304 | + 8 | − 211 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 6 | 219 | 189 | + 30 | − 14 | 16½ | 16½ | Dec. 31 | 30,923 | 2,043,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 7 | 1,615 | 1,534 | + 81 | + 8,874 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 3 | 843 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 7 | 3,453 | 3,152 | + 301 | +19,167 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 7 | 763 | 727 | + 36 | + 2,677h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 5 | 4,395 | 4,279 | + 116 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,784,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 6 | 856 | 654 | + 182 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 2 | 297 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 6 | 1,847 | 1,548 | + 299 | +22,190 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 6 | 165 | 150 | + 16 | + 152 | — | — | ,, 31 | — | 2,216,583 | 320,129A | — | — | — | — |
| Central London Railway | Jan. 30 | 6,992 | 7,004 | − 12 | + 118k | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | Feb. 7 | 3,239 | 3,213 | + 25 | − 917h | 6½ | 6½ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 4 | 396 | 372 | + 23 | + 53 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 5 | 212 | 200 | + 12 | − 231 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 7 | 164 | 168 | − 4 | + 48 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 7 | 103 | 93 | + 10 | + 35A | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 159 | 7·68 |
| Dublin U. T., electric cars | ,, 5 | 3,704 | 3,599 | + 105 | — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·62 | 2,741 | 5·06A |
| Dublin S. District, Electric | ,, 5 | 676 | 681 | − 5 | | | | | | | | | | | |
| Dundee City Tramways | ,, 3 | 803 | 761 | + 42 | — | 22 | 22 | May 15 | 35,874 | 9,081,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 4 | 577 | 509 | + 68 | + 8,107 | 10·75 | 10·75 | March 31g | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 6 | 13,140 | 12,021 | +1,119 | +52,080h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | Jan 27 | 2,159 | 1,877 | + 283 | + 6,182 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | Feb. 6 | 1,074 | 968 | + 106 | — | 34 | 34 | March 31 | 56,631A | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 4 | 2,001 | 1,661 | + 343 | + 6,439 | 25 | 19 | ,, 31 | 87,707A | 21,065,939 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 4 | 119 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 3 | 189 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 6 | 4,788 | 4,648 | + 150 | +15,263 | 77 | 77 | March 25g | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | Jan. 30 | 9,334 | 9,168 | + 166 | +47,740 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | Feb. 7 | 1,532 | 160 | − 68 | + 355h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — c |
| London County Council | Jan. 30 | 8,848 | 8,056 | + 782 | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 30 | 125 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Feb. 8 | 100 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 6 | 3,579 | 3,023 | + 556 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 6 | 1,391 | 1,230 | + 161 | + 5,167 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | Jan. 25 | 103 | 93 | + 10 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Feb. 4 | 384 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | Jan. 18 | 3,443 | 2,628 | + 815 | +45,490 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | Feb. 7 | 4,201 | — | — | — | 53½ | 53½ | Mar. 25g | 216,709 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 4 | 848 | 803 | + 44 | — | 11 | 11 | ,, 31 | 35,874 | 9,034,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 7 | 1,074 | 970 | + 104 | + 2,541 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,387,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 6 | 583 | 521 | + 62 | + 3,742 | 10 5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. A Half-year's figures.

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## EFFECT OF THE WAVE-FORM ON MEASUREMENTS BY THE TWO-WATTMETER METHOD.*

The measurement of the power in a three-phase circuit by means of the two-wattmeter method presents several advantages over the more commonly employed three-wattmeter method. By the first-mentioned method the whole power is measured by means of only two wattmeter readings. It is unnecessary to employ the neutral point of the system, which has often to be first specially opened up or even artificially produced. Further, the two wattmeter readings, $a_1$ and $a_2$, enable the power factor to be obtained without

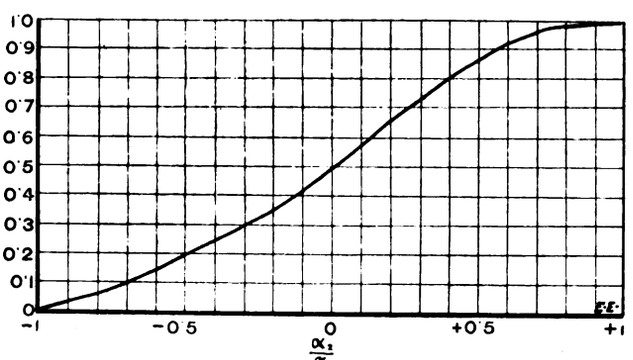


FIG. 1.—Determination of cos $\phi$ for Three-Phase Circuits by the Two-Wattmeter Method, $a_1$ being the greater and $a_2$ the smaller Wattmeter Deflection.

any separate volt and ammeter measurements by means of the formula

$$\text{Tan } \phi = \frac{a_1 - a_2}{a_1 + a_2}\sqrt{3} = \frac{1 - \frac{a_2}{a_1}}{1 + \frac{a_2}{a_1}}\sqrt{3}.$$

Even the conversion of tan $\phi$ into cos $\phi$ can be avoided if a curve such as Fig. 1 is made, showing the relation between cos $\phi$ and $\frac{a_2}{a_1}$ directly.

As has often been pointed out of recent years,† however, the tangent formula no longer gives a correct value for the power factor if the current and voltage curves are not sinusoidal. In such cases the power factor can, however, still be obtained in the usual manner by means of volt and ammeter readings. Thus:

$$\text{Cos } \phi = \frac{P}{\sqrt{3}.E.J};$$

where P = the total power; E = the line voltage; and J the line current. The effect of the curve form on the value of the power factor obtained by the above tangent formula will be investigated in this article.

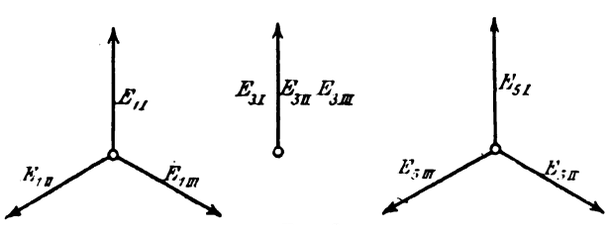


FIG. 2.

If E is the effective value, E′ the maximum value, and $e$ the instantaneous value of the phase voltage, the voltages of the three phases, I., II., and III., are

For the fundamental wave:

$e_{1I} = E'_{1I} \sin w t$
$e_{1II} = E'_{1II} \sin (w t + 120°)$
$e_{1III} = E'_{1III} \sin (w t + 240°)$.

For the third harmonic:

$e_{3I} = E'_{3I} \sin 3 w t$
$e_{3II} = E'_{3II} \sin 3 (w t + 120°) = E'_{3II} \sin 3 w t$
$e_{3III} = E'_{3III} \sin 3 (w t + 240°) = E'_{3III} \sin 3 w t$.

For the fifth harmonic:

$e_{5I} = E'_{5I} \sin 5 w t$
$e_{5II} = E'_{5II} \sin 5 (w t + 120°) = E'_{5II} \sin (5 w t + 240°)$
$e_{5III} = E'_{5III} \sin 5 (w t + 240°) = E'_{5III} \sin (5 w t + 120°)$.

So that the first, third, and fifth harmonics may be vectorially represented, as in Fig. 2, and from the seventh harmonic onwards the same relations repeat themselves periodically.

As is well known, the third, ninth, etc., harmonics of the three-phase voltages cancel out in amount and direction in each case, and so can produce no line voltage or current.

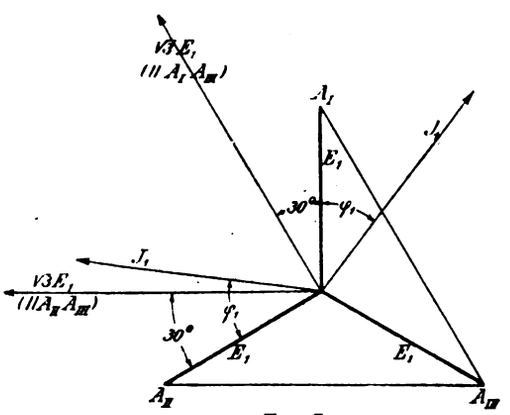


FIG. 3.

When measuring power by the two-wattmeter method, the current coils of the two wattmeters are in two of the phases—for instance, I. and II.—and the voltage coils are connected between these two phases and the third. Assuming a perfectly symmetrical three-phase system, and considering, for the present only, the first and fifth harmonics, the powers measured (see Figs. 3 and 4) will be:

By the wattmeter in phase I.

$$A_I = \sqrt{3}\, E_1 J_1 \cos(\phi_1 + 30°) + \sqrt{3}\, E_5 J_5 \cos(\phi_5 - 30°)$$
$$= A_{1I} + A_{5I},$$

and by the wattmeter in phase II.

$$A_{II} = \sqrt{3}\, E_1 J_1 \cos(\phi - 30°) + \sqrt{3}\, E_5 J_5 \cos(\phi_5 + 30°)$$
$$= A_{1II} + A_{5II}.$$

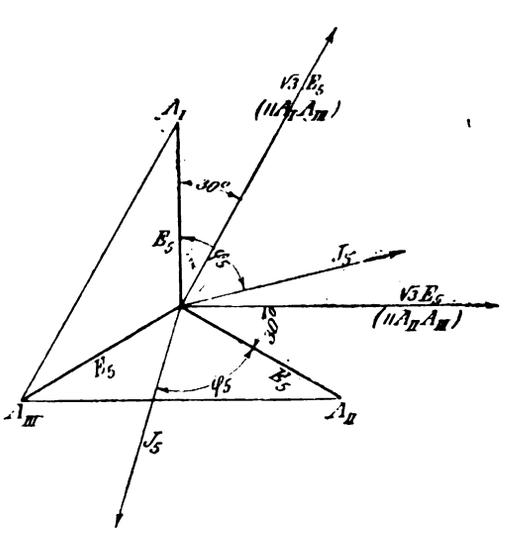


FIG. 4.

Applying the formulæ for the sum and difference of two cosines, and putting P = $P_1 + P_5$ = the load on one phase of the symmetrical three-phase system, we get

$$A_{1II} + A_{1I} = 3 E_1 J_1 \cos \phi_1 = 3 P_1$$
$$A_{5II} + A_{5I} = 3 E_5 J_5 \cos \phi_5 = 3 P_5$$
$$A_{II} + A_I = 3 (P_1 + P_5) = 3 P \text{ (total load)}.$$

* Translation, in abstract, of an article by Dr. L. Block, in *E. T. Z.*, Dec. 3, 1903, p. 993.

† Niethammer, *E. T. Z.*, 1902, p. 443; Rosenberg, *E. T. Z.*, 1903, p. 111; Benischke, *E. T. Z.*, 1903, p. 193.

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Further—

$$A_{1II} - A_{1I} = \sqrt{3}\, E_1 J_1 \sin \phi_1$$
$$A_{5II} - A_{1I} = -\sqrt{3}\, E_5 J_5 \sin \phi_5$$

From which

$$\text{Tan } \phi_1 = \sqrt{3}\, \frac{A_{1II} - A_{1I}}{A_{1II} + A_{1I}}$$

$$\text{Tan } \phi_5 = -\sqrt{3}\, \frac{A_{5II} - A_{5I}}{A_{5II} + A_{5I}}$$

The wattmeter measurements only give $A_I$ and $A_{II}$, and from these only an apparent angle of phase displacement, $\phi'$, can be obtained by the tangent formula. Thus:

$$\text{Tan } \phi' = \sqrt{3}\, \frac{A_{II} - A_I}{A_{II} + A_I}.$$

It can easilybe shown, however, that this formula involves tan $\phi_1$ and tan $\phi_5$, and that

$$\text{Tan } \phi' = \frac{\tan \phi_1 - \tan \phi_5 \frac{P_5}{P_1}}{1 + \frac{P_5}{P_1}}$$

If the seventh harmonic is not negligible the formula will become:

$$\text{Tan } \phi' = \frac{\tan \phi_1 - \tan \phi_5 \frac{P_5}{P_1} + \tan \phi_7 \frac{P_7}{P_1}}{1 + \frac{P_5}{P_1} + \frac{P_7}{P_1}}$$

In most practical cases, however, besides the fundamental wave and the third harmonic, which is excluded in this case, the most important effect is due to the fifth harmonic, and the seventh need not be considered.

If, besides $P_5$ and $P_1$ having the same sign, $\phi_5$ and $\phi_1$ are also alike in sign—*i.e.*, both indicate either a lagging or a leading current—then tan $\phi' <$ tan $\phi_1$ and cos $\phi' >$ cos $\phi_1$. If, on the other hand, the power factor cos $\phi$ is determined by measurements of the power, the volts and the amperes cos $\phi$ will always be less than cos $\phi_1$ if higher harmonics are present.

A few numerical examples will indicate the amounts of the deviations.

Let $E_1 = 100$ $E_5 = 10$ $E = \sqrt{E_1^2 + E_5^2} = 100{\cdot}5$.
$J_1 = 10$ $J_5 = 3$ $J = \sqrt{J_1^2 + J_5^2} = 10{\cdot}45$.
$E_1 J_1 = 1{,}000$ $E_5 J_5 = 30$ $E J = 1{,}050$.

Keeping these values constant, the effect of various phase displacements is shown below:

(1) $\phi_1 = 30°$ cos $\phi_1 = {\cdot}866$ tan $\phi_1 = {\cdot}577$.
$\phi_5 = 60°$ cos $\phi_5 = {\cdot}5$ tan $\phi_5 = 1{\cdot}73$.
$P_1 = 1{,}000 \times {\cdot}866 = 866$
$P_5 = 30 \times {\cdot}5 = 15$ } $P = 881$.

$$\text{Power factor cos } \phi = \frac{881}{1{,}050} = {\cdot}839.$$

$$\frac{\cos \phi}{\cos \phi_1} = {\cdot}969, \text{ or a deviation of } -3{\cdot}1 \text{ per cent.}$$

so that a power factor 3·1 per cent. lower than the cosine of the phase displacement, $\phi_1$, of the fundamental wave is obtained.

By the two-wattmeter method, using the above formula for tan $\phi'$ the value of cos $\phi'$ is made 881, or $\frac{\cos \phi'}{\cos \phi_1} = 1{\cdot}017$, or a deviation of +1·7 per cent. from the cos of the angle of phase displacement of the fundamental wave.

(2) $\phi_1 = 30°$ $\phi_5 = 90°$ cos $\phi_1 = {\cdot}866$ cos $\phi = {\cdot}825$

$$\frac{\cos \phi}{\cos \phi_1} = {\cdot}952 \ldots\ldots \therefore \text{deviation} = -4\,8 \text{ per cent.}$$

$$\frac{\cos \phi'}{\cos \phi_1} = 1{\cdot}015 \ldots\ldots \text{deviation} = +1{\cdot}5 \text{ per cent.}$$

(3) $\phi_1 = 0.$ $\phi_5 = 0.$ cos $\phi_1 = 1.$ cos $\phi = {\cdot}981.$

$$\frac{\cos \phi}{\cos \phi_1} = {\cdot}981 \ldots\ldots \text{deviation} = -1{\cdot}9 \text{ per cent.}$$

$$\frac{\cos \phi'}{\cos \phi_1} = 1 \ldots\ldots \text{deviation} = 0.$$

Actual test results confirm these conclusions. The tangent formula almost always gives higher values for cos $\phi$ than are obtained from current, voltage, and power measurements. With loaded asynchronous motors the differences may reach as much as 5 per cent., according to the curve shape, as has been pointed out by Niethammer (*loc. cit.*). With synchronous motors driven from other than a sine wave of E.M.F., or whose wave of E.M.F. differs from that of the generator supplying it, the differences are particularly great at the minimum current. This has been confirmed by numerous tests made by the writer, and is pointed out by Rosenberg (*loc. cit.*). Whilst the tangent formula gives $a_1 = a_2$, and, therefore, cos $\phi' = 1$, the quotient obtained from the power and the voltage × current per phase is often only ·3 to ·5.

If in such cases the curves of current and voltage are traced, it will be found that, whilst the value of $\phi'$ obtained from the tangent formula is generally smaller than the phase displacement of the fundamental wave, yet it is nearer to the latter than the still greater value of $\phi$ obtained from the power factor.

The question arises as to whether the tangent formula should be entirely abandoned when it is not certain that the curve shape is approximately sinusoidal. In such cases the power factor, in accordance with its definition, can only be obtained as the quotient of measured power and product of voltage by current, whether the two-wattmeter or three-wattmeter method is used. The value obtained in this way, however, cannot be considered as the invariable power factor of the motor in question, for with a different shape of voltage curve a different value would be obtained. Modern three-phase motors, especially asynchronous ones, are generally so constructed that if driven as generators with a continuous-current excitation they would give an approximate sine wave of voltage, and on this account they will also work with a maximum power factor if supplied with a sinusoidal voltage. If such a three-phase motor for which the maker has guaranteed a power factor of, say, ·9 is connected to a network whose voltage wave differs materially from a sine form, the power factor will naturally not be attained, and yet the design of the motor is not directly to blame. It is, therefore, advisable for makers to keep this possibility in view.

Measurements by the two-wattmeter method supply a means of discovering whether the power factor of the motor is unfavourably influenced by the presence of higher harmonics. In such cases the tangent formula gives different and generally higher values for cos $\phi$ than the quotient of power and current × voltage. The average of these two values approximates closely to the power factor which the motor would have if supplied with an E.M.F. of the wave-form most suitable for it. If anything, this average value is rather lower than the most favourable power factor. If in place of the power factor the angle of phase displacement of the fundamental wave should be required, *e.g.*, for use in drawing the diagram, it would save time and trouble to employ the tangent formula directly, as shown in the above examples.

On the whole, it would seem likely that even with waves which are not pure sine curves, the two-wattmeter method and tangent formula are not altogether without use, especially as the correct power factor can always be obtained with this method by calculation.

## QUESTIONS AND ANSWERS.

*Question No.* 652.—I wish to run a 100-volt 10-h.p. dynamo as a motor for starting an oil-engine. Energy would be supplied from a battery. Give sketch of connections showing how this can be done.

*Best Answer to No.* 652 (*awarded* 10*s.*).—I have several times been called upon, when installing both oil and gas plants, to provide some means of running the dynamo as a motor to start the engine. A switchboard suitable for this purpose is shown in the accompanying sketch, which I have found to work very satisfactorily. A is an ammeter with central zero, to read 75 amperes either way. B is a voltmeter. C is a two-way switch for ammeter enabling

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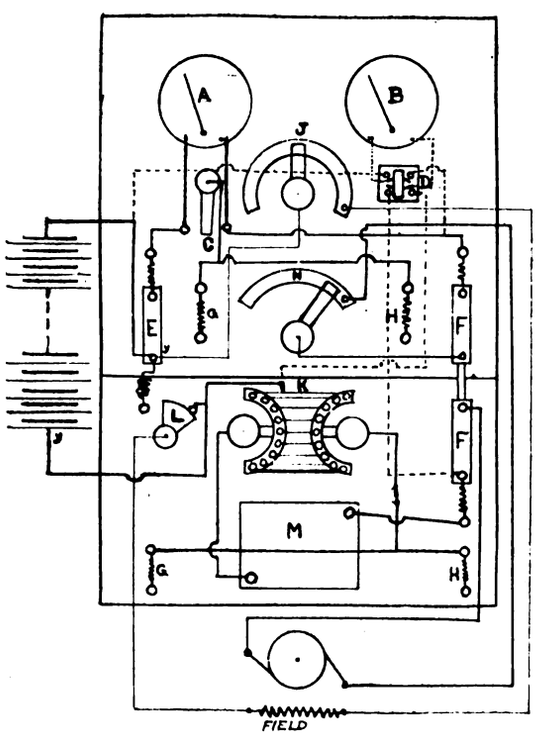
it to be connected either to the circuits, G and H, or to the battery or dynamo. D is a two-way voltmeter switch enabling the voltmeter to be connected either to the dynamo or battery. E is a single-pole switch and fuse controlling the battery. F is a double-pole switch and fuse in the dynamo circuits. G and H are two circuits fed from board. J is the shunt regulating switch. K is the battery charge and discharge switch, which is provided with a through-way contact at the bottom to enable the dynamo to be put direct on to the lighting circuits, G and H, with




the battery entirely cut out. From the other studs of the battery charge and discharge switch cables are taken to the regulating cells. L is the shunt breaking switch, which is provided with a contact to enable the shunt to be short-circuited through a resistance, and so prevent the damage that might otherwise be caused by breaking the shunt. M is an automatic cut-out in the battery circuit, which cuts off the battery in case the charging current fails, and so prevents the battery sending current back into the dynamo and motoring it. N is an eight-point resistance switch in circuit with the armature of the dynamo, to be used for starting purposes when running the dynamo as a motor. *y y* are the two points from which the dynamo shunt is excited, thus exciting the field direct across the battery, which is very desirable when running as a motor, as it enables you to obtain the full field, and, therefore, maximum torque at starting.

The following is the method of operation. To start the engine, switch on the field, then switch in all starting resistance, set the charge switch one or two blocks from the bottom, close the automatic cut-out, and fasten it in by means of the small catch provided, close battery switch, E, then dynamo switch, F. The machine should then commence to run as a motor and drive the engine. As the motor gets up speed, cut out the starting resistance slowly until all resistance is out and motor is running at full speed. Then open the oil supply, and the engine should commence to fire its charge and increase the speed until the volts of machine rise above those of battery, when a charging current will flow. Finally, release the catch on auto cut-out and the dynamo will be charging the battery. If it is desired to light the lamps at the same time as charging, raise the discharge switch to block, which gives correct voltage for lamps; if desired to run direct off dynamo with battery switched off, proceed as above until speed is up, then switch off the battery at E, and place both charge and discharge switch on bottom blocks, when the battery will be entirely cut out of circuit, and the dynamo will be supplying the lamps direct.

The chief difficulties found were that oil-engines installed for electric lighting purposes are usually either fitted with two flywheels, or else an extra heavy one, to enable steady running, and thus necessitate considerable power at the start, and therefore it was necessary to use resistance wire of heavy section in the starter, as with the heavy starting this was liable to burn out. This method puts a rather excessive discharge on the battery for a few seconds, but I have not found it detrimental to the cells in the least, as immediately the motor commences to gain speed this current falls to a normal value. Further, if starting, as is usual when starting by hand, you turn on the supply of oil first, the charge is liable to get drawn into the cylinder and exploded before the engine has got up any considerable speed, and back-firing is the result, which immediately pulls up the motor and blows the fuse. The best method is to start the motor up and allow the engine to gain speed before opening the oil supply. Then, on opening the oil supply, the engine will commence to work and drive the machine as a dynamo. If the battery is provided with an automatic switch to prevent reverse current, a catch will be necessary to hold this in while motoring, or else a main switch will be necessary to cut the automatic switch out of circuit until the volts of the dynamo rise above those of the battery, and a charging current is passing; this switch can then be cut out.

If the plant is already installed and it is not desirable to make any alterations on the present switchboard, the best plan to adopt would be to take two fresh leads direct from the battery terminals through a double-pole main switch and an ordinary motor starter direct to the dynamo and connect up in the usual way as for a motor, leaving the existing leads on just as they are. The dynamo could then be run as a motor by means of this separate circuit, taking care that the dynamo main switch on the switchboard was out. When the engine commences to explode, switch off the motor and proceed to switch on the machine as a dynamo to charge or run the lamps in the usual way. If adopting this last method, I should advise "H. H. R." to use a 15-h.p. starter to carry the rather heavy starting current, as a commercial 10-h.p. starter would no doubt burn out in a short time. If his machine is of the two-pole type, he must remember to alter the lead of his brushes before starting as a motor, or otherwise he will get vicious sparking. If, however, he has a four-pole machine with carbon brushes, which has been designed to run at all loads with fixed brush position, he will find that there will be no appreciable sparking when running as a motor without moving the brushes.—W. R. A.

*Answer to No.* 652 (*awarded 7s. 6d.*).—"H. H. R." does not state how his dynamo is wound, but it is presumed to be a shunt-wound machine and is used for charging the same battery which supplies the power to start it as a motor. There are several ways of arranging the connections to meet his requirements, but it would be an advantage to know what the existing switching arrangements are (if any) before suggesting what connections to make.

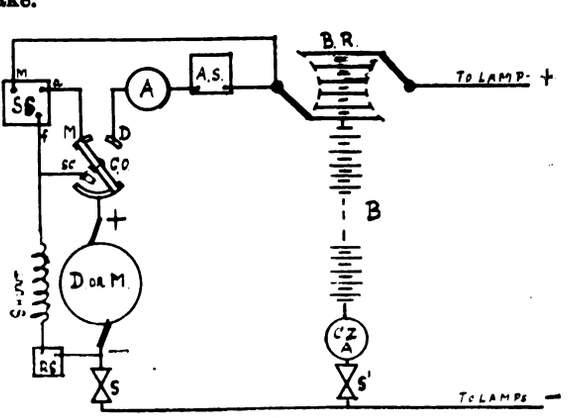



FIG. 1.

Perhaps the diagram (Fig. 1) shows the most simple method to employ, as it involves the least possible number of operations in changing over, this requiring consideration, especially when starting the engine. C O is a change-over switch which directs the current through A, and the auto-

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matic switch, A S, when the machine is to be run as a generator, or, if in the position shown, through the starting switch, S S, to run it as a motor. A separate small sliding contact is shown, S C, which makes contact with the change-over switch bar when in the position D. This connects the positive end of shunt coil to the dynamo main for running as a generator. A separate small switch can be used for this purpose, and be coupled to the main change-over switch if desired. Fig. 2 will make this clear.

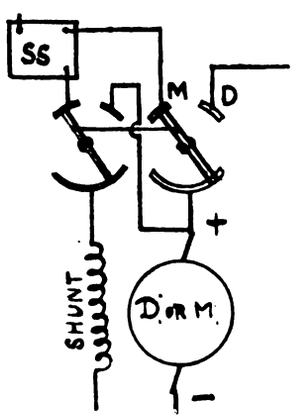


Fig. 2.

In starting as a motor it would be well to have the least possible number of cells in circuit and adjust the shunt resistance, S R, to give the motor the lowest possible speed, as it is only necessary to get sufficient speed on the engine to enable it to work by its own effort. The centre zero ammeter, C Z A, will indicate when the engine starts to do work, and as it gathers speed and the discharged current has dropped to zero, the motor can be switched off by S. C O can then be changed over to position D, and as soon as the starting-switch lever has sprung to the "off" position, S can be closed again, and the machine will commence to charge as soon as the volts rise sufficiently to close the automatic switch, A S. *Note.*—If diagram Fig. 1 is used, the starting switch should be connected so that the shunt circuit is broken when its lever is at the "off" position.

The position of the brushes will possibly require to be altered each time the machine is started as a motor and reset for running as a dynamo before being switched into circuit. It might be mentioned that the machine as a motor, being only required to start the engine, it will only be lightly loaded, so that a 10-h.p. starting switch will not be necessary; a 5-h.p. size should about meet the requirements.—F. H.

*Answer to No.* 652 (*awarded* 5*s.*).—As the question gives no information with regard to existing arrangements, we

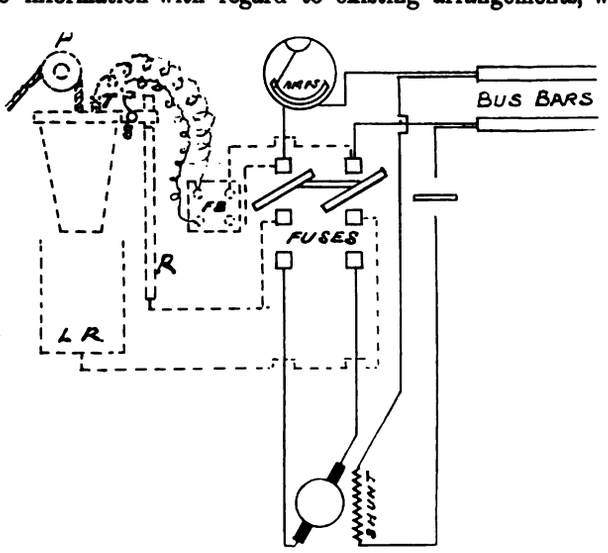


Fig. 1.

will suppose that the dynamo is belt-driven from the oil-engine. Fig. 1 is a diagrammatic sketch of the connections if the dynamo is shunt wound; Fig. 2 if the machine is compounded. All the parts to be added for the suggested method are shown in dotted lines. In the case of a compound-wound dynamo the series must be cut out when starting, or this part of the winding would tend to turn the machine, and consequently the engine, in the reverse direction. The sketches will almost explain themselves. L R is a liquid resistance, a lead plate which may be raised or

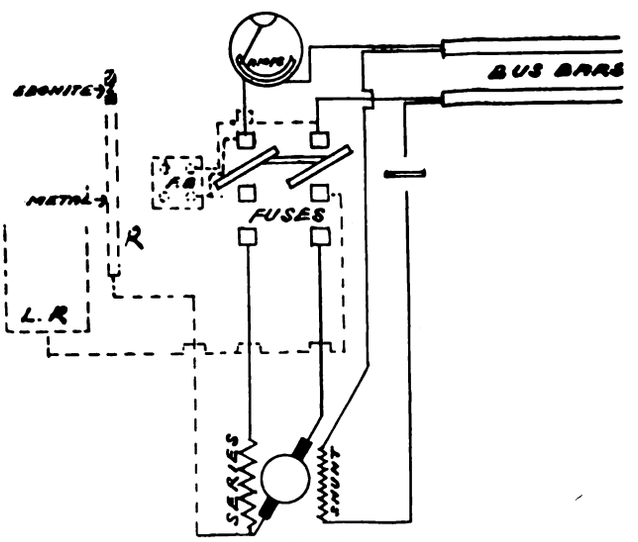


Fig. 2.

lowered by means of the rope passing over pulley, P, dipping into a solution of sodium sulphate or dilute sulphuric acid; F B is a double-pole fuseboard. One of the wires from this fuseboard goes to the terminal on the spring clip, S, the other wire making contact with the lead plate by means of the terminal, T. The spring clip slides up and down the rod, R. The upper port of this rod is of ebonite, the lower part metal, and is so arranged that the circuit is first broken between lead plate and liquid, thus preventing any trouble through sparking. If the dynamo is only fitted with a single-pole switch instead of a double pole, this rod will not be required, and the connections will be much simplified.

This method of starting will be found in practice very satisfactory, the only trouble is having to start up when the battery is supplying a load, as in that case the starting current required, together with the work already on the battery, may overload the cells. When starting, the current may be kept at a minimum by starting the engine very slowly, the exhaust valve being set so that there is no compression. When engine is up to speed, gradually bring on compression and start explosions. When the engine and dynamo are nearing full speed, the potential from dynamo will reduce current passing through the liquid resistance. With a little care the starting circuit may be broken with scarcely a spark.—M. M.

*Answer to No.* 652 (*awarded* 5*s.*).—The connections required are shown in Fig. 1 on the assumption that the dynamo is a compound-wound one, and that it is at present

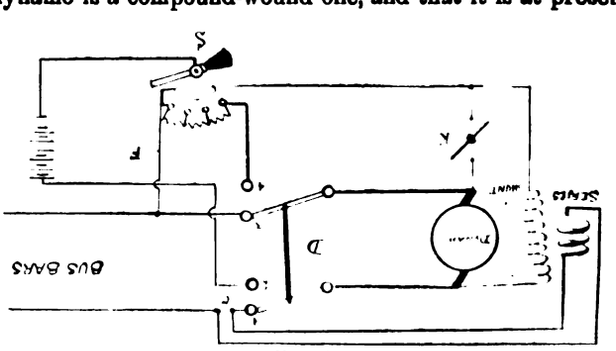


Fig. 1.

employed for other purposes than merely charging the battery. The additional apparatus necessary consists of a double-pole throw-over switch, D, for disconnecting the dynamo from the 'bus bars and connecting it to the battery terminals (this switch may be already in use), and a small starting switch and resistance, S, for starting up the machine

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as a motor from the battery. Since the conversion of a compound dynamo into a compound motor necessitates the crossing of the series winding connections, it will be as well in this case to leave the series winding out of circuit altogether when the machine is acting as a motor. This is easily done, as shown, by disconnecting the series winding from the dynamo terminals and connecting it in the 'bus-bar connection at C. The starting switch, S, can be of quite small capacity. Probably an ordinary 3-h.p. to 5-h.p. motor starter will be ample in this case, as its only duty is to start up the set, which is presumably a 10-h p. one, light. If the machine is intended to run in parallel with other dynamos when acting as a generator, it will be necessary to fit a small field switch at K in place of the lead, F. This switch, K, would be open whilst the machine is acting as a motor, but closed when acting as a generator, so as to allow the machine to be excited and to have its volts adjusted before it is switched on to the 'bus bars.—Q.

## THE DISTRIBUTION OF ELECTRICITY IN SHIPYARDS AND ENGINE WORKS.*

BY J. A. ANDERSON.

In submitting a paper to this meeting the writer has chosen the title "Distribution of Electricity in Shipyards and Engine Works" on the assumption that the day has gone by when a comparison of electricity with steam or gas motive power in engine works and shipyards possesses debatable ground or even interest. Before a meeting of Electrical Engineers, and in a neighbourhood where more has been done in the direction of power distribution than elsewhere in this country, such a comparison is unnecessary. On the other hand, the writer hopes that a description of the different means of applying electricity which he has met with as an engineer engaged in power distribution, and especially the figures he has been able to obtain may prove acceptable and possibly provoke discussion.

The first consideration in designing a distribution system for an engine works and shipyard is the choice of system to be adopted (1) for power, (2) for lighting. Some engineers advocate three-phase and others direct current throughout. The writer is however strongly of opinion that a combination of the two systems—namely, three-phase for power and direct-current three-wire for lighting—(and, in special cases, power)—possesses the greatest advantage.

Distribution from a power company is invariably on the three-phase system, and at first sight it would appear that three-phase should therefore be used throughout, but where there is a large motor load as well as lighting, it is preferable to have both systems. The motor load on the three-phase system does not affect the lighting load off the direct-current system—a most important consideration. This arrangement admits of a large momentary demand on the power side, and three-phase motors of 10 h.p. and under can be started up direct off the mains. The voltage drop does not appreciably affect the speed of the motor-generators for the direct-current supply, so that the lighting is unaffected.

Three-phase motors are much more cheaply maintained and stand overload to a much greater extent and length of time than direct-current motors, and hence in many cases a smaller motor can be used than would be possible on a direct-current system. To get the full advantage of electric driving in engine works, however, direct current should be available for driving a few variable-speed machines.

As most of my data is in connection with three-phase motors, a short description of the two types in general use with their respective advantages and disadvantages may not be amiss:

1. Those with a squirrel-cage or short-circuited rotor, started by means of a compensator which reduces the voltage at the terminals of the motor, the transformer portion being cut out by means of a throw-over switch when the motor has attained maximum speed. Compensators usually have three separate sets of connections, designed as a rule to give 80 per cent., 60 per cent., and 40 per cent. of the line voltage. I will in future refer to this motor as the squirrel-cage motor.

2. Those with a drum-wound rotor. Three ends of the winding are connected to slip-rings on the spindle and the other three ends are "star" connected. Resistances are inserted between the armature winding by means of the slip-rings when starting. These resistances can either be cut out by a controller, which also operates the primary circuit, or by a regulating switch, with a triple-pole switch for the primary. I will in future refer to this motor as the slip-ring motor.

The chief difference between the squirrel-cage motor and the slip-ring motor is the starting current. The squirrel-cage motor takes about 2½ times full-load current for full-load torque at starting, whereas the slip-ring motor gives about full-load torque when taking full-load current. The slip-ring motor is from 10 per cent. (for the larger sizes) to 20 per cent. dearer than the squirrel-cage motor, and the latter type is a little more efficient and less complicated.

For ordinary use, therefore, the squirrel-cage motor is the better, although it has to be very heavily fused if started up against a load, as is necessary in many cases in shipyards. It requires, however, much less attention, and the wiring is not so complicated and expensive. The last reason is sufficient to debar slip-ring motors for use on such machines as punches, shears, and beam benders, where the starting gear has sometimes to be placed at a considerable distance from the motor. For such machines as winches and cranes, the slip-ring motor is the only one which will prove satisfactory. The Newcastle Electric Supply Company have now out on hire over 40 three-ton shipyard winches driven by 10-h.p. motors of the slip-ring type, and they are entirely successful from every point of view, especially from the point of view of economy.

The following figures taken from one of the above winches show the kilowatts taken in starting various loads. Weights were placed on the foot brake lever as an artificial load, and the motor started up by a controller. The figures clearly show the low demand from the mains when starting in proportion to the load.

| Kw. | Volts. | Amps. | P.F. | Remarks. |
|---|---|---|---|---|
| 3·5 | 442 | 7·8 | ·6 | Winch running light. |
| 5·1 | 440 | 8 9 | ·75 | Running with weight on brake lever. |
| 8·4 | — | 17 | — | Starting on first step of controller. |
| 7 | 436 | 11 | ·84 | Running with increased weight on lever. |
| 8 6 | — | 16 | — | Controller on first step would not start without slight assistance. |
| 11·2 | — | 20 | — | Starting on second step of controller. |
| 9·5 | 436 | 14 5 | ·87 | Running with increased weight on lever. |
| 12·6 | | 22 | — | Starting on second step of controller. |
| 10·2 | 436 | 15·8 | ·86 | Running with increased weight on lever |
| 12·8 | — | 21 | — | Controller on second step, but would start without assistance. |
| 16·2 | — | — | — | Starting on third step of controller. |

A winch was tried fitted with a 10-h.p. squirrel-cage motor, but it could only lift about 15cwt. unless started with a slack rope, even when switching the motor direct on to the mains.

For ordinary use the squirrel-cage motor has so many distinct advantages over the slip-ring type, that it is well worth going to some extra expense to adopt an arrangement for placing lighter fuses in circuit when running. Figs. 1 and 2 show an arrangement which the writer has had in use for some months.

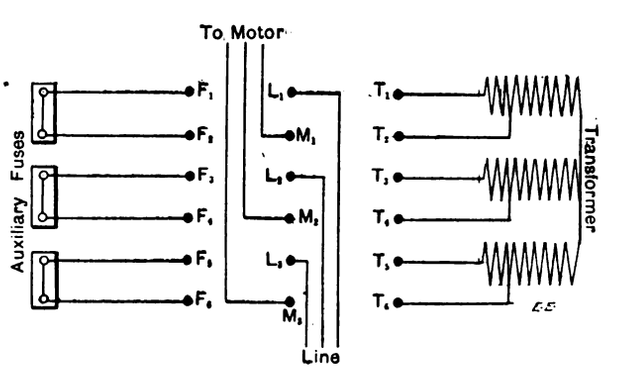


FIG. 1.

Fig. 1 is a diagrammatic sketch and Fig. 2 is a section through the oil-break switch of a 10-h.p. starting compensator, the split terminals of which were modified to suit. Originally the split terminals, $F_1$ and $F_2$, $F_3$ and $F_4$, and $F_5$ and $F_6$, were short-circuited, so that when the switch was thrown over to that side the motor was direct on to the line. These double terminals have been replaced by six single terminals, making both sides similar in this respect, and $F_1$, $F_3$, and $F_5$ are connected to $F_2$, $F_4$, and $F_6$ respectively through auxiliary fuses. The knife-blade terminals, $M_1$, $M_2$, $M_3$, $L_1$, $L_2$, and $L_3$, are mounted on a wood block, to which is connected the switch handle. At starting the switch is thrown over to the transformer side with the usual transforming effect. After the motor has got up full speed the switch is thrown over to the running side, and puts the auxiliary fuses in circuit. The ordinary motor fuses are placed at the distributing point in the usual way. This starting gear was first connected to a 10-h.p. motor driving a large punching and shearing machine which was exceptionally hard to start up, the slides being out of order. The compensator had to be connected up on the highest step, and the current through the ordinary fuses at starting was about 80 amperes,

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 18.

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the motor taking 44 seconds to get up to speed. With the above arrangement we were enabled to run with auxiliary fuses of 22 S.W.G. copper in series with the 18 S.W.G. copper necessary for starting.

The writer has now got this gear connected to a 10-h.p. motor driving a small machine shop at Carville power station, where the starting and running conditions are not so severe, and we have been enabled to run with 26 S.W.G. copper auxiliary fuses. The above switch would be greatly improved if a spring were attached, so that the switch could not be left in the starting position. It will be seen from the diagram that by merely short-circuiting the transformer terminals and cutting out the transformer, it is possible to start direct off the mains

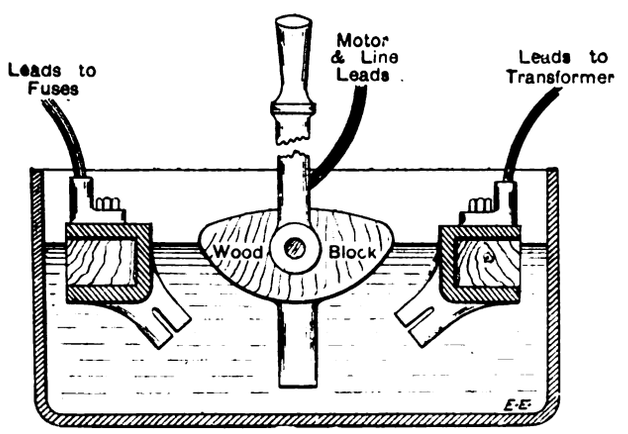


FIG. 2.

Having briefly described the two main types of three-phase motors, I now propose to consider the conditions under which they are set to work, and the arrangements it is necessary to make for their installation. Most of the machines in a shipyard should be separately driven. They have as a rule to be spaced far apart, which would increase the amount of shafting required to drive them in groups, and they have also to work very intermittently.

The following figures taken from a shipyard shed, and until last January driven by a 50-n.h.p. Crossley gas-engine through a friction clutch, illustrate the amount of power wasted in driving shafting. Most of the shafting has been done away with and squirrel-cage motors installed, with very beneficial results.

*Gas-Engine.*

Period of Test, Feb. 16 to July 16, 1902.

| | | | |
|---|---|---|---|
| Total gas consumption = 1,380,500 cubic feet at 2s. 6d. per 1,000, less 20 per cent. = | £138 | 1 | 0 |
| Man in attendance | 48 | 0 | 0 |
| Water | 4 | 11 | 0 |
| Oil and stores | 5 | 0 | 0 |
| Total | £195 | 12 | 0 |

The average daily gas consumption was about 8,320 cubic feet, and the average indicated horse-power about 62. Of this the indicated horse-power required to drive the main and counter shafting was about 40. The attendance expenses above do not include cleaning and repairs beyond the ordinary cleaning and oiling allowance daily.

*Three-Phase Motors.*

| Period of Test, Feb. 16 to July 16, 1903. | Motors. | Horse-power. |
|---|---|---|
| Six punching and shearing machines, with a 7½-h.p. motor on each | 6 | 45 |
| One 27ft. by 1½in. plate rolls | 1 | 30 |
| One scarfing machine and plate-edge planer | 1 | 10 |
| ,, ,, ,, | 1 | 10 |
| One 6ft. 6in. by 1in. straightening roll, two countersinks, and one grindstone | 1 | 10 |
| Two countersinking machines | 1 | 5 |
| Total | 11 | 110 |

Units consumed = 32,916 at 1$\frac{1}{16}$d. = £145. 14s.

In this case no man was required, the starting and stopping being done by the machine men, so that the saving effected equals £195. 12s. less £145. 14s., or £49. 18s. per half-year. The maintenance and other charges on the extra capital is more than counterbalanced by the upkeep on the shafting and belts and overhauling the gas-engine, not previously taken into account. The system of driving is such that practically all machines are stopped when not required to work, the saving being wholly effected by this. On a full day's work the costs of running as taken above are about the same for both systems.

Punching and shearing machines can best be driven by belt from the roof principals or from the top of the machine itself, although this latter position sometimes gives too short a drive. Quadruple punching and shearing machines with an overhead jib crane can only be driven with the motor underground, the use of a guide pulley is also necessary, making a very unsatisfactory drive. Driving such machines by gearing throws very heavy stresses on the motor, which are more or less avoided by using a belt. Belting is also more often than not much cheaper.

In one case plate rolls are driven by a 40-h.p. slip-ring motor with heavy resistances in the rotor circuit for speed regulation. The motor is geared to the rolls and reversed by the controller. When the rolls are under way the reversing current is very excessive: for this reason the fuses have practically to be short-circuited. A foot brake has been tried to stop the machine before reversing, so as to reduce the rush of current, but it has not been successful. In a boiler shop the plate rolls are driven by a similar motor, but by means of a countershaft and crossed belts for reversing purposes. This arrangement, where possible, is to be preferred, as it saves the momentum in the rotor and there are no heavy spur wheels to reverse. Although speed regulation of the motor is, perhaps, more satisfactory, it has been found to be practically unnecessary, as the operator can get what regulation is required by allowing the crossed and open belts to slip, but I do not think that the advantage is worth the extra expense incurred by using this type of motor. In another shipyard the rolls are driven by a 30-h.p. squirrel-cage motor by means of a countershaft with crossed and open belts. Although the rolls are lighter than the rolls previously mentioned, they do the same class of work, and are, on the whole, more satisfactorily driven.

In engine works, where sometimes direct-current motors are essential, separate mains should be run from the sub-station, but these motors should be as few as possible, and connected across the outers of a three-wire system. They are claimed to be of most benefit when driving variable-speed machines, such as lathes, drilling machines, and boring mills, as they do away with belting. This is not altogether an advantage, for, as is well known, the belt forms an elastic coupling between the motor and its load, and thus, if a sudden stress comes on the machine, the belt slips, and may save the motor and gearing from injury.

In engine works the current consumption is not much reduced by separate driving, for, as a rule, the machines are all running simultaneously, and not intermittently as in a shipyard. On the other hand, a great advantage is gained by being able to space the machines independently of the shafting, but as this benefit is greatest for large machines, separate motors for machines requiring 5 h.p. and over, and driving all the others from shafting, would seem a good arrangement. Among the former, one or two lathes might be driven by direct-current motors when a constant speed regulation is a great advantage, but other variable-speed machines, such as boring mills and drilling machines, when the amount of work done at one speed is considerable, might just as well be driven by three-phase motors with belts and stepped cone pulleys.

In reconstructed shops where some other motive power has been displaced, it is best to cut up the shafting into sections according to the nature of the shop, and at the same time do away with as much belting and shafting as is justified by the cost.

For driving large cranes in constant use, it has been proved that three direct-current motors give the best efficiency, but the first consideration should not be efficiency, but reliability and freedom from breakdown. The use of three direct-current motors with commutators, controllers, resistances, and complicated wiring all tend to increase the possibility of breakdown. On the other hand, a single three-phase squirrel-cage motor crane has very few electrical connections, a starting compensator displaces three controllers, magnetic brake, and heavy resistances with their respective connections. The three-phase type necessitates the use of a square shaft and friction clutches for the longitudinal traverse on the crane itself, but these require much less skilled attention than the direct-current motors with their connections and accessories, and the capital cost is also less. My experience with three direct-current motor cranes has, perhaps, been unfortunate, but, notwithstanding, I think the above points worth consideration.

Some engineers advocate the use of three three-phase slip-ring motor cranes where three-phase current only is obtainable, but the high efficiency gained by the three direct-current motor crane is no longer obtainable, due to the inefficiency of the motors when running with a heavy resistance in the rotor circuit, and at the same time the connections are more complicated, and the system necessitates the use of 11 trolley wires between the crane girders.

The following figures taken from a few of the three-phase motors connected to the Newcastle Electric Supply Company's system will, I think, help to support some of my remarks and suggestions:

5-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Two Countersinking Machines by Belt and Countershaft.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Shaft and countersinks running light | 2·7 | — |
| One head countersinking ¼in. holes in ⅜in. plate | 2·8 | Minimum. |
| ,, ,, ,, ,, ,, | 4·8 | Maximum. |
| Two heads ,, ,, ,, ,, | 2·8 | Minimum. |
| ,, ,, ,, ,, ,, | 7·4 | Maximum. |

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7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Punch and Shear by Belt on Flywheel. 27 Punches per Minute.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Running machine light | 3·1 | — |
| Punching ⅝in. holes in ⅝in. plate | 3 8 | Minimum. |
| ,, ,, ,, | 5·4 | Maximum. |
| Shearing ½in. plate | 7 4 | — |
| ,, ,, | 8·8 | Average. |
| ,, ,, | 9·4 | — |
| Shearing ⅝in. plate 21ft. long | 5·4 | — |
| ,, ,, ,, | 8 | Average. |
| ,, ,, ,, | 11 | Operation took 1min. 20sec. |
| Shearing ⅝in. plate 21ft. long, cut about 3in. wide | 5·6 | — |
| ,, ,, ,, ,, ,, | 9 | Operation took 1min. 10sec. |

In shearing, the load varies with the width of cut as well as the thickness. Some figures taken from another machine, shearing 1in. plate, 2in. to 3in. width of cut, show a 7½-h.p. motor taking from 6 kw. to 12 kw.

7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Mast Rolls by Countershaft and Open and Crossed Belts.

| Work done. | Kw. |
|---|---|
| Countershafting and loose pulleys | 2 8 |
| Rolls running light | 3·3 |
| Rolling $\frac{4}{16}$in. plate to half circle | 4 to |
| ,, ,, ,, | 7 |

7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving a Double-Headed Boiler-Shell Drilling Machine by Belt and Countershaft.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Drills running light | 2·6 | — |
| Drilling one $1\frac{3}{16}$in. hole in boiler shell | 3·5 | — |
| ,, ,, ,, ,, | 3·8 | — |
| Drilling two $1\frac{3}{16}$in. holes in boiler shell | 4·5 | — |
| ,, ,, ,, ,, | 5 | — |
| Drilling one 1⅛in. hole in 1½in. plate | 4·5 | Sharp drill. |
| ,, ,, ,, ,, | 4·7 | Operation took 1m. 40sec. |
| Drilling one 1⅛in. hole in $1\frac{5}{16}$in. plate | 4·6 | Blunt drill. |
| ,, ,, ,, | 5 | Operation took 2m. 5sec. |
| Drilling two 1⅛in. holes in 1½in. plate | 6·7 | Sharp drill. |
| ,, ,, ,, ,, | 7·7 | |

7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Brick Crusher.

| Work done. | Kw. |
|---|---|
| Crusher running light | 2 8 |
| Crushing bricks | 3 |
| ,, ,, | 6 |
| ,, ,, | 9 |

7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving a Buck and Hickman Mortar Mill with a Revolving Pan, 7ft. Diameter, 16 Revolutions per Minute, by Countershaft and Loose Pulley.

| Work done. | Kw. |
|---|---|
| Countershaft and loose pulley | 2·4 |
| Running mill with pan empty | 4·4 |
| Mixing with pan full | 7·6 |
| ,, ,, 5 minutes after | 6·8 |
| ,, ,, 15 ,, | 6·4 |
| ,, ,, 24 ,, | 6·4 |

7½-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving "Koppel Concrete Mixer by Countershaft and Loose Pulley.

| Work done. | Kw. |
|---|---|
| Running on loose pulley | 2·1 |
| Machine running empty | 2·6 |
| Hoisting tub filled with ballast and cement | 5·2 |
| Mixing with cylinder charged | 3·8 |
| ,, ,, ,, | 4·0 |
| ,, ,, ,, | 4·4 |

10-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Two-Headed Scarfing Machine and a Plate-Edge Planing Machine by Belt driving a Countershaft with Loose Pulleys, Crossed and Open Belts.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Countershaft and loose pulleys | 4·7 | — |
| One-head scarfing cut ⅝in. to ½in. by 9in. long | 5·2 | Minimum. |
| ,, ,, ,, | 7·8 | Maximum. |
| Planing ⅝in. plate 20ft. long | 9·2 | — |
| ,, ,, ,, | 13 | Average. |
| ,, ,, ,, | 16 | — |
| Planing $\frac{11}{16}$in. plate 20ft. long and scarfing ½in. plate | 10 | — |
| Planing $\frac{11}{16}$in. plate 20ft. long and scarfing ½in. plate | 13 | — |
| Planing $\frac{11}{16}$in. plate 20ft. long and scarfing ½in. plate | 16 | — |
| Planing $\frac{11}{16}$in. plate 20ft. long and scarfing ½in. plate | 18 | Maximum for five seconds. |

The above motor, although very often considerably overloaded, runs very satisfactorily and does not get too hot.

10-H.P. SLIP-RING MOTOR, 800 Revolutions, driving Angle-Iron Planer by Worm, Worm-Wheel, and Gearing. Speed controlled and rotation reversed by controller.

| Work done. | Kw. |
|---|---|
| Planing 10in. channel iron cut ⅝in. × $\frac{11}{16}$in. | 3·8 |
| ,, ,, ,, ,, | 4·8 |
| ,, ,, ,, ,, | 5·8 |
| ,, ,, ,, ,, | 6·6 |
| Planing 4in. angle-iron cut $\frac{11}{16}$ × $\frac{11}{16}$ to ⅜in. | 6 |
| ,, ,, ,, ,, | 6·8 |
| ,, ,, ,, ,, | 7 |
| ,, ,, ,, ,, | 8 |

10-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Quadruple Punching and Shearing Machine by Belt Motor Underground.

| Work done. | Kw. |
|---|---|
| Machine running light | 2·4 |
| Shearing ⅝in. steel plate | 12 |
| ,, ,, ,, | 13·2 |
| Shearing ⅝in. steel plate | 13·2 |
| ,, ,, ,, | 14·4 |
| Punching ⅝in. holes in above ⅝in. plate | 13·2 |
| ,, ,, ,, ,, | 14·4 |
| Punching 4in. holes in above ⅝in. plate, ⅝in. holes previously punched round the circumference | 10·8 |
| Punching 4in. holes in above ⅝in. plate, ⅝in. holes previously punched round the circumference | 12 |

All the above readings were taken with the belt slipping very badly. Belt dressing was put on, and the following readings taken:

| | |
|---|---|
| Shearing ⅝in. steel plate as above | 14 |
| ,, ,, ,, | 16 |
| Punching 4in. holes in ⅝in. steel plate as previously | 16 |
| ,, ,, ,, ,, ,, | 18 |
| ,, ,, ,, ,, ,, | 20·8* |

* Motor slowed up.

This machine had very light flywheels, and the steel plates were for some special purpose not often required in ordinary shipyard use. The plate was fed in as fast as possible for the purpose of taking the test.

10-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving Four Small Planing Machines, Three Small Shaping Machines, Three Slotting Machines, and Two Screwing Lathes by 95ft. of 3in. Shafting running at 175 Revolutions per Minute, and driving Six Countershafts.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Shafting and belt running light | 4·8 | — |
| Ordinary working | 5·6 | Readings taken at various dates. |
| ,, ,, | 6·6 | — |
| ,, ,, | 8 | — |
| ,, ,, | 9 | — |
| ,, ,, | 10 | Average. |
| ,, ,, | 12 2 | — |
| ,, ,, | 14·4 | Occasionally. |

10 H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving 6cwt. Pilkington Hammer and a Fan for Two Smiths' Fires.

| Work done. | Kw. |
|---|---|
| Shafting, fan, and loose pulley on hammer | 3·6 |
| Hammer cushioning | 8 |
| Hammer working | 11 |
| ,, ,, | 13 |

15-H.P. SQUIRREL-CAGE MOTOR, 600 Revolutions, driving Mangles, Scarfing Machine and Operating Gear for Lifting Large Rolls by Shafting and Belts.

| Work done. | Kw. |
|---|---|
| Shafting and loose pulleys | 6·4 |
| Scarfing machine cutting light | 8 |
| ,, ,, ,, ,, | 9·4 |
| Mangling ⅝in. plate | 12 |
| ,, ,, | 14 |
| ,, ,, | 16 |
| Reversing with plate in time 6sec. | 30 |
| Heaving large rolls | 15 |
| Scarfing, mangling, and heaving rolls simultaneously | 21 |

During this last operation the belt came off, and the motor was being lifted off its bed. The motor was then replaced by a 20-h.p., and is working satisfactorily, but I consider it would be worth installing separate motors for each machine—5-h.p. for scarfing and 10-h.p. on each of the other machines.

15-H.P. SQUIRREL-CAGE MOTOR, 800 Revolutions, driving a Manhole Punch by Gearing.

| Work done. | Kw. |
|---|---|
| Machine running light | 3·2 |
| Punching 24in. × 18in. manholes in $\frac{7}{16}$in. plate | 19·6 |
| ,, ,, ,, ,, | 21·2 |
| ,, ,, ,, ,, | 22·4 |

This machine punches heavier plates satisfactorily, although I have not had the opportunity of taking observations when doing so. The time taken for each operation was about five seconds.

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30-H.P. SQUIRREL-CAGE MOTOR, 480 Revolutions, driving 27ft. by 1¼in. Plate Rolls by Belt on to Countershaft with Crossed and Open Belts.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Rolls running light | 11·4 | — |
| Lifting top roll | 14·4 | — |
| Lowering top roll | 11·6 | — |
| Rolling ½in. plate | 12·8 | — |
| ,, ,, | 14·4 | — |
| ,, ,, | 40·0 | Momentary. |
| Straightening ⅜in. plate | 13·4 | — |

I have not had the opportunity of getting readings from this machine when rolling 1⅛in. plate, but the 30-h.p. motor has proved adequate. With bending and straightening rolls the amount of load is almost entirely in the hands of the operator, and is to a great extent independent of the size of plate.

30-H.P. SLIP-RING MOTOR, driving Joggling Machine by Gearing, with the Speed varied and Rotation reversed by a Controller with Heavy Resistances in the Rotor Circuit.

| Work done. | Kw. |
|---|---|
| Joggler running light | 4 |
| Joggling ½in. plate at 5ft. 9in. per minute | 5·2 |
| ,, ,, ,, ,, | 5·6 |
| ,, ⅛in. ,, ,, | 7·6 |
| ,, ,, ,, ,, | 8·4 |
| ,, ,, ,, ,, | 10 |
| ,, ⅛in. ,, ,, | 11 |
| ,, ,, ,, ,, | 12 |
| ,, ,, ,, ,, | 14 |

As will be seen from the above figures, a much smaller motor would be sufficient. I should say a 20-h.p. motor would be large enough to joggle plates up to 1in. thick at the above speed.

30-H.P. MOTOR, 480 Revolutions, driving One Large Horizontal Boring Mill, One Large Vertical Boring Mill, One 10ft. Chuck Lathe, One 30ft. Shaft Lathe, 14 Lathes (Various Sizes), and Two Drilling Machines by 160ft. of 3½in. and 70ft. of 2¾in. Shaft at 150 Revolutions per Minute, with Countershaft for Each Machine.

| Work done. | Kw. | Remarks. |
|---|---|---|
| Large chuck lathe cutting light | 17 | All others off. |
| 30ft. shaft lathe running light, chuck lathe cutting light, and vertical boring mill cutting out propeller boss | 20 | Ordinary working. |
| Chuck lathe cutting light, 30ft. shaft lathe cutting off centres, vertical boring mill cutting out crank webs | 21 | ,, ,, |
| Ditto ditto ditto | 24 | ,, ,, |
| Ditto ditto ditto | 25 | ,, ,, |
| Ditto ditto ditto | 26 | ,, ,, |
| Ditto ditto ditto | 30 | ,, ,, |
| All machines working except a few small lathes and horizontal boring mill. Large vertical boring mill drilling 5½in. hole in a shaft coupling | 26 | ,, ,, |
| Ditto ditto ditto | 28 | ,, ,, |
| Ditto ditto ditto | 31·2 | ,, ,, |
| Same as above only with large drill off | 20 | ,, ,, |
| ,, ,, ,, | 22 | ,, ,, |
| ,, ,, ,, | 23·2 | ,, ,, |

**Single-Phase Current Traction.**—In former articles Mr. M. Latour has shown the possibility of solving the problem of electric traction by single-phase current with three different types of collector motors, all of which would allow of working in the neighbourhood of synchronous speeds. Now, both in the case of repulsion and series motors being used, an available method of controlling the torque of the motor will be necessary. In a paper recently published in No. 51 of the *Electrotechnische Zeitschrift* the author discusses such a method, presuming the motors to be connected to the mains under constant pressure. It is pointed out that both the magnitude and sign of the torque will exclusively depend on the adjustment of the brushes on the collector. It will, therefore, be possible by a convenient regulation of the brush-holder to obtain at any time either the positive or negative torque for a given speed, so as to ensure any desired speed and to effect the recovering of work by braking from full speed down to rest. In order to avoid such mechanical complications as might arise from the handling of the brush-holder, the author suggests providing the stator with a device analogous to a collector being placed on the driving platform. The author purposes describing in a forthcoming paper his method for obviating the difficulties experienced in starting collector motors with alternating current on account of possible short-circuits at the brushes at low speeds.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Jan. 28 the following were the candidates balloted for:

*Members.*—H. T. Davidge, B.Sc., Wh.Sc., A.R.C.S., Ordnance College, Woolwich; J. A. Rudd, 177, West George-street, Glasgow; W. I. Taylor, 50, Fenchurch-street, E.C.

*Associate Members.*—C. Adams, 8, Crescent-gardens, Bath; C. B. Auel, Westinghouse Works, Trafford Park, Manchester; P. C. Booty, General Electric Engineering Company, Perth, W. Australia; R. B. Burrowes, Messrs. Ferranti Limited, Hollinwood, Lancs.; R. C. Dieppe, Lansdowne Lodge, Dartmouth-road, Forest Hill; P. H. England, care of Messrs. Arbuthnot and Co., Madras, India; J. J. Fyfe, Burma Ruby Mines, Limited, Mogôk, Upper Burma; J. G. Griffin, Corporation Electricity Works, Swindon; W. M. Harrop, Superintendent Engineer's House, West Riding County Asylum, Wakefield; R. W. Hutchinson, 18, Washington-street, Newland, Hull; H. H. F. Hyndman, 27, Pembroke-square, Kensington, W.; A. D. Linzell, 34, Nadine-street, Church-lane, Charlton, S.E.; J. McI. McBlain, Corporation Electricity Works, Pietermaritzburg, Natal; A. H. McBryde, Mina de S. Domingos, Mertola, Portugal; R. S. McLeod, 21, Victoria-avenue, Didsbury, Manchester; R. Meakin, Derby-road, Chellaston, near Derby; R. Mott-Trille, Cienfuegos, Cuba; Prof. J. Orr, B.Sc., South African School of Mines, Kimberley; G. D. Poulton, 3, Bath-road, Southsea; H. J. Robinson, Power Station, De Beers Consolidated Mines, Kimberley; R. P. G. Sims, 22A, College-hill, Cannon-street, E.C.; C. Smart, 13, Carlton-terrace, Swansea; K. R. N. Speir, Sutton Bonington, Loughborough; J. T. Taylor, 22, Cornhill-terrace, Leith; C. G. Trevett, care of Messrs. Green and Trevett, 15, Castle-street, Cape Town; W. H. Turner, 17, Highbury-terrace, Headingley, Leeds; J. C. Whiteley, 15, Beech street, Huddersfield; B. D. Williams, Gwaun-Adda, Dinas, Rhondda.

*Associates.*—F. G. C. Baldwin, 79, Clough-road, Sheffield; O. H. Bishop, 8, Avenue-road, South Norwood Park, S.E.; B. C. Bonnarjee, The Knowle, Wallington, Surrey; J. Carlaw, 11, Finnieston-street, Glasgow; G. H. Congdon, 15, Balfour-road, South Norwood; R. B. H. Cragg, Hope Villa, 5, Addington-road, Bow, E; K. O. Ghaleb, Projects Circle, Minia, Upper Egypt; H. N. Howlett, 12, Morden-grove, Lewisham, S.E.; J. W. Jackson, 79, Brudenell-road, Headingley, Leeds; C. B. Johnson, Arnside, Swinton, Manchester; A. H. Law, 5, Holmside-place, Heaton, Newcastle-on-Tyne; R. Lindsay, 281 High-street, Southwark, S.E.; R. A. Parsons, Eastgate-street, Gloucester; S. C. Rhodes, Gordon College, Khartoum, Soudan; C. Richardson, Romiley, near Stockport; E. E. Robb, Pinecroft, Tunbridge Wells; D. Sheppard, 4, Bloomfield-terrace, Wells-road, Bath; H. C. Siddeley, The Croft, Purley.

*Students.*—A. H. Acres, 3, Talbot-road, Tottenham, N.; W. B. Adams, Henddol House, London-road, Thornton Heath; F. Bacon, Melbourne, Park-avenue, Ashton-on-Mersey; T. O. H. Bates, Croft House, Gildersome, near Leeds; H. P. Baynham, Carlisle House, Bath-street, Rugby; D. W. Belbin, 292, Seven Sisters-road, Finsbury Park, N.; L. G. Bennet, 21, Queenswood-avenue, Highgate, N.; F. G. Brookes, St. Sepulchre's Vicarage, Northampton; J. K. Catterson-Smith, The University, Birmingham; G. F. Cobham, 5, Temple-road, Croydon; W. R. Cooper, 37, Claypole-road, Nottingham; L. C. Culle, 18, Montague-place, Russell-square, W.C.; E. B. d'Ade, 12, Beacondale-road, Upper Norwood, S.E.; R. M. Derry, Oaklea, Manor-road, Chelmsford; C. F. Edwin, 2, Stoke-road, Guildford; S. Featherstone, 11, Madeira-park, Tunbridge Wells; E. H. Field, 93, Gordon-hill, Enfield; F. Goodall, Woodbank House, Chesterfield-road, Sheffield; A. Hartley, Crow Nest, Hebden Bridge; E. M. Hayward, 1, Fairholme-road, Croydon; H. Headley, 11, Burlington-gardens, Chiswick; C. H. Hitchen, 38, Cambridge-road, Hammersmith; G. Holliday, 12, Elliscombe-road, Charlton; E. P. Hollis, 66, Station-road, Ilkeston, Derbyshire; S. Holmes, Westfield Park, Wakefield; G. Jacques, The Cringles, Thicket-road, Sutton; M. Jennison, 30, Western-street, Seedley, Manchester; W. O. C. Langdon, West Lodge, Hastings-road, Bexhill; C. E. Lucas, 144, Cardigan-terrace, Heaton, Newcastle-on-Tyne; T. J. Sack, 487, Caledonian-road, Holloway, N.; R. M. Sethna, care of Messrs. Thomas Parker, Limited, Wolverhampton; A. B. Smith, Sunnyside, Monkseaton, Northumberland; A. C. Stacey, Faraday House, Charing Cross-road, W.C.; W. G. Turner, 18, Heaton Hall-road, Newcastle-on-Tyne; T. A. Vincent, Rozelle, Maybury-road, Woking; S. E. Weeden, 4, Baskerville-road, Wandsworth, S.W.

## DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of the directors for the half-year ended Dec. 31 last states that on the revenue account the total receipts from all sources show an increase, as compared with the corresponding period of 1902, of £212. 12s. 5d. Passenger receipts show an increase of £184. 4s. 9d., and goods traffic an increase of £28. 4s. 3d. The total expenditure shows an increase of £113. 3s. 9d. There has been a reduction in most classes of expenditure, but maintenance and repairs have cost rather more than in the corresponding half-year. £225 included in this half-year's net revenue account is the amount of directors' fees accrued for some time past, which they did not draw, and which they relinquish in favour of the Company. After providing for debenture interest there is a balance available of £1,425. 11s. 11d., out of which it is proposed that a dividend at the rate of 5 per cent. per annum be paid on the preference shares, absorbing £475, and that £750 (as compared with £300 in each of the two last half-years) be placed to reserve account for payment on account of electrical equipment, leaving £251. 11s. 11d. to be carried forward. The directors recommend that the preference dividend be payable on March 15.

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## NOTES.

**Electricity in Mines.**—In the House of Commons last week Mr. Fenwick asked the Secretary of State for the Home Department whether any steps were being taken to prepare special rules for the purpose of regulating the use of electricity in mines in accordance with the recommendations of the departmental committee. Mr. Akers-Douglas said the report of that committee was now before him, and he was considering the best steps to take with the view of establishing special rules in accordance with its regulations.

**Institution of Mechanical Engineers.**—This institution has decided to hold its spring meeting this year in Chicago, the conference opening in that city on Tuesday, May 31. Arrangements for the visit are now going forward. New members who join the institution before March 5 next will be given facilities for attending the spring meeting. The annual general meeting will be held to-night at the Institution House, Storey's-gate, when the annual report will be presented and the officials for the ensuing year elected.

**A New Element.**—Prof. Dr. Markwald, of Berlin, is reported to have discovered a new radio-active substance, which he has named radio-tellurium. Before an audience of the leading scientists of Vienna, the professor said that in experimenting with pitchblende from Joachimsthal, Bohemia, he discovered minute quantities of a very active substance which at first showed all the reactions of tellurium, but further examination proved it to be a mixture of tellurium and most minute quantities of a substance hitherto unknown. The report adds that the quantity of the new element found in pitchblende is exceedingly small.

**A Canadian Electrothermic Commission.**—On the 23rd of last month there sailed from New York for Liverpool a party of engineers forming the commission appointed by the Canadian Government to investigate existing electrothermic processes of manufacturing iron and steel in Europe. After England the commission will visit Sweden, France, and Italy, and it is probable that some four months or more will be used in carrying on the work of investigation and research. For years the rich iron mines of Canada have remained dormant with abundance of water power available on all sides. But it is now believed by the Minister of the Interior in Canada, and by financiers, that the work of this commission will pave the way for great industrial prosperity in the Dominion.

**The American Institute.**—The annual dinner of the American Institute of Electrical Engineers was held in New York on the 11th inst., when the guest of honour was Mr. T. A. Edison. By a happy coincidence the dinner commemorated the twenty-fifth anniversary of the introduction of the incandescent lamp, and the date also coincided with Mr. Edison's birthday. The opportunity was therefore taken of presenting the deed of gift of the Edison Medal Association, which, as recently stated in these columns, has raised a large fund to commemorate the twenty-fifth anniversary of the incandescent lamp. The institute has accepted the trusteeship of the fund, and it is proposed to award a medal annually to the graduating student in America who shall present the best thesis on some original subject.

**Private Fire Brigades.**—The sixth annual tournament of the London Private Fire Brigades Association was held on the 6th inst. at Shoreditch Baths. The Robertson Electric Lamp private fire brigade, for the third year in succession, met with a considerable amount of success, the members of the brigade winning a prize in every competition in which they took part, and carrying off three first prizes, two second prizes, and one third prize. In addition to these prizes, the brigade won the championship for the whole of London, and are now holders of the Marshall challenge cup, which is given for the best all-round performance. The brigade also holds the Hibbert challenge cup for the best individual performance at the tournament These cups have both been wrested from the Railway Clearing House fire brigade, which has held the championship of London for the last three years.

**London Traffic Commission.**—We understand that the Royal Commission on London Locomotion have nominated Sir John Wolfe Barry, one of the Royal Commissioners, Sir Benjamin Baker, and Mr. W. Barclay Parsons, who is the consulting engineer to the Board of Rapid Transit Railroad Commissioners of New York, to advise the Commission on certain important technical questions connected with locomotion and transport in London. The Commissioners have taken a mass of evidence upon proposals which it is suggested would alleviate existing conditions of traffic and afford further facilities, and the advisers to the Commission will report upon the engineering and other technical considerations involved in these proposals. It will not be the duty of the technical advisers to the Commission to make any report upon specific schemes which have formed the subject of applications to Parliament.

**Junior Institution of Engineers.**—Mr. Fletcher Moulton, K.C., M.P., the president, presided over the nineteenth anniversary dinner of this institution on Saturday at the Hotel Cecil, when among those present were Mr. R. Kaye Gray, president of the Institution of Electrical Engineers, Prof. D. S. Capper, Sir Andrew Noble, and others. The last named, in the course of some remarks on the fiscal question, was inclined to attribute the outburst of prosperity following the abolition of the Corn Laws to James Watt and George Stephenson, the introducers of the steam-engine, rather than to Richard Cobden. Mr. R. K. Gray responded for "The Senior Institutions," and Lord Balfour of Burleigh, in giving the toast of the institution, referred to his visit to the giant engineering works at Assuan. We are pleased to hear that the institution itself is in a flourishing condition, and that a scheme is under consideration for enlarging its influence in the provinces.

**Electrical Test Track at St. Louis.**—In view of the great importance which electrical railways have gained in recent years, the directors of the St. Louis Exposition have decided to arrange for the testing of the different systems of electric transportation under the direction of a special committee, and upon a track specially constructed for this purpose on the fair grounds. The tests will be under the direct supervision of the department of electricity, of which Prof. W. E. Goldsborough is chief, and the members of the committee will have an advisory capacity in connection with these tests. The test track extends along the north side of the transportation building, and will be a double track 1,400ft. long, and nearly level its entire length. The Exposition Company will construct this track according to the latest methods, and will equip it with the most modern instruments and apparatus available. There will also be at the disposition of the participants any system of electric current desired. The principal aim of the tests is the accumulation of valuable data which will be of very great utility for the future development of electrical traction.

**Iron and Steel and Fiscal Proposals.**—The secretary to Mr. Chamberlain's tariff commission has sent us a copy of a memorandum on the iron and steel trades

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which has been adopted by the commission, in so far as it concerns the points upon which witnesses representing these trades are to be questioned. Broadly speaking, the witnesses will be asked to give their opinions on the present position of raw materials, processes, finished iron, standing charges, import duty, and trade with the Colonies. Of course, each witness will be invited to deal with the particular district he represents, but he will also be asked to give his opinion upon the general question of adopting a policy of protection on the iron and steel trades. There are 22 heads on which witnesses are to be examined, and these include the processes used in this country as compared with foreign countries, the importance of technical and commercial training and higher education of all grades, and the decimal system of weights and measures. We are informed that the response which manufacturers in the iron and steel and other leading trades are making to the general form of enquiry issued by the commission has been quite satisfactory.

**Electrical Power in Collieries.**—Mr. W. Johnson, president of the Mid-Glamorgan Colliery Managers' Association, offered some sound advice to electrical engineers who specialised in electrical mining plant on the occasion of a visit to the Bridgend station of the South Wales Electrical Power Distribution Company last week. Mr. Johnson recognised that electricity in connection with colliery work had come to stay, but declared that there were great difficulties to be overcome before it could be universally adopted. Electrical engineers had to recognise that colliery managers could not use their collieries for experimental purposes. He would advise those engineers who took up colliery work to visit the steam coal pits of South Wales, noting the difficulties that had to be contended with, and they would then be better able to understand why so many colliery owners and managers were seemingly opposed to introducing electricity into their mines. It was only by a careful study of these difficulties and overcoming them that electrical engineers could hope to have electrical power more generally adopted. They would then find that colliery managers were not the opponents to electricity they were supposed to be.

**Wireless Telegraphy at St. Louis.**—Wireless telegraphy is likely to take a prominent place at the World's Fair this year. The American De Forest Wireless Telegraph Company has bought the tower of the electricity building of the Buffalo Exposition, 1902, and is now erecting this tower on the exposition grounds at St. Louis, and will use it for a sending and receiving station. The tower is 350ft. high, and will be placed on an elevation south of machinery hall. Besides the tower a mast of 250ft. in height will be erected in the same place. In the base of the tower the electric power station will be installed, containing a transformer of 90 kw. and other necessary apparatus and instruments. Several smaller stations will be put up in the different exposition buildings, and communication will take place not only between these two stations, but also between the principal station and the centre of the city of St. Louis and the neighbouring cities. The company expects to maintain continuous communication between St. Louis and Chicago, sending a distance of more than 300 miles. Signor Marconi has also decided to demonstrate his system in the Italian section of the exposition. It is to be hoped that the European companies for wireless telegraphy will also participate in this interesting competition.

**Old Faradians.**—Old Faradians of Manchester and the neighbourhood dined together at the Midland Hotel, Manchester, on Saturday last, with Mr. C. D. Taite, borough electrical engineer of Salford, in the chair, and had a royal time. Mr. Robert Hammond was at his best in replying to the toast of "The Electrical Standardising, Testing, and Training Institution," but confessed that when he remembered that more than 20 years had passed since he first started the college in Red Lion-square, he realised that he was getting old, a statement which evoked general disapproval. Referring to an ambition he had when a boy to plant trees, which he had not found possible to satisfy, he felt that in planting the number of electrical engineers (about 500) who had passed through the institution in their profession he had achieved that ambition in a more valuable form. The toast of "The Visitors" was responded to by Mr. E. Cowan, chairman of the local section of the Institution of Electrical Engineers. The speeches were commendably brief, and the dinner was followed by a smoking concert. The gathering was a great success, and will be repeated next year. Much credit is due to Mr. J. T. Tiplady, the hon. secretary of the Dinner Committee, whose efforts were brought to such a happy fruition.

**Express Electric Railways.**—Although the recent high-speed trials on the experimental electric railway between Marienfeld and Zossen demonstrated the possibility under certain conditions of obtaining extremely high speeds, even up to 131 miles an hour, they by no means justify the conclusion that such speeds could be maintained in ordinary practice. A direct consequence of the eminently successful results obtained in those trials, however, is a couple of proposals for the construction of an express electric railway in Germany. The suggested line would run between Berlin and Hamburg. The two schemes are very similar in character, and both propose the erection of a central electric generating station at Wittenberg, while one only contemplates the use of the existing railway stations along the route for the purpose of the railway. At present the traffic between Berlin and Hamburg has become so heavy that the laying of a third track has become necessary for the steam trains, but the expenditure in this direction would be obviated in the event of one of the two plans in question receiving the approval of the Government. The journey between the German capital and Hamburg is accomplished by express trains in three hours, but each of the electric schemes provides for the run being reduced to 1½ hours.

**Engineering Standards Committee.** — The excellent and valuable work which the above committee has been carrying on since April, 1901, deserves the support of every manufacturer engaged in the engineering industries. A task of the magnitude which the committee has undertaken must necessarily be of a laborious and protracted nature, and though comparatively few reports have as yet been actually published by the committee—those that have made their appearance are valuable in the extreme—an enormous amount of information and material has been collected, and a large number of specifications and findings are approaching the stage of completion. These findings, there is little doubt, must ultimately have an enormous influence on the trade and commerce of this country. The Government, as our readers know, have recognised the utility of the committee's labours, and made grants towards the necessarily heavy expenses incurred in carrying on a work of this nature. This has been followed up by the proposal of the Government to make future grants equal in amount to that subscribed by the supporting institutions and firms interested. It is therefore to be sincerely hoped that the leading firms in this country will not allow the work of the committee to be curtailed for want of financial support. The secretary of the committee is Mr. Leslie S. Robertson, 28, Victoria-street, S.W.

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**Belgian Rails.**—The recent agitation against the practice of municipalities and others placing their orders for tramrails in Belgium lends considerable colour to a consular report on the industrial progress of that country which has just been issued. From this document it appears that there is no fixed price for Belgian tramrails, the price depending on the quantity ordered The average price, however, for exportation is stated to be about £5 per ton, carriage paid to Antwerp, and for use in Belgium £5 to £5. 4s. per ton. For the manufacture of these rails basic steel is employed, which is cheaper than the Bessemer steel used in the United Kingdom. Basic steel is considered by Belgian manufacturers to be more suitable than any other kind of steel for tramrails. Though a British invention, basic steel does not enjoy in the United Kingdom that favour which it obtains in Belgium and Germany. In the works where these rails are made the hours of work are longer, wages lower, and holidays fewer than in the United Kingdom. Wages vary considerably, but, approximately, skilled workmen receive 3·8d. per hour, ordinary workmen 2·37d. to 3·32d. per hour, and boys 0·76d. to 1 42d. per hour. The number of hours' work per week is 59, or 10 hours a day. Work begins on Mondays at 8, on other weekdays at 6.30 or 7 o'clock. Overtime is paid at the rate time and a-quarter. Except in blast furnaces there is usually no Sunday work. The usual working hours are from 7 a.m. to mid-day, and from 1 till 6 p.m. On the furnaces there are two gangs working 12-hour shifts.

**Science and Industry.**—The subject of discussion at the usual monthly dinner of the London Chamber of Commerce last week was "British Industrial Neglect of Applied Science," in which several eminent educationists participated. Sir A. W. Rücker, who was in the chair, after remarking on the want of appreciation on the part of English commerce of that careful scientific training for those who were to take the leading parts in it, said the matter of crucial importance was the necessity of drawing the educationist and the business man closer together. It was essential that educationists should know more definitely what business men wanted. What was wanted was that a man should be trained both on the literary and on the scientific side. Alluding to the University of London, he said that while they wanted it to be a university famed for learning, they wanted it to be no less a university famed for utility. Sir Wm. Anson doubted whether the mere multiplication of professors would achieve the desired object. He was of opinion that the connection of science to industry might be promoted by the higher cultivation of the masses of the people. What was needed was not a skilled group of people at the top, nor intelligent working classes at the bottom, but the middlemen, the great leaders of commerce and industry, to bring the two together. They wanted to induce the leaders of industry to understand the value of the application of science to their businesses, and not its application to the mere discovery of something which they could exploit, leaving it afterwards to take its chance. Prof. Armstrong joined in the subsequent discussion, and alluded to the willingness of the American, absent in the Englishman, to subordinate himself, and to act in concert with others for the common good. That was a quality which Englishmen must educate in themselves if they were going to meet the competition of the world. If there was one thing the Englishman did not at present believe in, it was the expert. Others who took part in the discussion were Sir Wm. Ramsay and Prof. Meldola.

**Motors on the Hire System.**—A meeting of the Glasgow Section of the Institution of Electrical Engineers was held on the 8th inst. At the opening of the proceedings a fitting tribute was paid to the memory of the late Mr. Walter McMillan, and sympathy was expressed with his widow and family. The subject for discussion was "Electric Supply Undertakings," which was introduced by Mr. Sydney E. Britton in a paper in which he debated the point whether they should advance motors on the hire or hire-purchase system. At the outset Mr. Britton said both systems had been tried in Motherwell, where they aided in the success of the electricity department. He explained that under the first system the undertakers lent motors to power users at a certain rent per annum, the motors remaining the property of the undertakers. In the case of hire-purchase, motors were lent to power users, who in return made at certain periods part payment of the capital cost of the motors plus, say, some 10 or 15 per cent. on the outstanding amount, and at the end of one, two, three years, or even longer, as the case might be, the motor became the entire property of the hire-purchaser. Some undertakings included interest, sinking fund, repairs, renewals, and general superintendence in the amounts charged. Others merely included interest, sinking fund, and general superintendence. Which was the more correct was a matter of opinion, but for his part he preferred the latter, chiefly because it relieved the undertaking of a liability which could only be guarded against in a speculative fashion. He could not see why objections were raised against a corporation letting out motors on hire or hire-purchase when it had an electric supply undertaking. He submitted that in the interest of manufacturers of electrical apparatus, of contractors, of supply undertakings, and of all classes of consumers of energy, unstinted encouragement should be given to those who wished to advance electric motors on hire and hire-purchase systems to consumers who had not the capital at hand to purchase outright, and who, but for these systems, would have to drag along without electric energy. A discussion followed, and at the close Mr. Britton was awarded a vote of thanks for his paper.

**Electricity in Japan.**—A great deal of activity is at present being shown in Japan in the utilisation of electricity for lighting, power, and traction purposes. The electric light works at Tokyo (the capital) are not a new installation. They have been in operation for some considerable time with a measure of success which may be gauged by the fact that it has become necessary to greatly extend the power-house. The plant at present installed has a capacity of 5,050 h.p., and this is being increased by an additional 3,600 h.p. Electric current is being supplied from the original plant to the equivalent of 100,273 10-c.p. lamps, and we understand that the demand for light is so heavy that applications for connections are received at the rate of over 1,500 a month. The new plant is expected to be in operation in April next, and immediately on its completion work will be commenced on a further extension, which will ultimately increase the output of the station by 10,000 h.p. A part of this scheme is to be realised by the summer of next year. Fresh demands for electric power are being made upon the electric light company by the light railway company, which is operating an extensive system of light railways in the city. In other parts of Japan there is evidence of similar progress in which the municipalities are taking a prominent part. For instance, one city proposes to develop close on 10,000 h.p. by utilising the power of the Tama River. This scheme provides for the harnessing of the water at three different places and the erection of an equal number of generating stations. Other places are going in for electric traction systems, such as Osaka, where the municipal authorities are seeking Government authority to lay down electric tramways as a municipal undertaking. Another instance of activity in the same direction is the

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completion of the Keihin electric railway, which is under construction. It runs between Shinagawa and Kanagawa, a distance of about 20 miles. The company is laying down a power plant with a capacity of 540 h.p., which will supply current for working the line, and an average speed of 50 miles an hour is to be maintained. It is likely to prove a formidable rival to the Government railway between Yokohama and Shimbashi, as it will have the advantage of a more frequent and rapid service.

**Wireless Telegraphy.**—The centre of activity in the wireless telegraph field would now appear to be Italy, where Signor Marconi is having the benefit of the practical support of the Government. Altogether there are already seven wireless telegraph stations in that country in constant work. Of these, five are used for maritime purposes and two exclusively by the army. The first of the maritime stations is at Capo delle Melle, in the Gulf of Genoa, and the others are situate at intervals along the coast connecting the mainland with the islands of Sicily and Sardinia. The military stations are at Monte Mario, a height above Rome, and on the island of Maddalena, off the coast of Sardinia, so that the passage of an enemy's ships along the western seaboard could be instantly signalled to the capital. Another station at Bari is approaching completion, as well as one at Antivari, on the opposite coast of Montenegro, which is to be used for commercial communication. Before June it is expected that three other stations along the Italian shore of the Adriatic will be in operation, so that there will be communication from point to point along the whole coastline of Italy. It will be seen that so far the activity in this direction in Italy has been confined to short-distance communication—an object which we have always contended is the particular province of wireless telegraphy. As is known, however, Mr. Marconi has devised an ambitious scheme for opening up commercial communication with England and North America on the one hand and Argentina on the other. With this end in view a station is to be erected near Pisa on a site which has been given by the King of Italy at San Rossore. Information has lately appeared in the daily Press that Mr. Marconi has succeeded in establishing a wireless telegraph service between this country and Holland, which, if correct, is the first service of the kind attempted between England and the Continent since communication between Dover and France was stopped by the Government. The messages are transmitted from the Poldhu station to Amsterdam, a distance of about 200 miles, 40 miles of which lie overland in the South of England. An interesting feature of the new service is that a commercial daily paper in Amsterdam has arranged to receive its English news by wireless telegraphy.

**Switchboard Design.**—This week Mr. L. Andrews has been exhibiting in the offices of Messrs. Cowans, Limited, at 82, Queen Victoria-street, some interesting new features in the design of high-tension switchboards which are intended to prevent fires such as destroyed the switchboard at the Bristol station at the end of last year. Owing to the short time at our disposal we are unable to illustrate these novelties in this week's issue, but the following *résumé* will give in outline Mr. Andrews's inventions. The first of these is a current direction indicator to show when an alternator is supplying current to the mains and when, owing to any defect, the current is going back into the alternator from the 'bus bars. For this purpose Mr. Andrews uses a transformer with differential windings. The transformer has three cores and two yokes. The two outer cores are wound with fine wire coils connected across the 'bus bars, and the centre core has round it a winding through which the current from the machines is circulated. In actual practice this current is obtained through a transformer, so as to keep the apparatus at low voltage. The differential action between the windings on this transformer causes a variation in the distribution of the flux in the two halves of the yoke. Two coils wound round these are connected respectively to incandescent lamps, one of which is green and one red. Under normal conditions, when no current is passing to and from the alternator the filaments of these two lamps are equally heated. The generating current causes the green lamp to become brighter and the red lamp more dull. Conversely, if the generator fails and current is returned to it from the 'bus bars, the red light brightens and indicates this. In parallel with these lamps Mr. Andrews connects the actuating coils of his automatic oil-break return-current cut-out. Details of these we hope to illustrate in next week's issue. Other features of interest shown us in connection with high-tension switchboards was a construction by which the whole of the high-tension switches would be placed below the switchboard in fireproof compartments, which will localise the arcing should anything go wrong with the switchgear. The cables would not be carried through these compartments, and arrangements are made to retain the burning oil in the base of the compartment should arcing occur, which is not probable.

**Electric Power in Yorkshire.**—We have pleasure in drawing our readers' attention to an attractive pamphlet which the Yorkshire Electric Power Company have issued on the advantages of the use of electric motors in factories and workshops where a cheap supply of power is available. The company will not be in a position to give such a supply until the end of the present year, but they are wise in preparing the ground early. A prominent feature of the pamphlet is a map showing clearly the area which will eventually be served by the company's mains. It includes the greater part of the industrial centre of Yorkshire, and embraces such places as Leeds, Huddersfield, Bradford, Wakefield, Barnsley, Doncaster, Rotherham, Keighley, Batley, and Dewsbury. Under their Act the company are naturally excluded from supplying power to consumers within the areas already served by municipal undertakings, but they should find a ready market for power among the many workshops and factories which lie in the districts named but do not come within the range of municipal supply. The four power-houses which the company are erecting are very evenly distributed over the area to be served. One is at Shipley, a little to the north-west of Bradford, another at Oulton, near Leeds, another at Thornhill, by Ravensthorpe, and the fourth at Wath, a few miles to the north of Rotherham. The company have designed the stations and the entire distributing system in the conviction that electric motors will be extensively adopted, and have fixed the charges at a reasonably low rate. The scale is arranged on the maximum demand system, and is generally as follows: for the first 50 kw. or 67 h.p., the charge is 0·85d. per unit per kilowatt-hour or 0·64d. per horse-power hour; for 50 kw. up to 150 kw. or 200 h.p., 0·8d. or 0·6d. respectively; for 150 kw. up to 250 kw. or 336 h.p., 0·75d. or 0·56d.; and so on up to from 850 kw. to 950 kw. or 1,280 h.p., for which the charge is fixed at 0·4d. per unit per kilowatt-hour or 0·3d. per horse-power hour. To these charges is added 15s. a quarter per horse-power of maximum demand; also the above prices are for high-tension current, and are subject to an extra charge of 10 per cent. for conversion. An example of how these charges work out is given, which shows the average cost for a motor running at 25 h.p. for 56 hours a week and consuming 13,500 units to be about 1·18d. per unit, or

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£2. 13s. per horse-power used per quarter, or a total of £66. 11s. These prices are decidedly low, and should induce manufacturers to adopt the electric drive very extensively. The pamphlet in question is well got up and fully illustrated, and merits careful study by intending power users.

**Railways or Tramways?**—This session the London United Tramways Company have two Bills in Parliament, one to authorise the construction of several extension lines of their tramway system in West London, the other for powers to lay underground "railways," which would convey the company's cars from the surface of the street at Hammersmith Broadway direct to the platform entrance of the District Railway Company's Hammersmith Station. From its novelty and from the departure from ordinary practice which it promises to introduce, the latter of the two schemes assumes a unique importance. The facilities for interchange of traffic between the company's extensive surface system and the Underground Railway Company's lines which such a connecting line as proposed would offer are obvious. The possibilities of through booking and cheaper fares are, perhaps, from the public point of view of first importance, but at least equal to these is the salutary effect which such an arrangement would have on the congestion which always occurs at a tramway terminus of the importance and size of that at Hammersmith. The company's suggestion is that this terminus should for all practical purposes be abolished, and that on arriving at this point the cars should be taken underground by means of an incline and run through tunnel to the entrance of the District Railway Company's station. The only instance of the kind in this country that we know of is at Bristol, where at one point on the tramway system the cars enter a private siding adjoining the entrance to the main railway station. Thus the passengers alight on private land, and the difficulties and objections to a terminus in the public thoroughfare are at once got rid of. That the proposals of the London United Tramways Company are sound and progressive, therefore, is evident, but there is likely to be some difficulty in obtaining the necessary powers from the fact that the company have designated these suggested underground connecting lines "railways," thus avoiding the responsibility of obtaining the sanction of the local authorities concerned, and depriving the latter of their power of purchase at a later date. The point was argued before Mr. Jeune, one of the examiners of Standing Orders, at the House of Commons on Monday, when the London County Council put in an objection based on the contention that the proposed lines are not railways at all, but tramways. This led to a discussion as to what the definition of a railway is, from which it became evident that Parliament has never yet put its own construction on the word. The examiner had therefore, as he said, to rely on "simple common sense" to decide the point. It appeared to him that this was obviously a tramway, which was to be run as a tramway, and it was a tramway in the ordinary conversational meaning of the word. He saw nothing, therefore, to take it out of the Standing Orders applicable to tramways. At this stage, therefore, the opposition of the London County Council has proved successful, but the Bill has yet another chance before the Standing Orders Committee, who have power to dispense with compliance with the Standing Orders in their discretion. We hope, in the interests of the community, the committee will take a broader and more public-spirited view of the question than that shown by the examiner. To throw out a scheme which aims at nothing but a useful public improvement on a mere technicality would scarcely be either justifiable or equitable.

**The Thermit Weld.**—At the Society of Arts on Wednesday last week Mr. C. V. Boys, F.R.S., read a paper on "Thermit and its Applications to Metallurgical Engineering." The author began with a description of the physical characteristics of aluminium, passing on to an explanation of its great chemical property, in which, together with magnesium, it surpasses all other metals—viz., the production of an enormous quantity of heat on combining with oxygen. The history of thermit dates back to the year 1894, when Claude Vautin, of London, made use of aluminium mixed with metallic oxides, sulphides, chlorides, etc., to effect a corresponding reduction of metals with which oxygen, sulphur, or chlorine might be combined. Two years later a development of this subject was effected by the same experimenter. Nearly three years afterwards Dr. Hans Goldschmidt brought out a further invention for utilising the heat of this reaction. In Dr. Goldschmidt's process a crucible of the mixture thermit after ignition consists of two layers, iron below, in an amount nearly half the weight of the original thermit, alumina above, both at a temperature approaching 3,000deg. C., so that it cannot be looked at without risk to the eyes. This double layer may be taken out of the crucible by either of two methods: it may either be poured out of the top, in which case the lighter material goes first and is followed by the heavier; or it may be run out through a small orifice at the bottom of the crucible, in which case the heavy iron will go first and be followed by the lighter alumina. The method of making a weld, which now appears to be, commercially, the more important, is to use not only the heat of the reaction, but to utilise the iron formed by the thermit as well as the heat. Perhaps the most extensive use that has been made of this method of welding has been in the welding of street tramrails. In this case there is no objection whatever to the thermit iron being allowed to adhere to the rail ends, forming a shoe round the foot and web of the rail. By this means the heat of the reaction is more completely utilised, so that a smaller quantity of thermit is sufficient to raise the ends of the rail to the welding point, and even to melt to a certain extent the surface. Mr. Boys went on to speak of tests carried out with the thermit weld at Leeds, which show, first, that the joint is far stiffer than the usual one made with fish and sole plates; and, secondly, that the electrical conductivity is better than that of the unjointed rail. The conclusion is that there is no more any occasion to subject the rolling-stock and the nerves of the passengers to the continual hammering of imperfectly connected rail ends. Besides Leeds, some 15 other towns, mostly in the North, have used thermit joints, but up to the present not to the same extent. The author went on to explode what he called the "expansion bogey," which seems to scare so many people. He contended that there was no trouble to be anticipated from this cause in the case of tramways, where the rails are buried in the streets, as distinct from rails on railways, that are exposed over their whole surface to the air. He also dismissed the objection with regard to making alterations as quite imaginary. As regards the various applications of the thermit weld, it seems it may be used successfully for pipes, rails, machine repairs, and ship repairs. In all these it has proved satisfactory. There was a discussion afterwards, in replying to which Mr. Boys again referred to the expansion question. He explained that the diurnal change of temperature is small in a rail which is buried 7in. in the ground, and the length of the line does not affect the question in the least. As regards exposed rails, the case is different, as the diurnal change of temperature is then large. He added that main-line rails exposed to the air and sun have not up to the present been welded.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E, A M I.C.E., ETC.

*(Continued from page 248.)*

TELEGRAPHY.

*The Old Plan—The Function of a Telegraph Wire.*—In order to estimate the chances of success of the new systems, and to understand the disadvantages under which they work, we may consider briefly some points in the older system, and see whether the ancient and modern systems have much in common. In the old system the electrical influence is transmitted by means of a wire. A magnetic field is created all round and inside the wire by the passage of a current. The lines of force (convenient, but entirely imaginary lines) are circles round the centre of the wire as a common centre. They are closer and closer together as we go out from the centre of the wire till we get to its circumference, then outside they again thin out, and become more and more distant as we go away from the wire. This is especially the case where an *oscillatory* current is employed, in which case the lines have to be built up each time the current *grows*—this building up giving a back E.M.F. due to *self-induction*, which *opposes* the current—and as they collapse each time the current dies away, they give rise to a direct E M F., tending to make the current flow on. With an oscillatory current of high frequency, such as that used in wireless work, the variation in the distance apart of the lines is very marked, the circles being crowded towards the circumference of the wire, so that its *surface* is the important thing. But with steady

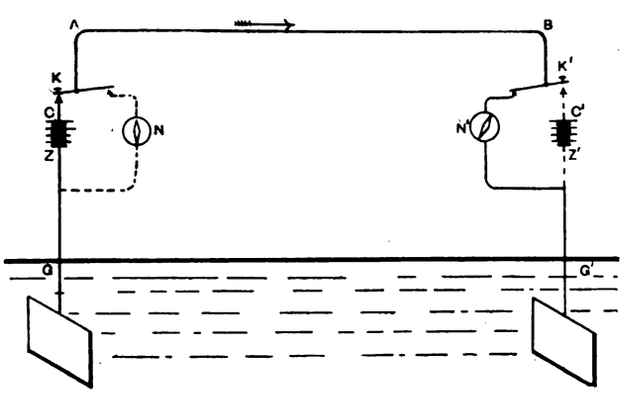


FIG. 1.

currents the self-induction effects are negligible usually, and the *area* of the cross-section of the wire is of importance. The magnetic whirls (represented by the circular lines of force) are set up at one end, and all along the wire they are propagated with a velocity which would be that of light but for modifications introduced by metals in the neighbourhood, and by other effects due to capacity, etc. Is the wire really necessary? Some authorities tell us that the wire does *not* convey the impulses—that they are sent through the ether or ether and dielectric (or insulator), the wire only *guiding* them. That the wire is not absolutely necessary our wireless friends have shown, though for the sake of *certainty* and economy of power it may pay to have the wire, even if it be expensive. As Dr. Lodge, in "Modern Views," clearly shows, we could, for instance, avoid the immense loss by radiation if we inserted a wire directly between the optic nerve and the source of light—say, the filament of an incandescent lamp—but we put up with the great loss for the sake of comfort and certainty, besides the radiated light does good all round. Reasoning the opposite way, it may be well in many cases to go to the expense of a wire for the sake of certainty, comfort, and because the electric radiations are not likely to do any good to anyone else.

The way in which an ordinary telegraph installation acts will be gathered from the diagrammatic sketch (Fig. 1). At each end of the line there is a battery, C Z, C' Z'. When the key K is depressed, a current passes along the wire, or, rather, the impulse is transmitted, the key K quitting company with the receiving instrument at its own end. The current passing through K' enters the needle instrument at N', and, causing a deflection of the needle (or in cases where used, attracting the armature of a sounder or Morse printer), returns to earth and thence to the battery at Z. If K' be depressed and K not, then the opposite action takes place, the current going in the reverse direction actuates the instrument at N. This arrangement also suits where a relay is employed to work a Morse instrument; the stronger auxiliary current passes through the coils of the electromagnet of that instrument as soon as the weak current closes the relay circuit, and the armature is attracted for a short or long period of time, thus printing a dash or dot on the moving ribbon in a way which will be understood from Fig. 2, where a somewhat old form of relay and Morse printer (an embosser) are shown, the action of the relay being here more easily traced than in newer forms. The key B being open, the faint current from the line energises the electromagnet of the relay, which attracts the armature, *a*, the upper end of which leaves F and moves into contact with E, completing the circuit of the local battery, which gives a more powerful current to the electromagnet of the Morse instrument, the armature of which, being attracted, stamps or embosses a mark on the ribbon of paper moved by clockwork. In the case of a Morse inker of the type now most in use, the armature when attracted raises a little inky wheel against the moving ribbon, and following the movement of the key at the distant end of the line prints a dot or a dash on the ribbon. In sending a message the key B, when depressed, closes the circuit connecting the line and line battery, allowing the impulses from the latter to flow to the distant station; the other end of the key B being raised, the relay and Morse at the sending station are cut out of action.

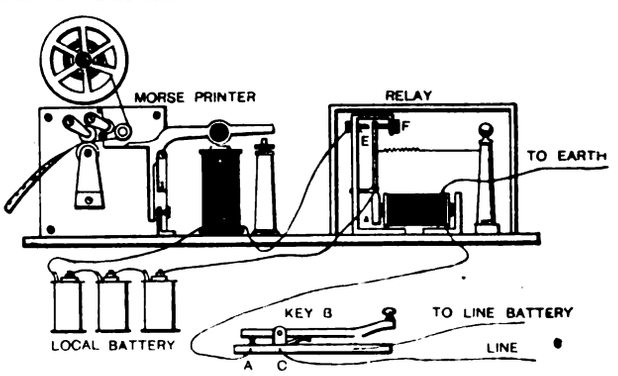


FIG 2.

The modern relay, such as that used by the Post Office, has two complete electromagnets alongside of each other, and so wound and connected that when a current is passed round their coils their opposite poles are adjacent. Two soft-iron armatures are fixed to an axle near the magnets, and play between the soft-iron pole-pieces of the magnets being kept permanently magnetised by a permanent magnet Upon the same axle is mounted a German-silver tongue which moves with the armatures already referred to, and whose longer free end makes contact with either one or other of two contact screws, according to the direction of the current in the relay coils. Imagine the electrical impulse to be received, not by the intervention of a connecting wire, but through an "aerial" or projecting piece of wire connected to a coherer or other like receiver, a relay and Morse printer being used as before, and the two systems have much in common, as a little reflection will show. The ether in the latter transmits the impulses instead of a wire or conductor, and they are usually very feeble when received, so that a special form of receiver is necessary, in order that tuning may be effected and the aid of resonance effects invoked.

The sending mechanism usually includes a spark apparatus to set up the ether waves. It will be seen that *no* telegraphy is really wireless, but that term is now in common use for systems in which *connecting* wires are dispensed with. In the latter case, the electrical impulses being very faint when received, the relay is usually modified; a single cell is placed in series with it. In ordinary circumstances the relay cannot act, as the coherer resistance overcomes the tendency of the cell to send a current round the relay electromagnet coils. When the

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impulse is received the coherer is made conducting, the balance is upset, and the cell sends its current round the relay coils, attracting an armature and closing an auxiliary circuit in which is a stronger battery sufficient to actuate the Morse instrument, where such instrument is used. The Morse dot-and-dash alphabet as used in wireless telegraphy is given below.

THE MORSE ALPHABET.

| | | | | |
|---|---|---|---|---|
| A · — | F · · — · | K — · — | P · — — · | U · · — |
| B — · · · | G — — · | L · — · · | Q — — · — | V · · · — |
| C — · — · | H · · · · | M — — | R · — · | W · — — |
| D — · · | I · · | N — · | S · · · | X — · · — |
| E · | J · — — — | O — — — | T — | Y — · — — |
| | | | | Z — — · · |

NUMERALS.

| | | |
|---|---|---|
| 1 · — — — — | 5 · · · · · | 9 — — — · |
| 2 · · — — — | 6 — · · · · | 0 — — — — — |
| 3 · · · — — | 7 — — · · · | |
| 4 · · · · — | 8 — — — — · | |

Full stop · — · — · — Call up — · — — · — —

Understood · · · — · —

*The New Plan—The Function of an Aerial.*—When an electron leaves an atom it is connected to the latter by lines

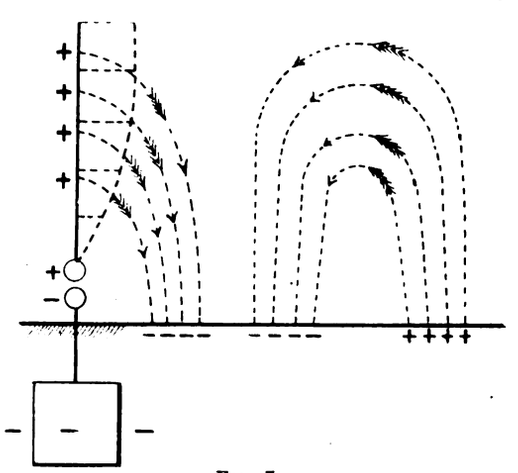

FIG. 3.

of electric strain, and hence the function of an aerial may be diagrammatically represented as in Fig. 3, where the vertical wire with spark-gap has sent off a wave, and is being again charged, the electron pressure becoming higher and higher towards the top of the aerial at the instant considered by the surging back of some of the electrons which had before been released, as well as by the entrance of those sent in by the "electron-pump." The *pressure* is greatest at the top, but the movement of the electrons (therefore the current) is greatest at the spark-gap. The magnetic flux due to the action of the aerial* would be shown by circles at right angles to the lines of strain. The action on the ether has been likened to that on the air in an organ pipe, and it has been shown that whilst in an elementary aerial with spark-gap the pressure rises gradually towards the top, as shown in Fig. 3, it is possible by the introduction of capacity and suitable alteration of the inductance of the circuit to produce overtones, so that there may be two or more points of maximum pressure in the aerial; but whilst it is easy to produce overtones in an organ pipe—in fact, it is difficult to get the fundamental note alone—the opposite is the case with the aerial, and overtones are only produced with difficulty.

Overtones may be set up by having the aerial in the form of a loop, like a tall U upside down, one side being earthed, but it is necessary that the loop be unsymmetrical, and Prof. Slaby has tried this form, in which one of the legs of the loop contained a grid consisting of several parallel or nearly parallel wires. In this way a first odd harmonic may be produced with a potential node at the lower end of each leg of the loop.

The energy stored in an aerial when charged to its maximum pressure is comparatively small. Dr. Fleming* gives the formula

$$F = \frac{3\,C\,V^2}{8 \times 10^6}, \text{ or } F = \frac{27\,C\,S^2}{8},$$

where F is the energy stored in foot-pounds; C the capacity in microfarads; V the charging voltage; and S the spark length in millimetres. Roughly, the voltage is 3,000 volts per millimetre spark. The energy stored in an ordinary aerial when the pressure is 30,000 volts is only about $\frac{1}{14}$th of a foot-pound, and this will give a signal clearly recognisable at a distance of 100 miles. If, however, we consider the number of times the aerial has to be charged and discharged in a second, we see that whilst the *energy storage* of the aerial is small a considerable *amount of power* may be necessary, especially where condensers and multiple aerials are employed.

METHODS OF SIGNALLING.

Ordinary methods of signalling, such as by waving flags, moving a semaphore arm, or flashing the sun's rays by means of a heliograph, are, of course, known to all readers. It may be stated in passing that any method in which light waves are employed to convey the signal is a species of ether-wave telegraphy. These can be used, however, only over comparatively short distances and under favourable conditions. There is no doubt that many oriental and even some savage peoples are able to convey information for considerable distances, in some unknown way, with astonishing rapidity. Many stories regarding this are related by travellers and others. One is to the effect our officers in Afghanistan were greatly puzzled as to how the intended military movements of the British could be so clearly known to the enemy in distant places so shortly after they were determined upon. Not the swiftest horses in the British lines could have covered half the distance in the given time, and a strict watch failed to detect any heliographic or beacon-light signals. The offer of bribes was ineffective—money could not purchase the secret nor could the fear of death extort it—it remains in the possession of the natives till this day. It is said that on the day on which that good man General Gordon was murdered in Khartoum the event was known in the bazaars of Cairo. This may not be true, for his murderers had probably few sympathisers in Cairo; but, if true, it is a mystery how the news travelled so quickly, seeing that there was then no railway and no telegraph to Khartoum, and even had there been a railway, a train running at 60 miles an hour would have taken something like 16 hours to accomplish the journey. It may be that the sensitive oriental nervous organisation is susceptible to etheric influences which we cannot detect, and that in this way two similarly endowed persons are affected so as to be able to emit and receive impressions more or less tangible. That this power of rapid communication is shared to some extent by the Kaffirs is shown by a recent writer (Mr. D. Blackburn on "Kaffir Telegraphy" in the *Spectator*), and the Matabele have often astonished our officers in the same way. These stories have really little interest for us to day, except to excite wonder and speculation, since modern science has furnished us with surer and swifter, if more expensive, methods. Messages have been transmitted without the intervention of a metallic conductor over 2,500 miles, and greater wonders are said to be in store for us.

In considering some of the modern methods of "telegraphing without wires," we may divide them into three classes—I., earth conduction; II., induction; and III., ether-wave systems.

*(To be continued.)*

## THE CURTIS STEAM-TURBINE.

The following facts about this turbine, introduced into this country by the British Thomson-Houston Company, are taken from an interesting paper read before the Rugby Engineering Society last year by Mr. F. Samuelson. They are worthy of noting, and show not only the details of the

* Cantor lectures on "Hertz Wave Telegraphy," March, 1903.

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turbine, but also the results obtained on the one in the power-house at Rugby.

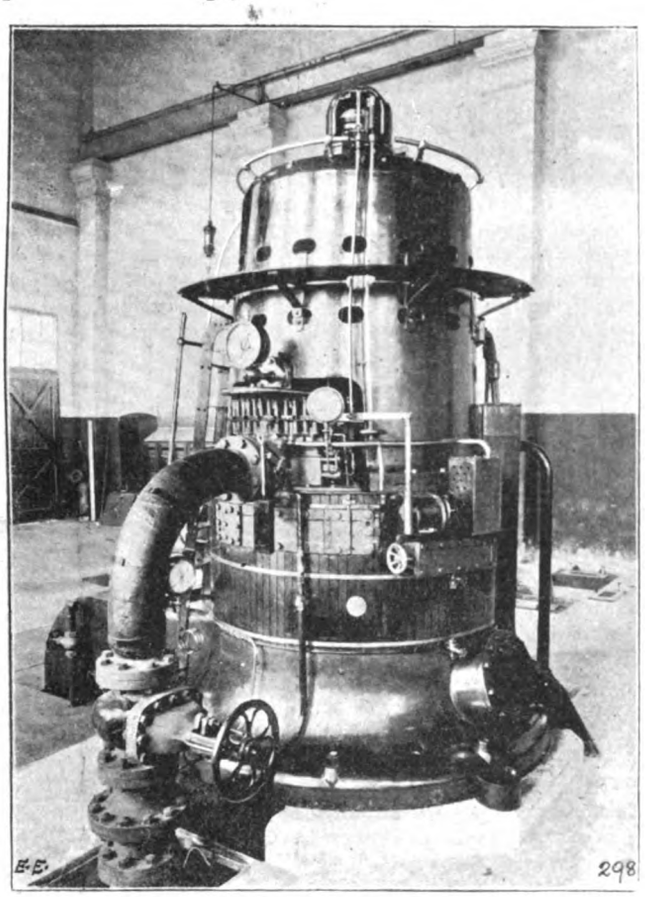


FIG. 1.—View of a 500-kw. Curtis Steam Turbine.

The general features of the Curtis turbine may be briefly described as follows: Velocity is imparted to the steam in an expanding nozzle so designed as to effectively convert into kinetic energy the expansive force of the steam between the pressure limits used. After leaving the nozzle, the steam passes successively through two or more lines of buckets on the moving element, which are placed alternately with reversed buckets on the stationary part of the turbine. Thus, the steam is thrown first against the first set of buckets on the moving element, and then re-directed against the second moving set of buckets by passing through the first set of the fixed buckets, rebounding alternately from stationary to movable buckets, until the steam is brought to rest. By this means a high steam velocity is made to efficiently impart motion to a comparatively slowly moving element. The nozzle is generally made up of many sections or units adjacent to each other, so that the steam passes to the buckets in a broad belt when all the sections are open. This process of expansion in the nozzle and subsequent abstraction of velocity by successive impacts with the buckets is generally repeated two or more times, the device for each repetition being generally designated as a stage. There are various numbers of stages and various numbers of lines of buckets in each stage. The number of stages and the number of lines of buckets in each stage are governed by the degree of expansion, the peripheral velocity of the buckets which is desirable or practicable, and by various conditions of mechanical expediency. A steam-tight diaphragm is placed between each stage, the only outlet for the steam passing to the next stage being through the nozzles in the diaphragm. The leakages in the buckets are, therefore, not total losses, except in the last stage, as the steam has to pass through the nozzles in the succeeding diaphragm and do further work.

One of the boldest and most noticeable features in the Curtis turbine is the vertical shaft. This type of construction has been adopted for all sizes from 500 kw. upwards, and experience has thoroughly justified its use and demonstrated its desirability. The use of a vertical shaft necessitates a foot-step bearing, which is fixed to the bottom of the base and removable from below, a pit or opening being provided in the foundation for this purpose. The bearing part proper which supports the rotating elements of the turbine and generator consists of two circular cast-iron plates, one being fixed to and rotating with the shaft, the other is fixed to the base. Though a hole in the stationary plate oil is forced between the plates from centre outwards in a

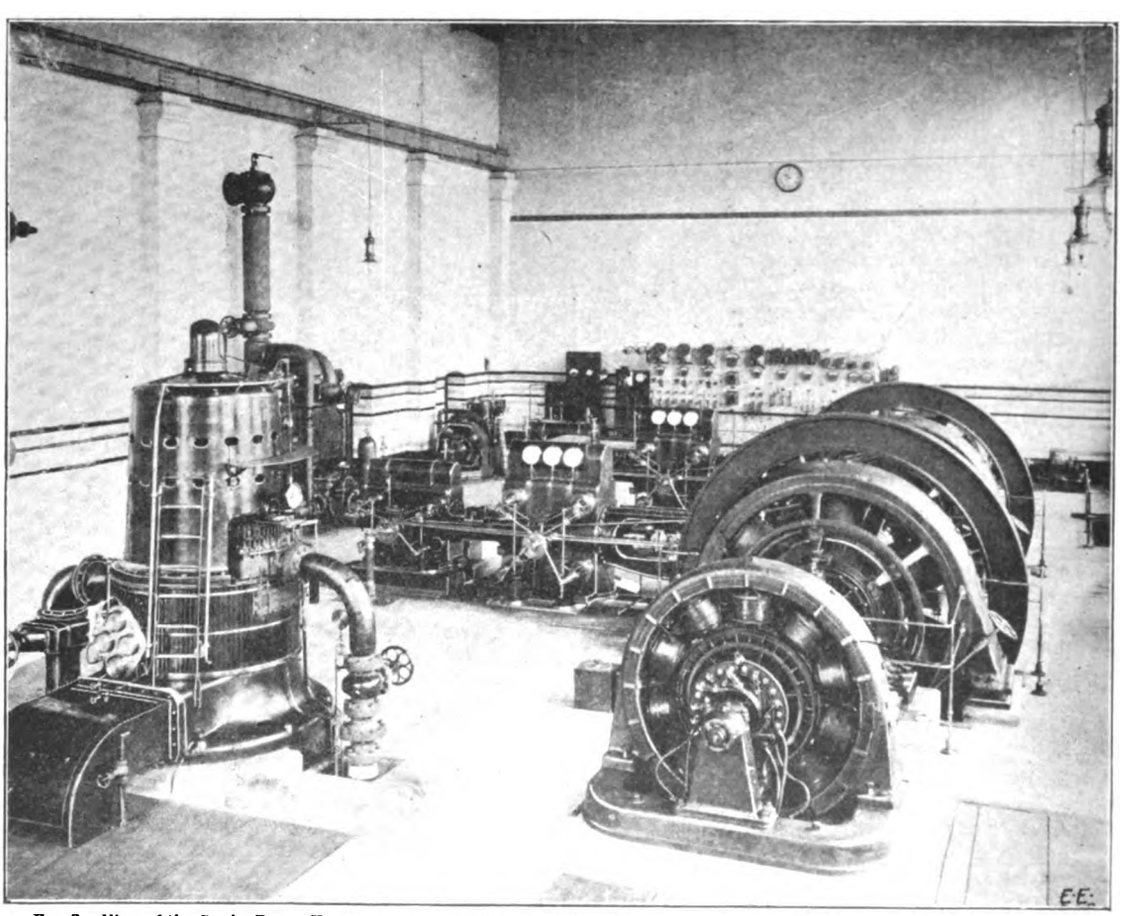


FIG. 2.—View of the Rugby Power House, showing a 500-kw. Curtis Turbine, which is equal in capacity to the three reciprocating sets.

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thin film separating the two plates, and taking the weight of the revolving parts. The 500-kw. turbine has three wheels or rows of movable buckets in each of the two stages. Each wheel consists of a solid steel disc with the buckets cut from the solid rim, and the three wheels are bolted to a common hub which fits the shaft. The total number of buckets on the wheels in this turbine are 1,395, a small number compared with other turbines. The stationary buckets have approximately the same shape as the wheel buckets, and are fixed to the casing of the turbine. The number of stationary buckets is dependent on the number of nozzles in the stage, as they need only cover the same periphery of the wheels as the nozzles do. On account of the large increase in volume of the steam, and to keep the depth of the buckets as small as possible,

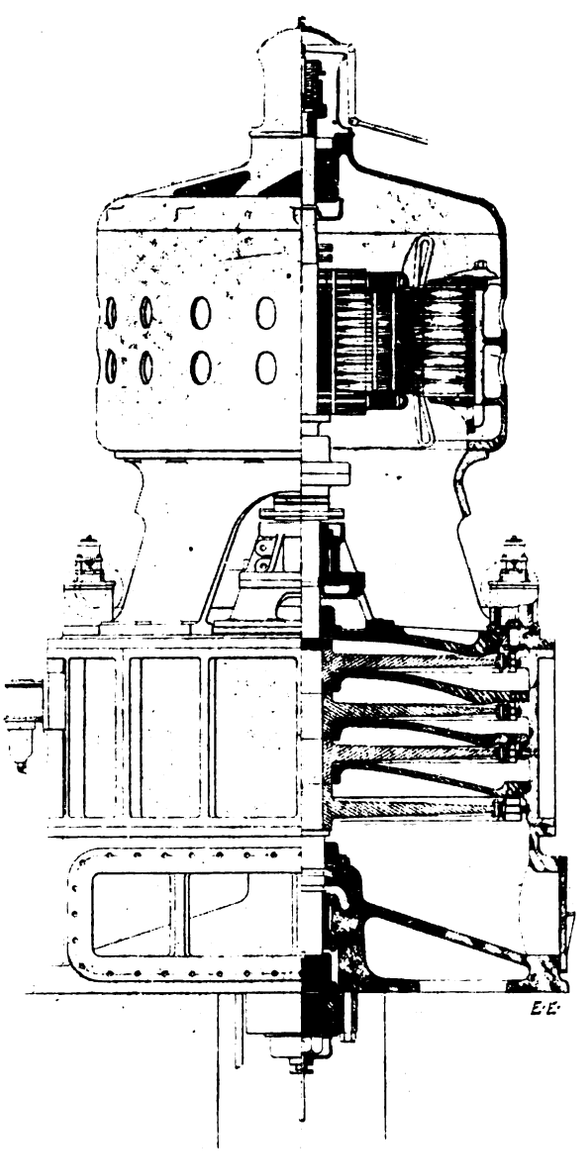


FIG 3. Section of the Curtis Turbine, showing Details.

the last stage wheels are completely surrounded by nozzles and stationary buckets.

In the later designs of the turbine, the construction of the wheels has been modified. Instead of using separate discs bolted together, a single cast-steel wheel is used with the bucket rings or segments bolted to the sides at the periphery of the wheel. The clearances between staticnary and rotating parts vary from ·02in. in the small to ·08in in the 5,000-kw. turbine. These are the clearances between the outer shrouding of the buckets and the rings of metal from which the buckets are cut, presenting broad smooth surfaces to one another. The buckets are made a little narrower than the rings, so that they cannot possibly come into contact with each other. Adjustment of the clearance is made by means of a heavy screw bolt at the bottom of the step bearing, which supports the foot-step blocks. Inspection holes are provided in the casing, so that the clearances between the buckets can be readily seen.

The governor is of the centrifugal spring loaded type, and is generally set for a speed regulation of 2 per cent. between full and no load with a maximum momentary variation of 4 per cent. For the purpose of synchronising, and to make the turbine take its proportional share of the load, a supplementary spring is introduced which acts in conjunction with the main governor spring and allows the speed of the turbine to be varied 2½ per cent. on each side of the normal speed. In the smaller turbines this adjustment is made by hand, a wheel being placed in a convenient position near to the main throttle valve. In the larger turbines, from 1,500 kw. and upwards, a small motor actuates this spring. The motor is controlled by a double-pole double-throw switch placed on the switchboard or at any other convenient position. The governor operates a controller opening or closing the electrical circuits of magnets which operate pilot valves, these in turn admitting steam or exhausting it from the spaces behind the pistons of the main valves, one of which is provided for each nozzle or group of nozzles, the governor thus opening and closing these valves and varying the number of nozzles in service in proportion to the load.

Since each nozzle represents a comparatively large proportion of the whole power at light loads, one of these valves would be called upon to open and close alternately

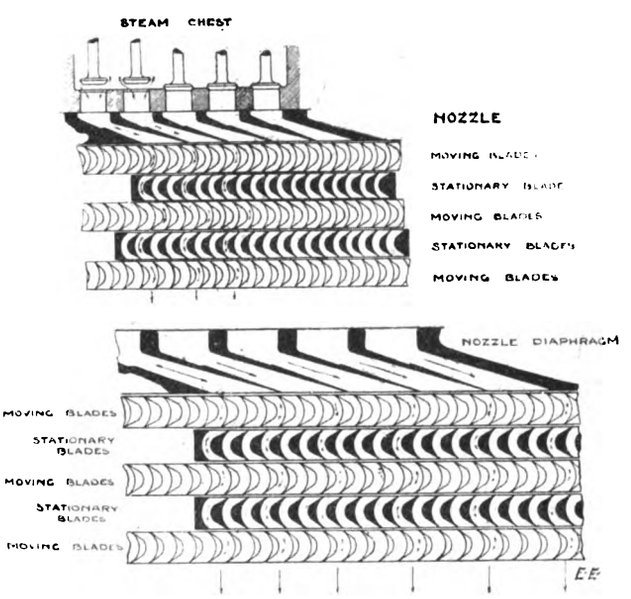


FIG. 4.—Diagram of Arrangement of Nozzles and Buckets.

in rapid succession in order to hold the speed constant. To avoid this, a balanced throttle valve is placed in series in the steam path of the first valve and corresponding nozzle, and so connected to the governor that it must be fully opened before the governor can open the next valve, and again fully closed before the controller moves backwards and closes the valve last opened. The result is that the turbine can run at a constant speed on any load, although only a small part of the whole steam flow is throttled. Thus the disadvantages of admitting steam in puffs, with the consequent tendencies to variation in speed at light loads, making the parallel running of the generators difficult, or of throttling the whole steam flow, are avoided. In the process of governing, the nozzles in the later stages are also in some of the turbines opened and closed, so as to maintain an adjustment of pressures proportional to that of the first stage, which is always the primary source of governing. A sufficient number of nozzles are provided in the first stage to run the turbine at full load non-condensing. Hence the turbine has an overload capacity of about 100 per cent. when operating condensing with a 28in. vacuum. In addition to the speed-regulating governor, which will always hold the no-load speed of the turbines within about 2 per cent. of the full-load speed, an emergency governor is provided, whose function is to trip a trigger should the speed of the turbine increase 15 per cent. above normal, and thus permit a weight to fall and give a hammer blow to a butterfly or damper valve in the main steam-pipe, closing the valve

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instantaneously. This governor is located on the shaft, between the turbine and the generator, and consists of an ordinary centrifugal device balanced against a spring.

Fig. 5 shows the effect of different expansions or vacua upon the steam consumption. The curve is plotted from tests made on a 500-kw. turbo-generator in the British Thomson-Houston Company's power-house referred to above, and

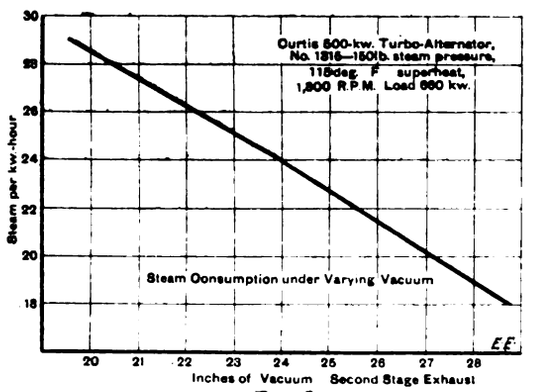


FIG. 5.

shows very clearly the enormous gain in economy with a high vacuum. No difficulties were encountered in obtaining a high vacuum. The outfit consists of an ordinary horizontal surface condenser with a cooling surface of 1,500 square feet, a twin Edwards air-pump, and a centrifugal pump for the circulating water. The pumps are motor driven,

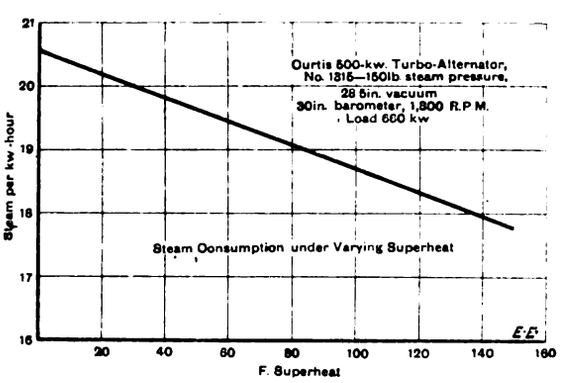


FIG. 6

and the power taken by the air pumps was 1·8 kw., and by the circulating pump 7·1 kw., at a load of 470 kw., representing 1·9 per cent. of the output of the turbine. The effect of superheat is shown in Fig. 6, and was obtained from tests carried out on the same turbine. With the conditions prevailing then it was impossible to get a higher

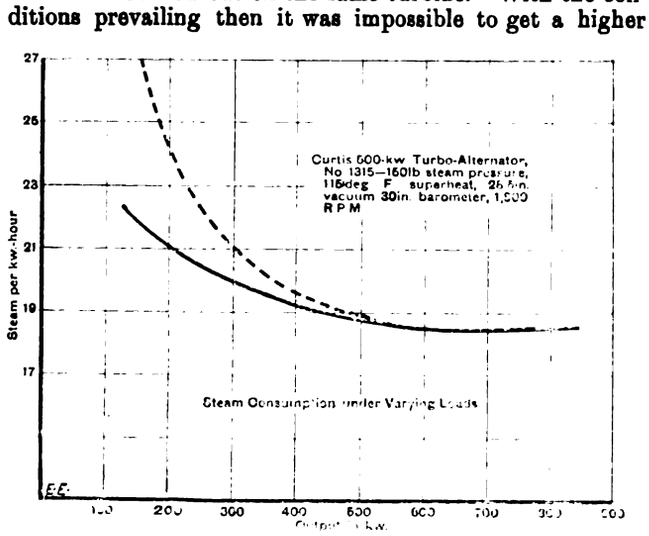


FIG. 7.

superheated steam for the turbine, but from tests made elsewhere on a Curtis turbine of the same output, the tendencies of the curve are shown to continue to about 300deg. F. superheat. Superheating improves the real thermal efficiency, or in other words, reduces the coal bill. The probable reasons are the increased steam volume, and that, the steam being less wet after the expansion, the friction in the buckets is considerably reduced.

Fig. 7 shows a curve plotted giving the steam consumption for different loads. To obtain a steady load on the generator, water resistance boxes were made use of, and careful readings of all instruments were made every sixth minute. The condensed steam was delivered alternately to two tanks and weighed at six minutes' intervals. All by-passes were disconnected and all precautions taken to obtain absolutely reliable results, and the tests with different loads were repeated. The flatness of this load curve is at once apparent, and compares very favourably with similar curves obtained from reciprocating engines and other turbines. At the normal full load rating of 500 kw. the difference in steam consumption between full and half load is 1¾lb. per kilowatt-hour, and between full and quarter load is 3½lb. The 500 kw. rating for this turbine is, moreover, a very conservative one, and it could well be rated as 750 kw.—that is, drive a 750-kw. generator. In that case the load points would be located lower on the curve, and the difference in steam consumption still better, being between full and half load only 1lb., and between full and quarter load 2·9lb. The dotted curve line represents relatively the average steam consumption from a number of first-class reciprocating engines of approximately the same rating as the turbine and assuming the full-load steam consumption to be the same for both. This comparison is very instructive, and shows how much more economical the turbine is on varying loads.

Mr. Samuelson concluded his paper by pointing out the advantages of the Curtis turbine. A special point is that of the very small floor space occupied. Thus in Fig. 2 the capacity of the turbine is equal to that of the two generators shown, and one further in the background, so that the entire reciprocating engine sets have only the capacity of the small turbine, and yet they occupy a very much larger amount of floor space.

## ELECTRICAL FURNACES.

At a meeting of the Metallurgical Society, held in the Birmingham Municipal Technical School on Saturday, Feb. 13, 1904, the president, Mr. A. H. Hiorns, in the chair, Mr. J. H. Slansbie, B.Sc., F.I.C., etc., gave a paper on "Electrical Furnaces." The lecturer drew attention to the difference between furnaces where the electrolytic action of the current is used in addition to its heating effects, and those in which the heat due to the current alone is employed. For examples, Sir Humphrey Davy's classic experiment by which he obtained sodium was described, also the Cowles, Siemens, and other leading types of electrical furnaces. Fig. 1 is a sketch of the experimental furnace constructed by the author for the purposes of this paper. It consists of blocks of fireclay bolted together; the top is provided with a hole to allow fumes to escape, and also to enable a picture of the interior of the furnace to be projected on a screen by means of the lenses and mirror. The coil of wire surrounding the furnace has for its object the drawing of the arc down into the crucible. It does this by virtue of the well-known fact that adjacent conductors carrying currents in a like direction are attracted to one another. The arrow shows direction of current flow in the surrounding coil, and it is seen by arrow heads that the current passing through the arc goes in a like direction. By adjusting the resistance in the circuit of this coil the arc may be deflected as desired. The side elevation shows how the top of coil was divided so that the rays could pass to the collecting lens. Both the resistances used were lead plates in a dilute solution of sulphuric acid. Some nails and tacks were placed in the crucible, and the projected image on the screen informed the audience that these were at once melted. Copper was also melted, and gave a fine colour effect on the screen. The lecturer handed round some chromium oxide ($Cr_2O_3$); this he made into a globular mass with treacle and water. Some of this mixture was then placed in a carbon crucible along with a quantity of powdered carbon, and the current

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switched on to the furnace. In a very short time the oxide was reduced, and the rare metal chromium obtained. The chemical reaction for this is given by the equation: $Cr_2O_3 + 3C = 2Cr + 3CO$ The lecturer gave a short explanation of electrical units, and pointed out that the energy of the arc was represented by the readings of the instruments — 80 volts, 100 amperes. Speaking roughly, this meant that work was being done in the crucible at the rate of about 11 h.p.

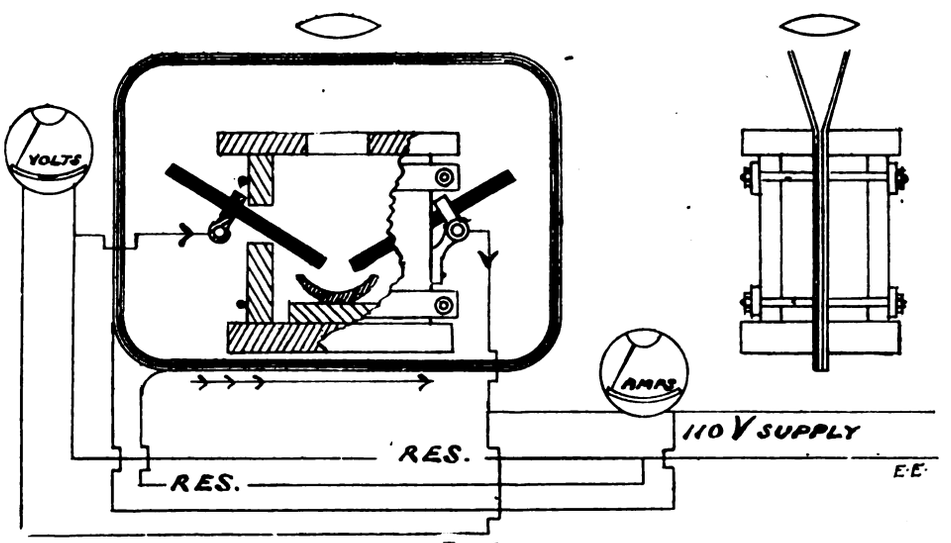


FIG. 1.

Fig. 2 is an arrangement by which several beautiful experiments were shown. The sides are hinged, and by means of the helical spring may be drawn together. Thus the carbon electrodes can be adjusted to any required pressure: if too slack, arcing takes place; if too tight, delicate articles would be crushed. Two carbon electrodes were placed in this apparatus (Fig. 3 is a section), having a carbon tube supported in the countersunk recesses. This tube was ¾in. long and ⅜in. outside diameter. The interior was filled with a mixture of alumina and carbon. With the instruments showing 90 volts and 60 amperes the small tube soon became regularly heated to a bright yellow. This was kept up for five minutes. When taken out the tube contained a certain amount of aluminium. The reaction is $Al_2O_3 + 3C = 2Al + 3CO$.

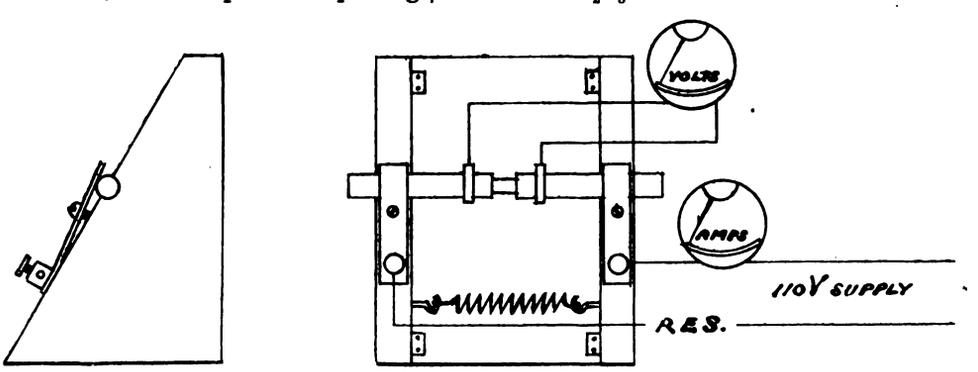


FIG. 2.

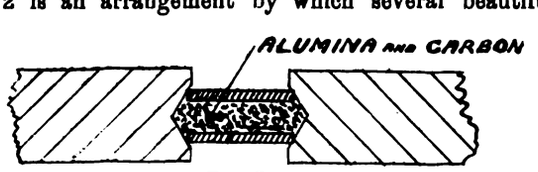


FIG. 3.

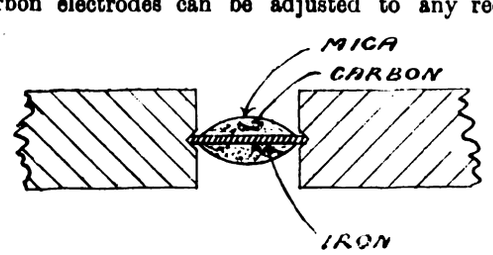


FIG. 4.

Another experiment, first performed many years ago by Pepys, is illustrated in Fig. 4. A flat piece of iron, round which a quantity of powdered charcoal was kept by a mica wrap, was placed between two carbon electrodes. After the current had passed for a few minutes the iron was turned into blister steel. Micrographic slides were then shown by the optical lantern illustrating the crystalline structure before and after the process. All the carbon electrodes employed by the lecturer were heavily plated with copper for nearly their whole length. Thus losses by resistance and faulty contacts were reduced to a minimum.

After the demonstration members had the opportunity of examining the apparatus and trying for themselves several of the experiments performed by the lecturer. A good discussion followed the paper.

## THE AUTOMOBILE SHOW.

The increase in the self-propelled vehicles in this country is indicated by the number of exhibits at the Crystal Palace Automobile Show, which is now in full swing, and is the largest show of the kind held up to the present in this country. The 270 exhibitors tax even the large amount of space available in the Crystal Palace. Thus the exhibits this year cover 130,000 square feet of space as against 87,000 square feet in last year's show. We are pleased to see that British-made cars are so largely on the

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increase, and that in accessories also the home industries are making exceedingly rapid strides. Any notice of a show of this magnitude in our columns is apt to become a mere catalogue of the large variety of electrical cars and accessories, as, owing to the space at our disposal, we cannot go fully into or even mention each individual exhibit. Such an examination will, however, repay any electrical engineer interested in motorcar work.

The first point with which we propose to deal is that of the ignition arrangements. The electric ignition has now practically superseded the tube ignition, and the question before motorcar manufacturers is rather as to how far magneto ignition will supersede electric sparks obtained from induction coils supplied from storage batteries. The history of the development of magnetic ignition is practically shown on Stands Nos. 149 and 150 of the Simms Manufacturing Company. Here are seen examples of both the high and low tension systems of ignition. In the earlier forms the Simms-Bosch magneto was used with an oscillating H armature, but this has now been replaced by an armature revolving continuously. With the low-tension type the electric circuit is interrupted between two contacts within the cylinder, and the resultant spark fires the charge.

With the more recently introduced high-tension magneto the armature is rotated at one-half the speed of the engine. A sufficiently high voltage is obtained to enable a spark plug to be used, which avoids the introduction of moving contacts into the cylinder. All the difficulties of obtaining sufficient energy in the spark to ignite the charge when starting up at slow speeds have been overcome. The construction of the four-cylinder Simms-Bosch magneto is well worthy of a close inspection. The contact maker connects the armature conductor to each of the four cylinders in turn, and on breaking connection the spark passes. The return, as in all these systems, is made through the engine frame. The same firm also exhibit their new "S. B." high-tension ignition plugs, in which soapstone insulation is used. The life of these plugs is remarkable.

Another high-tension magneto of interest is to be seen on the cars of the Duryea Company at Stands Nos. 190 and 191. The engines for these cars are manufactured by Messrs. Willans and Robinson, Limited, of Rugby. The magneto in question is of the Dawson type, and its special feature is the arrangement by which the magneto armature is driven by a series of jerks at low speeds. Instead of directly coupling this armature on to the chain wheel which is driven from the engine, a clutch is introduced which makes the rotation of the armature variable at low speeds, whereas at high speeds there is no such periodic vibration in the rotation. The clutch acts in such a way as to give a sudden jerk forward of an eighth of a revolution at the instant when the spark for firing is required. In this way the inventor obtains the high voltage when required for firing even at low speeds. We find, however, that he employs a transformer to increase the voltage. The distribution to the various cylinders is carried out on the high-tension side of the transformer. The Eisemann high-tension magneto is exhibited on Stand 254 by G. T. Riches and Co.

The accumulators exhibited for motorcar work are most numerous, and one meets with several examples of cells which have proved their value under years of trial. So far, however, the accumulator which will do without recharging has not been invented, but there are a number of makes which have proved capable of withstanding the exceedingly severe usage to which such accumulators are frequently subjected by car drivers. The following firms are deserving of special mention: The lithanode electrical storage batteries on Stand 197, exhibited by Longstreets, Limited, are intended for both traction purposes and also for ignition. The ignition type has recently been considerably improved, and the arrangements for obviating any spilling of the acid or leakage are good. The firm also show a new terminal insulator which prevents the creeping of acid and the corrosion which is so frequently found at the positive terminals.

The N.S. Storage Company have on exhibit their type of solid cells on Stand 34 in the south wing corridor. The construction of these and their light weight for a given capacity render them specially suitable for motorcar work. Messrs. Peto and Radford, on Stand 146, have a large collection of electrical accessories. Their armoured accumulators are of a specially strong type for motorcar work, and they also show a type in which a semi-solid electrolyte is used. The firm have also on view what they term their "Energy" battery, which is practically a combination of a primary and secondary battery. In this a single negative plate, in the form of a lead envelope, is used between two positive plates. As a result of the low capacity of the negatives, the battery, while it can be charged as an accumulator, cannot discharge to any large extent, as its voltage falls almost to zero after an hour's discharge. In order to get the rest of the energy out of the positive plate, cadmium pellets are dropped into the pocket formed by the negative plate. It is claimed that the cells can stand for a long time without waste, and that there is no loss so long as the cadmium is removed. Over a thousand miles can be negotiated on a single charge. Some experiments on this cell as to the actual cost of producing electrical energy would be of great interest. The firm also show a neat form of magneto speed indicator.

Induction coils of many shapes and sizes are to be seen on a large number of exhibits. Electrical engineers should pay a visit to Stands 188 and 189, where Messrs. Willson and Pilcher, Limited, show their single-trembler multiple-way induction coils. The exhibit is well arranged, and shows many neat devices for quickly testing the various details of this type of electric ignition. The firm supply one equipment with two tremblers, which can be used alternately at will. Their apparatus for testing the sparking in each cylinder of a four-cylinder engine is interesting.

On Stand 146 Messrs. Gilbert Gilkes and Co., of Kendal, show a neat little water motor direct-coupled on to the dynamo for charging ignition accumulators. The combined set occupies exceedingly little space, and can be driven by means of water from the mains. The Hector water motor used is designed for water pressures from 40lb. upwards. The whole apparatus, including water motor, dynamo, and ammeter and voltmeter, is exceedingly reasonable in price.

Other exhibitors, such as J. G. Statter and Co., exhibit small dynamos and direct current transformers for reducing the ordinary supply pressure to that required for charging these ignition cells—*i.e.*, from five to six volts. This arrangement is much more economical than the too frequently adopted method of connecting the cells across the supply main in series with a high resistance.

Electric vehicles are exhibited by a large number of firms, and a general tendency to higher types of framing which enable weight to be saved is evident. The Vehicle Equipment Company on Stand 223 show a considerable number of electric carriages for private and trade purposes. This New York firm have as their English agents the Anglo-American Motorcar Company and the Olds Mobile Company. On certain of their trade lorries they fix an electric hoist, which is of great service when delivering heavy goods. For instance, one of these vehicles used by a safe company is convenient not only for delivering the safe, but also for hoisting it up to the floor of the building on which it is to be placed. On Stand 61 the London Electric Mobile Syndicate exhibit a doctor's brougham and two other cars. By careful design they have kept down the weight of the brougham to 18cwt., of which 6cwt. is accounted for in the storage batteries. These are of the Hart Accumulator Company's make, and 42 cells are employed. The battery is worked in two halves with series-parallel control. A single motor drives the two rear wheels through differential gearing. The controller also is arranged for magnetic braking. This firm claim that their vehicles will run 40 miles on a single charge.

It is quite interesting to an electrical engineer going through the show to see how many electrical firms have gone in for motorcar manufacture. Thus at the Crystal Palace one notices the Langdon-Davies Electrical Company, the Brush Electrical Engineering Company, the Sir W. E. Armstrong Whitworth Company, etc. We trust that in these days of keen competition the firms in question will do well in their motorcar departments. We have done no more than indicate a very few interesting exhibits, and trust that our London readers will visit the show for themselves, as a few spare hours could not be better spent. The exhibition remains open until the 24th inst.

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## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

663. How long should a 500-h.p. Lancashire, also a 350-h.p. Babcock and Wilcox boiler, take to run up to full pressure from cold? State how you would calculate the various strains to which they are subjected.—ARC.

664. Describe an automatic switch which will "switch in" extra transformers when the load on the main rises beyond a predetermined point, and "switch out" again when the load falls below that point.—R. H.

### ANSWERS.

*Question No.* 655.—A polyphase motor when driven at a slightly higher speed than synchronism, and paralleled with a synchronous machine, become a generator. Unlike a synchronous generator, it is not self exciting; also its speed must be increased to maintain the frequency on increased load. Explain thoroughly the action of such a machine.

*Best Answer to No.* 655 (*awarded* 10*s.*).—The action of all induction motors depends on the production of a rotating magnetic flux by means of the stator windings, and the cutting of this flux at a greater or less speed by the rotor conductors. The speed of the rotating flux depends simply on the periodicity of the supply and the number of poles into which the motor winding is divided, one pole being travelled over during half a period of the supply voltage. When such a motor is running light, its speed is practically synchronous—*i.e*, the speed of the rotor is practically the same as that of the rotating field. As the load on the motor increases the speed of the rotor falls, in order that a greater difference of speed between the rotating field and the rotor conductors may be obtained. This allows a greater E.M.F. to be induced in the rotor winding, giving rise to the increased currents for developing the increased torque.

Now, if the stator is left connected to the supply mains, and the speed of the rotor (in the same direction as before) is increased by mechanical means above that of the rotating field, currents of reversed direction will be induced in the rotor windings—*i.e.*, rotor conductors passing through a north pole of the stator field will have E.M.F.'s induced in them in the opposite direction from those induced in the same position when running below synchronism. The effect on the rotor currents is, in fact, much the same as would result from a reversal of the direction of rotation of an ordinary alternator. This reversed rotor current calls forth a corresponding reversed stator current, just as in the case of a transformer loading the secondary produces a current in the primary, giving an approximately equal number of ampere-turns oppositely directed. When acting as a motor the working current input, as distinguished from the wattless current, is in phase with the stator supply voltage, and in direct opposition to the stator back voltage. When the machine is driven mechanically above synchronism, and the stator current is reversed as described, this current becomes directly opposed in phase to the terminal voltage, and is in phase with what was the back voltage of the motor. In other words, the machine has become a generator, and the stator is delivering current to the circuit under the action of what was the back voltage instead of taking current from the circuit under the action of the supply voltage. The effect of speed change in such a generator is peculiar. It has no effect on the frequency, but a decided effect on the amount of current delivered by the machine, and it is on this account that the speed has to be raised as the load taken from the machine increases. As the speed increases, the rotor cuts the flux at a greater rate, and the rotor current rises and tends to increase the stator current. If the external resistance (lamps, etc.) is constant, this increase in stator current cannot occur, as the voltage of the machine cannot increase above that of the 'bus bars, consequently a greater wattless current is drawn from the 'bus bars into the stator until the resultant of stator and rotor currents again equals the magnetising current necessary to produce the correct stator terminal voltage.

When several generators are running in parallel on the same 'bus bars, the effect of small speed changes is to transfer the load more or less from the lower-speed machines to the higher-speed ones, the action being to a certain extent self-righting, as in the case of continuous-current machines in parallel. The governers of engines driving alternators of this type should have a definite maximum speed limit beyond which the engine is never allowed to rise, for above a certain critical speed (about 20 to 30 per cent. above synchronism) the output of the generator and the torque required from the engine commence to fall off again, owing to the leakage set up by the heavy rotor and stator currents, just as in the case of an induction motor, the maximum torque is attained with a certain slip and falls off again with any further drop in speed. The way in which the torque developed as a motor and absorbed as a generator varies with the speed is shown in Fig. 1. The

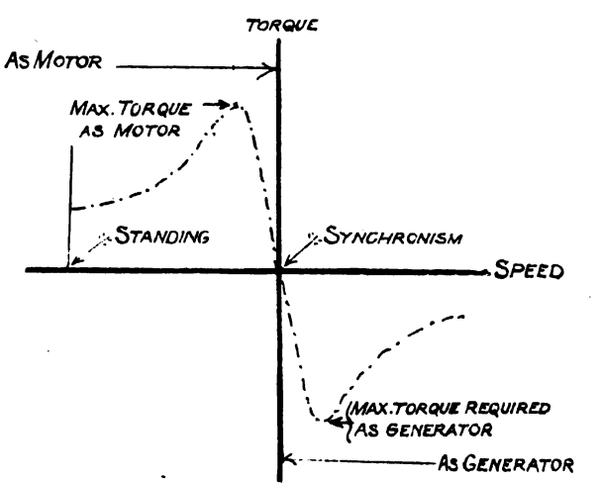


FIG. 1.

exact speed at which the maximum torque is reached, and also the exact speed at which the generator should be run when developing full load, depends on the resistance of the rotor windings, just as the slip in an induction motor does. A high-resistance rotor will have to be raised more above synchronous speed than a low-resistance one in order to obtain a given output from the machine. The frequency of such alternators is decided entirely by the frequency of the 'bus bars, and this latter is maintained at the required value by always keeping at least one ordinary synchronous alternator of the right frequency connected to the 'bus bars, to act as a sort of pacemaker. The size of this synchronous generator must be sufficient to supply the wattless magnetising currents of all the asynchronous generators connected to the 'bus bars.

Although, as stated in the question, ordinary induction motors used as generators are not self-exciting, but depend on a synchronous machine connected to the same 'bus bars for their exciting current, yet a special type of asynchronous generator has been patented by Mr. Heyland, which is self-exciting at least when given a small initial excitation by continuous current to start the action. In this machine the rotor winding is connected to a small commutator whose segments are connected together by resistances. The brushes bearing on this commutator are connected to the stator supply volts either directly or through a transformer, and serve to convey the exciting currents direct into the rotor windings instead of into the stator windings as usual. These machines do not require to be run in parallel with a synchronous generator, as they maintain their excitation and, approximately, their frequency unaided.—Q.

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*Answer to No.* 655 (*awarded* 7*s.* 6*d.*).—"J. G." asks for an explanation of the action of a polyphase induction motor as a generator when driven above the speed of synchronism, this speed of synchronism being fixed by a synchronous alternator in parallel with the induction motor, which is being used as a generator, or even by a synchronous motor only driven by the induction machine, provided the synchronous motor has been started by some other machine. That this phenomenon is considered remarkable is a proof that the explanation is not obvious. It is fairly easy to see that a driving torque must be exerted upon the rotor of such a machine as we are speaking of in order to make it run at a speed above synchronism—that is to say, if the rotating field is already provided by currents supplied from outside to the stator, it is obvious that to make the rotor revolve faster than this rotating field a positive driving torque must be exerted upon it, since the relative motion of field and rotor winding generates currents which produce forces tending to reduce the relative motion, according to the well-known law enunciated by Lenz.

But it is not so easy to see how it is that the mechanical work put into the rotor, to thus drive it above synchronism, can be converted into electrical energy delivered to the system to which the stator windings are connected, in the form of current at exactly the same frequency as is already in existence on the system. Let us, therefore, attack the problem by splitting it up as much as possible, and taking the parts separately, for this is almost always good strategy; and if we thus succeed in understanding the action of the machine the answer to the latter part of the question, as to the necessity of increasing the speed as the load increases, for the frequency to remain constant, will be included as a part only of the complete explanation.

Let us first of all suppose the machine to be running, the stator excited by a polyphase generator so as to produce a uniformly rotating field of constant strength, and let us suppose the rotor to be driven mechanically by a engine, at precisely the same speed as the rotating field, so that the windings of the rotor do not cut any magnetic lines of force, and the magnetism in the iron of the rotor remains unchanged. Under these circumstances there will be no power required from the engine except in overcoming friction of the bearings and windage, and the stator winding will have in it currents just sufficient to produce the magnetisation—that is, in each phase of the supply there will be a current, largely wattless, the only energy required being that to make up the hysteresis loss in the stator, and the very small loss due to slight heating of the winding; the current, in fact, will be of just the same character as the magnetising current of a transformer.

Secondly, suppose a second independent winding exactly similar to the first stator winding in the same slots, supposing still that the rotor is being driven in synchronism, this second winding will act just as the secondary of a transformer; in fact, it is the secondary of a transformer of which the first winding is the primary, and it may be loaded accordingly, any current delivered by this secondary being supplied by an equal and opposite current in the primary winding, in addition to the lagging magnetising current it was already carrying, so that the polyphase synchronous generator connected to the first synchronous winding is now really supplying current to a loaded transformer, and this current has to be supplied against a back E.M.F. due to the cutting of the stator windings by the rotating field.

Now let us suppose the speed of the rotor to be increased. Its windings now begin to cut magnetic lines of force, and a little consideration will show that the E M.F. thus induced will be in just the opposite direction to the back E.M.F. in the stator winding (considering adjacent portions of rotor and stator), for since the rotor is travelling faster than the field the relative rotational motion between the rotor windings and the field is in the opposite direction from the relative motion between the revolving field and the stationary stator windings, hence the currents induced in the rotor are in the same direction as the power currents in the first stator winding, and have just the same effect on the second stator winding; in fact, they do away with the necessity for the power currents in the first winding, which they therefore in effect displace. As the speed of the rotor increases, this displacement becomes more complete, until at last there is no current but the magnetising current in the first stator winding. Let us now suppose the rotor speed to be still further increased. What will happen to the polyphase generator? It will be *receiving* instead of *giving* power, and can be disconnected from its engine, as it will now continue to run as a motor. It must, however, still continue to supply the magnetising current to the stator of the induction motor used as generator, so that it is really receiving currents which in the stator are equal and opposite to the portion of the rotor current producing them (always considering adjacent parts of rotor and stator), less the magnetising currents.

It is fairly obvious now that nothing will happen if the two stator windings are combined, since they are under identical conditions—in fact, they were only devised as an aid to the reasoning, and are, of course, not in any way required in duplicate. We see, however, that there must be a synchronous machine somewhere on the system to fix the frequency, since the frequency depends upon that of the magnetising current, and this magnetising current must be produced by a *back* E.M.F —that is, an E M F. which is not in any way produced in the generator itself, and hence this novel generator cannot be self-exciting. As was anticipated, if the foregoing is clear, the reason for increase of speed for increase of load is now easily understood, because the currents generated in the rotor depend upon the excess of rotor speed over synchronous speed, and the currents induced in the stator winding are proportional to the currents in the rotor winding.

It has been attempted to make the explanation as simple as possible, and hence certain assumptions have been made as to uniformity of rotating flux, etc., and certain points have been neglected, such as magnetic leakage in the machine, but these points do not invalidate the argument.—SUPERHEAT.

*Question No.* 656.—Compare the use of gas-engine plant run by producer or Mond gas with a steam plant. Capacity about 250 kw., ordinary lighting station. Consider (*a*) capital cost; (*b*) running cost, including repairs and labour; (*c*) reliability of working, and possible nuisance from gas-engines. Coal about 21*s.* per ton for Welsh; good engine slack not available at a reasonable price.

*Best Answer to No.* 656 (*awarded* 10*s.*).—(*a*) *Capital Cost.* There being no idea given of maximum or minimum load, so as to economically select sizes of plant, it is assumed that two 125-kw. direct-coupled sets will be installed, and figures are worked out on a kilowatt basis. Steam: two 125-kw. steam dynamos, two boilers (300lb. steam per hour), economisers, pumps, condensers, piping, tanks, and buildings, at £14 per kilowatt, £3,500. Gas: two 125-kw. gas-driven sets at £7 per kilowatt, producers, washers, blowers, pumps, boiler, and buildings at £5 per kilowatt, £5,500. These figures are correct for estimating purposes, the steam prices being an average of many similar stations. The prices for gas plant are given by good authorities, and generally accepted as correct.

(*b*) *Running Costs.*—Steam: Working on an evaporation of 8lb. of steam per pound of coal, and engines consuming 32lb. of steam per kilowatt, or 4lb. of coal per kilowatt-hour, including auxiliaries. Cost per kilowatt-hour or Board of Trade unit—coal, 4lb. at 21*s.* per ton, ·45d.; oil, waste, water, and stores, ·25d.; wages, repairs, and maintenance, ·86d.—total works cost per Board of Trade unit, 1·56d. Gas: For a gas-engine of 200 i.h p. the consumption of gas should be 120 cubic feet per kilowatt-hour. Mond producers will generate about 60 cubic feet of gas for every pound of slack. It is stated in question that slack is not available at a reasonable price, but it is assumed that it can be bought at 12*s.* per ton. This price is excessive, but would be cheaper than buying and then crushing large coal. Cost per kilowatt-hour or Board of Trade unit: coal, 2lb. at 12*s.* per ton, ·13d.; oil, waste, water, and stores, ·25d.; wages, repairs, and maintenance, ·86d.—total works cost per Board of Trade unit, 1 24d. This shows a saving in favour of gas of 33d. per Board of Trade unit. Assuming the plant will be generating 120 kw. for 365 days of 15 hours, approximately 650,000 units will be generated; 650,000 units at ·32d. = say, £860 per annum saved. Against this saving is to be set off the interest and depreciation on the extra initial outlay for gas plant, 10 per cent.

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interest and depreciation on £2,000 = £200. Assuming these figures to be at least fairly representative, there is a sum of £660 saved per annum owing to cheaper running costs of gas plant.

(*c*) *Reliability of Working and Possibility of Nuisance from Gas Engines.*—There is little to choose between gas and steam engines if made by reliable firms. It is well known that quick-revolution steam-engines, with forced lubrication, will run continuously for years with practically no repairs. A gas-engine, using Mond or any other clean producer gas, will also run continuously with ordinary attention. At Messrs. Brunner-Mond's works a 60-n.h.p. Crossley gas-engine, coupled to a Siemens dynamo, has run continuously with an average output of 88·8 e.h.p. for 16,930 9 hours out of a possible 17,852 hours—*i.e.*, 96·6 per cent. of the whole time. This running included a period of 138 days and nights without stopping—average, 114 7 i.h.p. When taken down, not a single cam or roller had signs of heavy wear. The only parts renewed in 2½ years were one set of piston rings, some valve springs, and a small brass ignition valve. Gas and air valves were good as new. Given equal good makes of engine and equal staffs, there is very little difference. Assuming engines equal, we have gas-producers *versus* steam-boilers to solve. It will at once be apparent that gas under slight pressure is much easier to control than high-pressure steam. Boilers require feed pumps, injectors, feed and steam systems, all under pressure. Gas-producers require blowers, water-pumps (low pressure); method of driving dashers in washers; coal must be handled mechanically owing to bunkers having to be placed above producers. Small boiler must be provided, chiefly for steam to producers and also for driving blowers, it not being considered good-practice to drive blowers electrically unless batteries are used in station. This is due to the fact that gas produced, therefore electricity generated, is directly dependent on air blast; and if blowers are driven electrically, making air blast, therefore gas, dependent on electricity generated.

It is obvious that in a gas-producer station there is a multiplication of small apparatus, each one alone being extremely simple of action, but when put together forming an apparent conglomeration of plant. Until the staff has been properly drilled and instructed, it appears that the shift engineers must have a rather unhappy time. Thermometers have to be watched on superheaters and producers, air and steam have to be used in certain proportions for economical working, water-level in washers kept at proper level, clinkering producers, etc., tar-settling tanks watched, and many other items too numerous to mention. In a steam plant it is very easy to get a shift of men together who, after learning the little peculiarities which all machinery suffers from more or less, can perform their various duties with little or no supervision. This must be considered when deciding the merits of the two systems, especially on the ground of reliability. Also it may be found necessary to pay more for management with a gas installation. For ease of manipulation and dealing with peak and sudden loads, gas-producers are equal to water-tube boilers.

*Possible Nuisance from Gas-Engines.*—Unless an extremely costly form of gas-engine is employed—say, a three-cylinder vertical—there is always that bugbear, vibration, to deal with. This, with care taken in construction of large and solid foundations, isolated from main buildings can almost entirely be obviated. At least, it can be minimised, so as to be no more troublesome than the throbbing which can always be heard and almost felt in the neighbourhood of a high-speed steam-engine plant. The possible nuisance of noise from exhaust, with properly designed exhaust and the use of silencers or pits, can entirely be prevented.

*Summary Balance-Sheet.*

| For. | *Gas.* | Against. |
|---|---|---|
| Low working costs. | High initial cost. | |
| No high-pressure plant. | Possible excessive management expenses. | |

| For. | *Steam.* | Against. |
|---|---|---|
| Low initial costs. | | High working costs. |
| Standard plant. | | High-pressure plant. |

—J. H. S.

*Answer to No.* 656 (*awarded* 5*s.*).—Owing to early failures and the backwardness of most of the leading English gas-engine makers to design and develop a specific type of gas-engine suitable for direct coupling to dynamos, gas-engines are looked upon with great suspicion by a large number (happily rapidly decreasing) of consulting and operating engineers engaged in central-station work. The most sceptical on the subject of gas-engines, however, will agree that with a small plant of 250 kw. and coal at 21s. per ton the gas-engine plant will be the most economical to adopt. In comparing capital cost of each type of plant it will be as well to enumerate the various items required to work each plant (steam and gas) at its highest efficiency:

*Steam Plant.*—(1) High-pressure boilers; (2) superheaters; (3) steam-main (including water-bottles and traps); (4) compound or triple-expansion steam-engines; (5) receiver, reheater, and low-pressure cylinders, steam-jacketed exhaust pipe; (6 and 7) grease extractors, condensers; (8) feed-water heaters or economisers; (9) expensive feed pumps; (10) some system of artificial draught, or an expensive chimney.

*Gas Plant.*—(1) Gas-producer, includes low-pressure boiler to provide steam for steam jets, cleaner, cooler, and scrubber for the gas; (2) and gasholders; (3) piping to engine; (4) three-crank vertical high-speed gas-engine, governing by altering the quantity of the mixture; (5 and 6) exhaust pipe and silencer; (7) compressed-air reservoir for starting engines; (8) circulating water for cooling cylinders.

In making out the two lists, everything necessary in order to obtain the best results has been included. The capital cost of items 1 and 2 on the steam plant will be considerably higher than the cost of items 1 and 2 of the gas plant. Item No. 3 on the steam side—viz., steam-main capable of carrying high-pressure steam and provided with the necessary water-bottles and steam-traps—will cost more than double the amount necessary for the piping from the gasholders to the engines. Item No. 4 will cost about 20 per cent. less on the steam plant than on the gas plant, but it should be borne in mind that the price of suitable gas-engines is bound to come down in the near future; also the steam plant will have an advantage owing to the steam-engine being capable of running efficiently at far higher speeds than the gas-engine, thus reducing the size and cost of the dynamo. On the steam plant, items 5, 6, 7, 8, and 9 are necessities in order to obtain any high economy; the only portions of these items necessary on the gas plant are the exhaust pipe and silence. Item No. 10 on the steam side is not required by the gas plant, whilst items 7 and 8 on the gas side are not required by the steam plant. The air-compressor is worked by the engine before being shut down and the air stored ready in the reservoir, the circulating water pump being worked off the main engine, and, being small, takes very little to keep it going.

On looking over this analysis of the two types of plant, it would appear that the gas-driven plant should be a good deal cheaper than the steam-driven plant. That this is not so at the present time is simply owing to the want of competitors, and is rapidly disappearing. The actual cost of the gas plant may be somewhat higher at present than that of an equivalent steam plant, but if the space saved by using the gas plant is taken into consideration, as it should be, the gas-engine installation will be found to have a lower capital cost than the steam plant.

As to actual running costs, the gas-engine has a tremendous advantage over the steam-engine. To begin at the fountain head, the use and management of the gas-producer is simple, and can be rapidly learnt by any ordinary labourer; there is only a small low-pressure boiler in use (about 60lb. to the square inch); the producers, scrubber, cleaners, and coolers, and pipes to the engines are also under a very low pressure, and do not need the expert supervision occasioned by the use of high-pressure steam-boilers, superheaters, the necessary piping to engines, and all the various auxilaries necessary in a steam plant to produce a high economy. The firebars and hopper valve of the gas generator, and some of the brick lining, require renewing about once a year; the small boiler, of course, requires periodically cleaning; the coke in the scrubbers needs to be renewed once a year, the old coke being burnt as fuel in the boiler. There is practically nothing to do beyond this except to paint the ironwork. The depreciation is, as

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might be expected, very low. The gas when made can be easily and efficiently stored and kept for an indefinite period, so that a reserve of energy is always at hand. The producers are also capable of being forced without risk of harm to them, and a cold producer can be opened out and be put in full work in 20 minutes. There is no loss of power due to condensation in either the pipes from producers to engines or in the engine cylinders themselves, and the engines can be started up from cold and put on full work in three minutes. When the producers are banked up at night the loss is also very small, amounting to no more than 3lb. of coal per hour with a producer capable of supplying a 300-h.p. engine. It will thus be seen that the stand-by losses are reduced to a minimum. The water necessary for cooling the cylinders is very small in quantity, and, if necessary, can be kept smaller by being circulated, and does not need in any case to be below 190deg. F. It is sometimes urged against gas-engines that they require a lot of attention and repairs. The attention whilst running is, however, very small, and no more than that required by a steam-engine, whilst the extent of repairs necessary to a good make of gas engine are not any greater and are very similar to the constant little bits of tinkering required by Corliss engines. It is true that a gas-engine requires opening up about every six months in order to examine and clean the ports, cylinders, pistons, and rings, the valves, exhaust valve, passages, port, and pipe. This, however, the writer considers to be an advantage, as it compels attention to be given to the internal parts of the engine. The way in which steam-engines in the majority of central stations are left alone until some fault develops betokens a beautiful trust in providence, but is very bad practice. The thermal efficiency of a gas-engine is also very much higher than that of a steam-engine, and the heat losses do not commence until the engine starts and cease as soon as the engine stops. There are half a dozen makers of producers and suitable engines who will guarantee a consumption of 1lb. of anthracite per brake horse-power hour; this can only be approached by the very best steam installations of considerable size.

On the score of reliability, the gas-engine can hold its own. The performances at the Walthamstow and Felixstowe electricity works and at the works of the Metropolitan Carriage and Wagon Company, Birmingham, show the gas-engine to be a reliable and economical prime mover. The extensions at the Walthamstow works are to be carried out on similar lines, and it was dead against the wishes of the resident engineer and his staff at Felixstowe that a newly-appointed consulting engineer for some occult reason handed over the place to the tender mercies of the steam-engine for extensions. With modern plant there is no nuisance due to vibration, exhaust, or smells from the producers.—W. T. W.

*Answer to No.* 656 (*awarded* 5*s.*).—(*a*) The capital cost for a gas-engine plant would be about 20 per cent. more than for a steam-driven plant of equal output. Suppose it is decided to instal three engines and three dynamos, each engine to have an indicated horse-power of 150. Taking the price as for dynamos, engines, and boilers in the one case, and for dynamos, engines, and gas generators in the other, with necessary fittings and foundations, the steam plant would cost £8,500, the gas plant £10,000. These prices are approximate only; a perusal of published lists of tenders will invariably exhibit considerable differences in price for machinery to the same specification. With a gas plant less ground area is required, and no towering chimney; a tall stack is always an expensive item, and in many cases, owing to the value of land, compactness in the arrangement of the station is of primary importance.

(*b*) The running cost depends greatly on circumstances; each case would have to be determined on its own merits; local conditions must be taken into account. With steam coal at 21s. per ton it will hardly be possible to bring down coal cost per unit to a very low figure. Nothing is said in the question as to price of fuel for gas generating apparatus, but if this can be procured at ordinary prices it would be a point in favour of gas driving when the ton of steam coal costs 21s. The steam plant would require more water; oil and sundries with either arrangement would be about on a par. Labour will also probably be much the same in both cases, as although the gas plant would have the advantage as regards stokers, for the satisfactory handling of a gas driven plant a higher standard of skill on the part of the attendants is demanded.

With regard to repairs and (*c*) reliability of working, these are extremely difficult to estimate, as so much depends on the personal equation. Given an engineer who knows his business, and backed by qualified subordinates, gas-engines will be found quite as reliable and cost no more for repairs than steam-engines. A point often urged against gas-engines is that a faulty ignition tube brings the engine to a standstill. This is, of course, true, but a common practice is to have two ignition tubes fitted, one being a stand-by. If then a tube bursts, the second one is connected; the broken tube can be replaced while the engine is running. With electric ignition every confidence can be placed in obtaining regular explosions. Gas-engines have a great advantage over steam-engines where there is a low load factor. A gas-engine can be shut down and the stand-by losses be practically nil. With steam-engines under like conditions there are considerable losses by radiation and "banking" or firing the boilers to keep steam. With modern gas-engines dynamos may be run in parallel, and give every satisfaction. As a heat engine, the gas-engine is certainly ahead of the steam-engine as regards efficiency. Many engineers readily admit this, but give the palm for reliability to steam.

The question of nuisance may crop up with both gas and steam. The writer has been in trouble with regard to emanations of "visible matter" from a boiler stack, and, with change of circumstances, has had great difficulty in so "silencing" gas-engine exhausts as to prevent legal action on the part of those objecting to what they termed "incessant cannonading." All machinery is liable to create a nuisance by vibration. This may be mitigated by suitable foundations and well-balanced parts. Engine-rooms where gas is used require to be well ventilated. Producer gas also has very bad effects on the system when inhaled; therefore, every precaution must be taken to keep leakages at a minimum.—M. M.

## STEAM-TURBINES.*

BY F. C. PORTE, A.M.I.E.E

The author in this paper gives descriptions of the four best known steam-turbines of the present day—namely, the De Laval, Parsons, Curtis, and Rateau. These descriptions are accompanied with illustrations to show the construction of the different turbines, and by figures obtained from the working of these turbines in practice.

Before proceeding with the turbines of the present day, the historic turbine designed by Hero, of Alexandria, is described, and a working model of it exhibited. From the time of Hero up to the fourteenth century nothing was done, and from that time until 1629, when Branca made a turbine, there was another big blank. This Branca turbine consisted of a jet of steam from a boiler impinging on a wheel, which caused it to rotate. Nothing of real value, however, was done until De Laval invented his first steam-turbine in the year 1882. This turbine was originally constructed for the direct driving of milk separators, and was much on the same principle as Hero's. The driving wheel was a pipe bent in the shape of the capital letter S, to which the steam was admitted through a stuffing box in the centre, where the shaft was also fixed. The steam issued from the open ends, thus imparting to it a rotary motion. This turbine was mounted on the same shaft as the separators, and on account of the high speed and small space occupied, was most suitable for its purpose; and many of these separators are still at work in all parts of this country. But on account of its high speed and big steam consumption, and also requiring constant attention, it was not made in large sizes; and the present De Laval turbine is on a different principle, being worked on the action or impulse system. It has been built for outputs up to 500 h.p.

The Parsons turbine was first made by the Hon. C. A. Parsons in 1884, and is of the reaction type; it has undergone a great many improvements, until now it is made as large as any steam-engine in the world, and has about the same efficiency as the best reciprocating engines.

The author then describes the construction of the De Laval turbine, and investigates the actual velocity of the steam

* Abstract of paper read before the Dublin Local Section of the Institution of Electrical Engineers on Feb. 11, 1904.

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issuing from the conical-shaped nozzles at varying pressures and discharging into vacuum. He also deals with the alteration in velocity caused by variations in the vacuum, and calls attention to the enormously increased power to be obtained from the same quantity of steam when exhausting into a good vacuum. The next point taken up is that of the most efficient speed for the revolving buckets. As an example, with steam at an initial pressure of 200lb. per square inch discharging into a vacuum of 28in., the steam leaves the nozzle at 4,127ft. per second. The correct speed for the centre line of the buckets would be 47 per cent. of this, or 1,940ft. per second. This tremendous speed is too high for practical purposes, the highest speed yet used in any of the De Laval turbines being 1,380ft. per second in the 300-h.p. size. The diameter of the wheel of this turbine is 30in., and its speed 10,600 revolutions per minute. Details of the construction of these wheels, in order that they may withstand the enormous stress to which they are subjected, are then described. The author deals with the means by which vibrations caused by the rotation are reduced by allowing a certain amount of flexibility in the shaft. In these turbines helical gear is used to reduce the speed to that required on the dynamo shaft. Examples are quoted of these gears working for four or five years without appreciable wear. These turbines are governed by throttling the steam, but when a turbine is running under light load some of the nozzles are turned off by hand. The author then gives figures to show the saving from superheating the steam.

Referring next to the Parsons turbine, the author states that Mr. Parsons has done more for the advancement of steam-turbines than any other man in the world. His turbine is designed on the reaction principle, and the author shows how, by employing a number of fixed and movable vanes, the speed of the turbine shaft can be reduced. The expansion of the steam takes place gradually on its way through the turbine. The expansion of the steam in this turbine practically follows the adiabatic curve. The speed of the steam is usually about 600ft. per second, and it is apparent that under these circumstances the moving blades, on account of only having to absorb a small portion of the kinetic energy at each ring, can run efficiently at a low rate, and the larger the number of rings of blades the less the drop of pressure in each, and consequently the slower the speed of the turbine. The number is, however, limited for mechanical reasons, as the shaft would get too long between the bearings, and would be inclined to whip or spring.

The first ring of fixed blades generally has only a few guide blades in it, the rest of the ring being solid. The number of blades in the fixed rings will then increase towards the low-pressure end. This, of course, is to allow of the proper expansion of the steam. The moving rings of blades are, however, made with the blades all round the circumference. For the Parsons turbine, again, the author gives a large amount of detailed information which is illustrated by diagrams and drawings. The history of the development of these turbines is also followed, showing the gradual introduction of improvements due to condensing, superheating, etc. The compound turbine was introduced by Mr. Parsons in 1894, and in that year was largely introduced into the Manchester-square electric light station in London on account of its freedom from vibration. This station had been stopped from using steam-engines because of the vibration caused. With reference to the reliability of these turbines, the author quotes the case of a 600-h.p. turbine driving a dynamo supplied by Brown and Boveri, of Baden. This turbine ran continuously under load for 7,000 hours, at the end of which time the necessary repairs to the double-beat valve only took five hours. The consumption of oil on this turbine was only 95 gallons per annum. These turbines have lately been used for driving ventilating fans, pumps, and air compressors. The author gives an instance of three high-speed centrifugal pumps directly coupled on the turbine shaft for the Sydney waterworks. Each of these pumps can lift 1½ million gallons 240ft. in 24 hours. With the pumps connected in series, as has been arranged, the combined lift is 720ft. The steam consumption on trial was found to be 28lb. per water horse-power per hour, which shows a pump efficiency of 55 per cent. Before leaving the Parsons turbines the author gives particulars of their use for driving ships, and also a large number of test figures which show what has been done under varying conditions.

The next turbine described is the Curtis, which was developed by Mr. C. G. Curtis in New York in the year 1895, and is manufactured by the General Electric Company of New York. The first of these turbines to be installed in Ireland is now being put down by the Cork Electric Tramway and Lighting Company. This will have an output of 500 kw. This turbine differs from those previously described, in that it has a vertical shaft, the dynamo being placed directly over the turbine, which reduces the floor space required to a minimum. This turbine has not the very high speeds of the De Laval, whilst it has not the great number of vanes in the Parsons type. It acts partly on the action or impulse system, like the Laval, and partly on the reaction principle, like the Parsons. The expansion takes place in stages, and at the beginning of each stage the steam expands in a slightly conical nozzle until it has a high velocity, which is then reduced by giving impulse to the revolving vanes. It then expands again through another set of nozzles, and discharges on to more moving vanes. The number of stages depends on the steam pressure, and also on the speed required. Generally speaking, the slower the speed the more stages there must be. In this turbine, as in the Laval, governing is effected by reducing the number of nozzles in use. The author then gives particulars of the construction of these machines, accompanied with illustrations. Comparisons are also made as to the relative floor space required for these Curtis turbines with that required for reciprocating engines.

The last section of the paper is devoted to the Rateau turbine, designed by Mr. Rateau, of Paris, and manufactured both in that city and by one firm in Switzerland. This also was designed to avoid the high speed of the Laval turbine and the clearance problem in the Parsons turbine. Rateau then designed his turbines like Parsons, in that the steam was expanded through a number of stages, and so each turbine consisted of a large number of rings and blades, but he made like De Laval's in that the steam acted on the impulse system. Each wheel is enclosed in a separate chamber, the nozzles or guide passages being in the diaphragms between the wheels, so that the steam, after passing through the first set of nozzles on to the first wheel chamber, goes through a set of nozzles in the diaphragm on to the next wheel. This, too, is described in detail and illustrated by the author. Results are quoted to show that the Rateau turbine is doing extremely well in steam consumption under conditions which are not exceptional.

Having described the above four special types, the author explains that a number of other turbines are being introduced. He concludes that the benefits from a good vacuum are greater in a steam-turbine than in a reciprocating engine, owing probably to less initial condensation. Also, in the turbines a large part of the gain from the vacuum is caused by the immensely increased expansion of the steam. This means a greater rate of outflow, and, secondly, increased kinetic energy. Another gain is due to the decrease in surface friction in consequence of the decrease in the density of the medium in which the wheel revolves. To quote a specific case. To rotate a 150-h.p. De Laval wheel at normal speed in steam at atmospheric pressure took 25 h.p., but to run the same wheel in a 28in. vacuum only took 2½ h.p. Consequently it is essential for good results with steam-turbines to have as perfect a vacuum as possible, both on account of the extra energy of the steam and also to reduce the skin friction between the wheel and the steam, the saving amounting to from 4 to 5 per cent. for each extra inch above 24in. to 25in. vacuum. The author adds that it is easier to get a good vacuum with a turbine than with an engine. The marked increase in the efficiency of steam-turbines with superheated steam is greater than can be accounted for by thermo-dynamic reasons. The average gain in the Parsons turbine for moderate superheats is about 1 per cent. for every 8deg. F. Part of this gain is due to reduction in initial condensation, but a considerable portion the author states is due to reduction in friction, which reduction is much more on the turbine than on the steam-engine. The author puts this down to the fact that the wetter the surface of the turbine blades the greater the friction.

The author concludes his paper by the statement that he believes the steam-turbine will entirely supersede reciprocating engines for power produced by steam, though he does not think that the steam-engine in any form will be the final solution of power production. He considers that in the comparatively near future the internal-combustion engines of very large sizes, and probably of the turbine type, will be the most economical means of generating power, which will be immediately converted into electrical energy and distributed over large areas, and all except the very largest isolated plants for the production of power will entirely disappear and the electrical motor will take their place. He sums up the favourable points in the steam-turbine as follows: 1. A reciprocating engine is now very nearly as perfect as it is likely to be, both from a mechanical and thermal point of view. 2. Steam-turbines are cheaper to build than reciprocating engines of equal power. 3. They occupy only one-fifth to one-tenth of the floor space and require considerably less attendance, being the simplest form of engine. 4. They use no more steam than the highest-grade reciprocating engine. 5. On account of the practical absence of vibration, they require little or no foundation. 6. They have a perfectly even turning movement, consequently have no dead points and require no flywheel. Have no heavy masses of metal to reciprocate, causing great waste of power. 7. They require no internal duplication, consequently the condensed steam, as it is perfectly clean and free from oil, can be pumped back into the boiler without any purification, thus saving the costly and troublesome oil-separating plant which is usually fitted to large installations. 8. The life of a steam-turbine—that is, the period through which it will maintain its initial efficiency without serious repairs—is very much greater than that of the reciprocating engine is now.

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## TRAMWAYS AND GOODS TRAFFIC.

There is not the slightest doubt that we are a nation of grumblers. We are also rapidly developing another national trait, which to say the least of it is baneful. Smiles is still alive, and no doubt deplores his inability to beneficially inculcate national self-help. If the sun shines, the nation or municipality ought to provide shade; if it rains, the same authorities ought to provide shelter. If Lancashire wants cotton, the nation must tell it where to go and experiment in growing. Ages ago each little community was governed by its chiefs, each member of the community was told where to live and what to do. Progress changed all that, but modern ignorance seems to tend backwards to the ancient methods. Land is to be nationalised—brains are wholly ignored or made common property—you can only invent for your own benefit for a few years. The author of a book sees his property become public, or if he leaves this sublunary sphere knows that his heirs can only reap the harvest his brains have made for a few short years. The fact is, Britishers are such a mixed race as to at one and the same time be intensely conservative and socialistic. They are socialistic in everything that does not immediately concern their own pockets, and conservative in all that does. Perhaps this double characteristic is nowhere better understood than by examining the criticisms against our railroad management. Everybody who buys wants to buy at wholesale rates, and everybody who sends a parcel by rail, be its weight a pound or a ton, expects to be charged as if he was sending a whole train load at a time. Really, we are a wonderful nation. According to the ordinary notion of those who write letters to the papers, the railway authorities treat every nation under the sun better than they do their own kith and kin. Of course, a moment's thought would show the utter absurdity of this view; but there, we do not as a nation think, neither do we as a nation read. So far as the railways are concerned with goods from abroad they load up at the docks in trainloads, not in meagre parcels, in numbers which result in scarcely-filled trucks. The cost to the railway to deal with hundreds of tons at one spot is quite a different matter to the collecting of a similar quantity in driblets at a large number of places. Just the same ignorance that rules with railway matters rules with tramway matters, and in the course of a few years the wonder will be that these things were not seen and prepared for in the early stages of the work. There is so little distinction between tramways and light railways, that whatever may be said of the latter will apply to the former, and *vice versâ*.

The plea put forward for tramways is that they facilitate intercommunication. Some people disagree with the argument, and with putting tramways upon common roads. But there they are, and being there must be dealt with in the concrete and not in the abstract. Hitherto tramways have been used almost entirely for passenger traffic, but the question as to the use of tramways is a larger one, and involves goods traffic also. We do not think it will be disputed if we assert that in most large and busy towns the tramway service does interfere with the goods traffic, and the better and quicker its service for passenger traffic the greater the interference with goods traffic. The roads and streets are common for both passengers and goods, and if the one interferes detrimentally with the other a remedy must be found. Assume the correctness of the assertion that tramways do facilitate passenger traffic and delay goods traffic, is it impossible so to organise the service that both passengers and goods may be facilitated? To do this, tramways will have to be used for goods service as well as for passengers.

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Is there any insuperable objection to this? A few attempts have been made, more or less successfully, to deal with the matter, but as tramways get linked up and intercommunication by their means is possible between a number of towns in a district, ought not the whole question to be carefully examined. Our text is that tramways occupy public roads to the detriment of one class of traffic, and that such a state of things cannot long continue. The individual loss by delaying goods may be small, but it is there. It seems to us that the subject, "Organisation of goods traffic on tramways," would be an admirable one for the Municipal Electrical Engineers to discuss and thrash out. Originally central stations were erected solely with a view to the lighting requirements; it took but few years to recognise that power distribution formed an important factor in success. May not something of the same thing be found as regards tramways—passengers plus goods to a greater success rather than passengers only to give a moderate success.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### COMPARATIVE COSTS.

SIR,—As the compiler of Table A embodied by Mr. G. H. Bowden in his paper on "Electrical Transmission," and as the writer of the pamphlet mentioned in Mr. Ellington's letter in your current issue, will you allow me a word of reply to the latter.

Your correspondent quite truly points out that my comparison does not quote hydraulic power rates at the equivalent of 2½d. per unit. But why should it do so? The table is a comparison of actual costs, not of hypothetical costs under imaginary conditions. If hydraulic power companies actually supplied owners of single machines, requiring only about five pounds' worth of power per annum, with energy at the rate of 2½d., that figure, or its equivalent, would have appeared in Table A.

Mr. Ellington's underlying contention is that 1 h.p. of hydraulic energy applied in a good hydraulic lift will do more work than the same amount of electrical energy can in a good electric lift, and this may be readily conceded.

But it is, nevertheless, useless for the hydraulic advocate to prove that point to the prospective consumer if he has to follow it up with the admission that the larger amount of electric power required for an average case will cost more than the smaller amount of hydraulic. The consumer will brush aside all questions of mechanical efficiency, and decide for financial economy—never caring how it comes.

Without going into the reasons why, the broad fact stands out that the small, and even the average, consumer can buy electric power at lower rates than hydraulic, notwithstanding the sliding scale.

Mr. Ellington says the pamphlet was prepared for "trade purposes," and, I presume, wishes to suggest bias. While merely reminding him of dwellers in glass houses, may I point out that I am, by training together with lifelong practice and associations, a hydraulic engineer; that my firm have erected many more hydraulic machines than electric; and that we are still supplying a large number of the older type of machine. We, therefore, occupy a perfectly impartial position as regards interest, and the sole aim of the pamphlet was to set forth actual facts to assist our friends in making their choice.—Yours, etc.,

C. G. MAJOR.

### MUNICIPAL TELEPHONES.

As long ago as Nov. 19, 1903, we received a request to review a pamphlet, printed and published by the *Manchester Courier*, dealing with "Glasgow Telephones." In the letter accompanying the pamphlet is the following paragraph: "The matter is of great public importance, and indirectly raises the question as to whether municipal councils have not already as much work in hand as they can possibly get through with advantage to the ratepayers." It is evident that the view of the pamphleteer is that we have too much municipalisation, and with that view in the abstract we entirely and unreservedly agree. But we are just as emphatic upon another point, and that is criticism of "Glasgow Telephones" is not and ought not to be considered a question affecting the question of municipalisation, unless principles are proved to have been ignored.

Referring to the pamphlet again, it discusses not only Glasgow, but has also "a note on Portsmouth and Guernsey." This seems to point to the view that the main object of the pamphlet is not to discredit municipalisation, but to discredit an engineer, and causes the thought, is the critic a rival in need of a job? If the aim is to discredit municipal trading, the method of procedure is difficult to understand. A good or a bad estimate affects a man, not a principle. One way or another way of keeping accounts, so long as they are accurate, affects a man, not a principle. So far as we can see, the critics of Glasgow telephones have attacked minor details and left principles unnoticed. To say municipalities keep their accounts wrongly, to cavil as to what is or should be depreciation, and a score of similar things, has no earthly connection with the question of whether it is right or wrong for a municipality to do the work. Another engineer may give another estimate, another accountant may modify the system of book-keeping more in accord with the critic's views, and then it is seen the principle of municipalisation is untouched. Putting on one side the all-important question of municipalisation or not, the consideration of figures and accounts may serve a good purpose. Of course, every critic must be assumed to be honest in his criticism, and to be filled with an enthusiastic desire to guide municipal officials towards the ideal state of perfection; if, however, stupid blunders are made and careless perversions of facts, the value of the criticism falls to the ground.

It may, perhaps, serve our purpose better by discussing the various points in the criticism which appeared in our excellent contemporary the *Electrical Review* in its issues of Oct. 9, 16, and 30 last year. Its strictures are many; the question is, are they correct? If so, the remedy is clear and simple—change the methods shown to be wrong.

#### Firstly—Nomenclature.

A great deal is made about Glasgow counting instruments instead of lines. We hear of "subscribers," "lines," "stations," and "instruments." The unit to be used by everybody is not agreed, but probably the Glasgow authorities have followed the example of the Post Office, which counts entirely by stations, each station being represented by a working instrument. Thus the adverse criticism against Glasgow for reckoning by instruments is merely a statement that the critic adopts a different unit. What connection has such a difference in the use of nomenclature to do with the principle of municipalisation. The critic is ingenuous; he suggests what he knows is not correct—or, at least, such seems to be the plain interpretation of his argument. The estimates for Glasgow and for every other system provide for a certain number of instruments and a certain number of lines, which lines include a proportion of spare lines. (The criticism on this proportion will be dealt with later on.) It is urged that extension instruments, especially in the same buildings, cost much less than direct lines, and that the Glasgow Corporation is wrong in counting such instruments in with the exchange lines Now, there are two very important points here in which the *Review* critic is hopelessly wrong. How he could have erred is difficult to say, if it was not too great haste to condemn a particular organisation. When an extension instrument is placed in a room in the same building, the instrument which was estimated for is used, so is the lightning guard and the internal wiring. The line in the cable estimated for another instrument is still in the cable, and free to be used—so surely that spare line remains an asset. The department have actually incurred the expense of a complete line, although only the instrumental portion of it has not been put to immediate use; the remainder, according to the most exact idea of accountancy, must go to credit in the

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spare line ledger. The fallacy underlying Mr. Bennett's critic—for, as we say, this part of the criticism is personal rather than directed at the Corporation—is he incorrectly assumes that an estimate was made for so many lines—for clearness, say, a hundred—and, further, that a hundred lines are not there, because there are a hundred instruments, and some of the instruments are extension instruments not needing a special line. As against the critic, we say the lines are there, and when all are in use and none spare, the number of instruments will be 100 + the extension instruments. We say this mistaken criticism has probably been caused by the want of agreement as regards the definitions.

As regards another point we must quote the critic's exact words, *vide Review*, Oct. 16, p. 610: "In the Town Council these 9,000 instruments become 9,000 'subscribers' which they are not. But the technicalities of telephonic nomenclature are not understood by the general public, not always by chairmen of telephone committees, nor even by all technical journals, and '9,000 subscribers' become a current fiction."

Is it possible to believe the *Review* critic ever read the report and accounts he thus criticises? It is best to assume he has not, otherwise such a deliberate statement has an ugly look, and leads to conclusions about the critic's *bonâ fides* which are unpleasant.

On p 5 of the report is a paragraph, entitled "General Remarks," to the following effect:

"At May 31 there were 9,122 instruments connected, *these being subscribed for by 8,145 persons and firms*" (the italics are ours).

Is not this statement clear enough? Does the Corporation attempt to denominate "subscriber" as "instrument," or in any way to indicate the one as equivalent to the other?

If the critic suggests he is criticising in these words some speech at a Council meeting, it seems to us that he makes his case worse, and almost proves that his wish is to obscure the truth rather than to obtain it. The report is definite, and a generalisation in a casual speech, or even by a chairman of a telephone committee, or even a generalisation in an ignorant technical journal, has no more to do with principles of municipalisation or an engineer's methods than the critic's words have to do with Borneo.

## THE LATE MR. WALTER McMILLAN.

A last tribute to the memory of their late secretary was paid by the President, Council, and members of the Institution of Electrical Engineers at their ordinary meeting on Thursday evening last week.

Mr. R. KAYE GRAY (President) said they were all aware, through the Press, of the death of Mr. McMillan, but this was the first meeting of the Institution since the sad event. He had no intention of telling them, who knew Mr. McMillan so well, what his qualities were. He was sure they all missed him very much. There was only one thing which he, as president, would like to say, that Mr. McMillan had left a widow and two children. Unfortunately, as their constitution was, they could not as an institution deal with the matter from a financial point of view as they should all like to do, and therefore at the first meeting of the Council that day since his death, the Council had decided to invite the members of the Institution to do what they could for those Mr. McMillan had left behind. In other directions the Council had done everything that it could do. It had shown the last respect to Mr. McMillan's remains, and their president, Mr. Swan, Mr. Webb (their ex-secretary), and Mr. Patchell went to Golder's Green, where the body was cremated. The rest of the Council, so far as was possible, attended the memorial service at St. Leonard's Church, Streatham. He had nothing further to say, but as they would undoubtedly like to express their sympathy with Mrs. McMillan in her great loss a resolution would be submitted to the meeting.

Sir HENRY C. MANCE moved the resolution, which was in the following terms: "That the members of the Institution of Electrical Engineers, in full meeting, desire to express their profound sorrow at the death of their late secretary, Mr. Walter George McMillan, and to put on record their high appreciation of his personal character, and those qualities which, as a scientific man and as an administrator, have contributed so much to the prosperity of the Institution; and also to express to Mrs. McMillan and the other members of the family their heartfelt sympathy under this sudden calamity." He was sure the resolution would meet with responsive sympathy from all of them. There were few men who enjoyed the respect of their fellow-men to a greater extent than Mr. McMillan. As he listened to the President's remarks, it came home to him that as they grew older time seemed to fly with greater rapidity with every additional year. He could hardly realise that it was six or seven years ago when he, as president, presided over the Council meeting which met to appoint a successor to Mr. Webb, and he could bear testimony to the impartiality and care exercised in electing Mr. McMillan. Time and experience had shown the wisdom of that choice. If Mr McMillan had one fault, it was that of extreme devotion to duty and to the care of the interests that were entrusted to him. As an administrator he endeavoured faithfully and conscientiously to carry out to a successful conclusion the wishes of the Council. He showed tact and amiability, and, as every past-president would agree, it was a pleasure to work with him. He would conclude by simply saying that while the Institution had lost a valuable official, all of them had lost a personal friend.

Prof. JOHN PERRY seconded the resolution. He said it needed no words from him to ensure their recognition of the great loss they had sustained. The loss to the Institution was of enormous importance, but there was also the loss thah each of them personally felt—the loss of a kind and sympathetic friend. In their difficulties Mr. McMillan was their friend, and many of them had gone to him for help, sure and certain of obtaining it. Mr. McMillan was ever a discourager of wrong-doing. He did all that was possible for a man in his position to set an example of Christian conduct. Members of Council, perhaps, knew this better than the ordinary members, but only the President and Past-Presidents knew it thoroughly. Prof. Perry went on to refer to his remarks at the close of his term of office, and quoted the following: "I get the credit, but Mr. McMillan was the man who did the work. But there is a serious side to this power of Mr. McMillan to take up all sorts of work and pull it through. We are taking too much out of Mr. McMillan. There is a great deal too much output, and I am sorry to say it is an output with a large load factor." Now, he was sure they had allowed Mr. McMillan's zeal to overcome his discretion. They might mourn for him, but their mourning would be as nothing to the sorrow of his widow and children. It was a great blow to Mrs. McMillan, but the blow would be lessened by the knowledge that her husband had earned the respect and gratitude of the whole Institution. To her, therefore, to her two sons, and to the other members of his family, it was most fitting that they should send this message of condolence.

The PRESIDENT said it was quite unnecessary to put the resolution to the meeting. As regards the memorial fund, they thought they might get about £2,000. He was glad to say that the fund that had been started privately had the support of the Council. Contributions to that fund had been handed over to the Institution for management, and any further contributions would be dealt with in a like manner.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Feb. 11 the following were the candidates balloted for:

*Members.*—J. W. Jacomb-Hood, Engineer's Office, Waterloo Station, S.E.; G. H. Oatway, 82, Milton-park, Highgate, N.

*Associate Members.*—P. Storey, Corporation Electricity Works, Torquay; A. H. Tracy, Standish, Sevenoaks, Kent.

*Associates.*—W. Emmett, 13, Southgate, Wakefield; E. H. Lamb, 37, King William-street, E.C.; R. N. Mayne, Corporation Electricity Works, St. Helens, Lancs.; E. W. L. Nicol, 36, Lessar-avenue, Clapham, S.W.; J. E. Williams, care of Messrs. T. Cook and Sons, Limited, Boulac, Cairo, Egypt.

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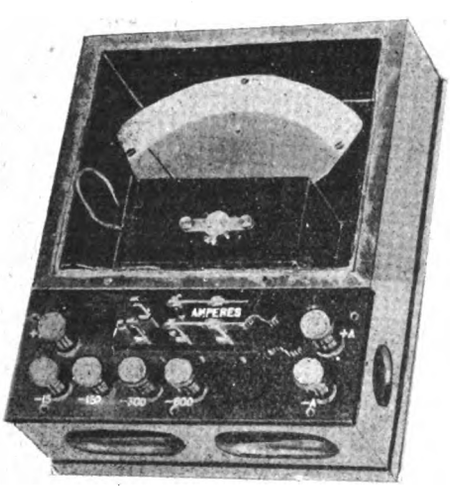
## TRADE NOTICES AND NOVELTIES.

### Further Improvement in Nernst Lamps.

We are advised by the Allgemeine Elektricitäts-Gesellschaft, Berlin, of an important improvement which has been made in regard to their Nernst lamp, "Model B," for 110-volt circuits. The remarkable success which attended the introduction of their high candle-power lamp has led them to apply the same arrangement of burner and heater characterising this lamp to their "B Model" lamp. This new high candle-power "B" burner is claimed to be far superior to the model hitherto employed, both as regards lighting power, diffusion, and, above all, maintenance of the rated candle-power. Hitherto the development of the Nernst lamp has been principally for high voltages, but the high candle-power B lamp is now claimed to be undoubtedly the most economical among the electric incandescent lamps yet introduced even on 110-volt circuits. The use of small opal globes is recommended with these lamps. Although we have the above information direct from the makers, we would remind our readers that the agents for the Allgemeine Elektricitäts-Gesellschaft in this country are the Electrical Company, Limited, of 122-124, Charing Cross-road, London, W.C.

### A New Portable Testing Set.

Messrs. Nalder Bros. and Thompson, Limited, have recently placed upon the market a new portable testing set, which contains many points of novelty. The set has been specially designed to meet the demand for an instrument that can be used in an engine-room, and can be placed anywhere without the danger of obtaining erroneous results through stray fields. The screening of the instrument has received very careful attention, and is so efficacious that it is almost impossible for the readings to be affected even if it be placed quite close to a dynamo or motor. The instrument is of the moving-coil type, and is absolutely dead-beat; it has a white enamelled scale and is fitted with a metal mirror which enables accurate readings to be taken.




A New Portable Testing Set.

Measurements up to 1 500 amperes and 600 volts can be made, and as a double-pole change-over switch is provided, resistances can be measured by the practically simultaneous observation of current and E.M.F. The volts required to deflect the instrument to the top of the scale on the ammeter side terminals, A A (see the accompanying illustration), are ·12, and as the scale is divided into 120 divisions, each division corresponds to ·001 volt, so that the fall of volts on rail joints, etc., can be conveniently tested. The current shunts are of a new design and very convenient for connecting to, in addition to which they are light, and a complete set to 600 amperes can be carried in quite a small box. The illustration herewith shows the instrument with part of the top cover removed, thus exposing to view the very complete method of screening which has been introduced.

### Miniature Arc Lamps.

We have received from Mr. G. Braulik, 217-218, Upper Thames-street, London, a copy of the third issue of his price-list dealing with "Eclipse" miniature arc lamps. These lamps are neat in appearance. For burning in single parallel on circuits of 100-120 volts tension the construction is that of a main current lamp, the solenoid being provided with a special winding, making it possible for the lamp to be connected direct to the circuit without a line resistance (if specially desired). It is, however, recommended that an external line resistance should be supplied with the lamp. Lamps for burning two in series on 200-230 volts are provided with differential mechanism and a suitable line resistance.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 19.

**Royal Institution.**—At 9 p.m., discourse by Mr. C. T. R. Wilson on "Condensation Nuclei."

SATURDAY, FEB. 20.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture I.).

**Northampton Institute.**—Distribution of prizes by Lord Kelvin.

**General Electric Company.**—At 6 for 6.30 p.m., annual dinner, Trocadero Restaurant.

**Institution of Electrical Engineers.**—At 2.30 p.m., students' visit to the Central Electric Supply Company's Works; meet at Grove-road Generating Station, Marylebone.

TUESDAY, FEB. 23.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Papers: "The Construction of Railway Wagons in Steel," by Mr. J. D. Twinberrow; "The Construction of Iron and Steel Railway Wagons," by Mr. A. L. Shackleford; "Iron and Steel Railway Wagons of High Capacity," by Mr. J. T. Jepson.

WEDNESDAY, FEB. 24.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the reinforced concrete pier under construction at Purfleet; train, 1.48 p.m. from Fenchurch-street.

**Institution of Electrical Engineers.**—Students' Section: at 7.30 p.m., ordinary meeting. Paper: "Automatic Railway Signalling," by Mr. E. Fisher.

**Liverpool Engineering Society.**—At 8 p.m., ordinary meeting. Paper: "Conduit and Surface-Contact Tramway Systems," by Mr. Geo. Balfour.

THURSDAY, FEB. 25

**Institution of Electrical Engineers.**—At 8 p.m., ordinary meeting. Discussion on paper, "Transatlantic Engineering Schools and Engineering," by Dr. R. M. Walmsley.

**Royal Institution.**—At 5 p.m., Prof. H. L. Callendar on "Electrical Methods of Measuring Temperature" (Lecture I.).

FRIDAY, FEB. 26

**Institution of Electrical Engineers.**—Manchester Section: Annual dinner.

**Physical Society.**—At 5 p.m., at the Royal College of Science, ordinary meeting. Papers: "A New Dilatometer," by Mr. Bornikeen; "A Quartz-Thread Vertical Force Magnetograph," by Dr. W. Watson; "On Stresses in a Magneto-Static Field," by Mr. G. W. Walker; "Some Hints on the Preparation of Diagrams," by Dr. W. Watson.

**Institution of Civil Engineers.**—At 8 p.m., students' meeting. Paper: "Boiler-House Design," by Mr. L. G. Crawford.

**Royal Institution.**—At 9 p.m., discourse by Mr. A. Siemens on "New Developments in Electric Rays."

**North-East Coast Institution.**—Meeting at Newcastle-on-Tyne.

**Electro-Harmonic Society.**—At 8 p.m., ladies' night concert, King's Hall, Holborn Restaurant.

**Electrical Engineers Volunteers.**—At 9 p.m., Kensington Town Hall, annual regimental ball.

SATURDAY, FEB. 27.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture II.).

**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 23; Newcastle, May 6 and 7; Buxton, May 20 and 21.

## PERSONAL.

The Warrington Guardians have increased the weekly salary of Mr. Walter T. Sampson, electrical engineer.

Mr. Wm. Burr, station superintendent at the Reading electricity works, has been appointed chief assistant electrical engineer at the Croydon electricity works out of 154 applicants for the post.

Mr. R. W. Kemble, Bournemouth, has been appointed staff engineer and Mr. T. C. Hunt, West Ham, mains assistant to the West Ham Corporation.

## APPOINTMENTS VACANT.

**Assistant Clerk** Woolwich Electricity Department. Salary, £100 per annum. Applications by Feb. 29. Particulars from Mr. J. B. Mitchell, electrical engineer, White Hart-road, Plumstead.

**Electrical Engineer,** Holyhead Electricity and Refuse Destructor Works. Particulars from Mr. C. E. Moreton Prichard, Urban District Office. Applications by Feb. 22.

**Secretary,** Institution of Electrical Engineers. Salary, £500 per annum. Applications by March 7. See advertisement.

**Premium Pupil,** to obtain experience in all branches of central-station work. Apply, Electricity Works, Canterbury. See advertisement.

**Fitter-Driver,** Keighley. Wages, 35s. per week. Applications to Borough Electrical Engineer by Feb. 26.

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## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion resumed the taking of evidence at the Westminster Palace Hotel on Friday, Sir David Barbour presiding.

**Mr. J. E. Waller,** engineer, who had suggested the appointment of a Traffic Board, which should be a Government department, said that that body should have the power to investigate and sanction, with or without modification, the schemes brought before it. The Board should have absolute legislative powers, subject, however, to a right of appeal to Parliament, with the sanction of the Board, such sanction being granted in all cases where it was thought that the interests of the opponents were of such magnitude that the proposals of the promoters ought to be submitted to Parliament. Such appeal should come before a standing joint committee of the two Houses. The powers of the Board of Locomotion should be absolute. The inspection and certification of the tramways as fit for public traffic should also be in the hands of the Board. Generally speaking, the powers, duties, and responsibilities of such a Board would be onerous, but he believed the creation of such an authority, constituted of members having the necessary technical experience, would provide the most practical means of solving the question.

**Mr. Charles E. Baker,** parliamentary agent, said the district councils concurred in the suggestion that there should a new and independent tribunal to deal comprehensively with the question of traffic in and out of London. There should be a right of appeal from any decision of the new tribunal to Parliament or the Board of Trade.

**Mr C. G. Mott,** chairman of the City and South London Railway Company, said he was of opinion that they could only look for serious relief of the future growing traffic of the Metropolis to the construction of the deep level underground electric railways, such as the City and South London, the Central London, and the Waterloo and City. At present these railways had to be constructed under the lines of the existing streets, in order to avoid payment for the use of subsoil; but it was clear that in many instances it would greatly conduce to the public advantage if the railways could be constructed in more direct lines under private property. The cost of the conveyance in each case now prohibited companies going under private property, and he suggested that Parliament should fix some uniform sum to be paid for it, and so avoid the enormous legal expenses involved. The electrification by the London County Council of the tramways in South London caused a serious loss to the railway company, but there were indications that the railway was slowly recovering the traffic it had lost. When the company agreed to take over the powers of the City and Brixton Railway it was their intention to proceed with the construction of that line at an early date, but the effects of the competition and the low fares charged by the London County Council on the electric tramways had rendered it at present impossible to raise the funds necessary for the construction of the Brixton Railway. They were, however, making arrangements at an early date to proceed with the extension to King's Cross and Euston. He was of opinion that the present mode of procedure in regard to private Bills was, on the whole, the best.

**Mr. A. E. Gathorne Hardy,** chairman of the East London Railway, suggested that in the consideration of measures for the improvement of the means of locomotion by the development of intercommunication of railways and tramways on or below the surface, due consideration should be given to the position of the East London Railway.

The Commission adjourned.

# LEGAL INTELLIGENCE.

## SWANSEA TRAMWAYS PURCHASE.

In the Chancery Division of the High Court of Justice, Mr. Justice Buckley had before him the case of the Mayor and Corporation of Swansea *v.* the Swansea Improvement and Tramways Company, in which the plaintiffs claimed a declaration that upon the true construction of the Tramways Act, 1870, and the Swansea Tramway Act of 1882 the plaintiffs were entitled if by special resolution passed in accordance with the provisions of Section 43 of the Tramways Act, 1870, they decide within six months from Feb. 28, 1904, that being the date of the expiration of 21 years from the completion of such tramways authorised by the Act of 1882, as had, in fact, been constructed, and within six months after the expiration of every subsequent period of seven years, the approval of the Board of Trade having been obtained, to require the defendant company to sell, and the defendant company were thereupon bound to sell, to the plaintiffs the whole of the tramway undertaking within the borough of Swansea. They also asked for a declaration that upon such purchase being made the defendant company were not entitled to have any lease granted to them by the plaintiffs of the purchased property or any part thereof. Plaintiffs' contention was that by virtue of the Tramways Act of 1870 they were entitled, upon giving the proper notice, to take over the tramways constructed after the expiration of 21 years from their construction. The defence was that the Board of Trade had properly refused to sanction the purchase as the time was not yet ripe, and defendants claimed the right to oppose sanction being given by the Board of Trade.

Mr. Warmington, K.C., and Mr R. J. Parker appeared for plaintiffs, and Mr. Balfour Browne, K.C., Mr. Haldane, K.C., Mr. Buckmaster, K.C., and Mr. P. Wheeler for the defendants.

**His Lordship,** in giving judgment, said in this case plaintiffs asked the Court to declare what were the rights as between plaintiffs and defendants in an uncertain future—namely, in the event of the plaintiffs availing themselves of a statutory option to purchase defendants' tramways. The defendants concurred in asking the Court to say what those rights were. The question depended upon the construction of a certain Act of Parliament. But for the request on the part of the defendants, he should have felt considerable doubt as to whether he could thus prematurely declare what the rights would be in a future event, but it seemed that defendants also wanted to know his view as to the construction of the Act of Parliament, and he saw no objection to expressing it, leaving the question open as to whether the declaration he now made would be binding if a future event should hereafter happen as between parties who at that time were interested in the question to be determined. The facts were these: In 1882 the defendants held three statutory rights of metal tramways, and had made, in whole or in part, tramways under these several authorities. They were respectively of date July 16, 1874, July 4, 1878 and Aug. 11. 1879. In each case Part 3 of the Tramways Act, 1870, in which Section 43 was included, applied, and the result was that at certain intervals, the first of which was 21 years from each of those three respective dates, and subsequently at intervals of seven years, the plaintiffs had statutory right, if they were so minded, to buy those three respective tramways of the defendants The earliest dates at which those several options would arise were 1895, 1899, and 1900. In that state of facts in 1882 was passed the Act which I have to construe. The three systems of 1874, 1878, and 1879 were sets of tramways in Swansea communicating one with the other, except that one small portion of the earliest set of tramways was detached. The tramways authorised by the Act of 1882 effected certain connections between the previous existing tramways—a sort of semi-circular route forming connections between some parts of the previous system. The Act of 1882 contained Section 35, upon which the question to be determined arose. The Act incorporated Parts 2 and 3 of the Tramways Act, 1870, and thus included Section 43 of the Act of 1870, and by Section 3 it defined the tramways as meaning the two tramways of 1882. He therefore had to read the Act of 1882 as if it contained Section 43 of the Act of 1870 and contained also Section 35 of the Act of 1882. Section 35 created with the plaintiffs a new right of purchase altogether in the tramways. The plaintiffs sought to say that a new statutory option to purchase all four sets of tramways as forming one amalgamated undertaking had become vested in them. He was unable to arrive at any such conclusion. He did not think the section had any such effect. Section 35 of 1882 was not affirmative, but negative. It proceeded on the footing that there being already, by virtue of Section 43 of the Act of 1870, a right to purchase at various dates to be ascertained in the way he had mentioned, the Corporation should not purchase except in the way mentioned in Section 35. It was wholly negative, and in no way affirmative. It was addressed to two sets of facts—the first where the lease of the tramways or some part of them had been granted by the Corporation to the company, in which case during the existence of the lease the Corporation were not to buy the company out unless the company agreed; and, in the second case, where no lease had been granted, they were not to buy until the expiration of the 21 years from the completion of the tramways. Originally the time was 21 years, not from completion, but from authorisation. As a matter of fact, the tramways were completed in 1885. The effect of Section 35 was that until 1906 the Corporation were not to exercise the statutory power to purchase conferred by Section 43 of the Act of 1870. There was no new right of purchase at all. It was a prohibition, restriction, or limitation imposed upon the existing right of purchase. The plaintiffs had said that if that was so, the result would be very extraordinary, that if a lease was granted it might postpone the right of purchase for several periods of 21 years. So far as his Lordship saw, that was so. He did not see anything irrational in that state of things which would lead him to come to a contrary conclusion. The object might have been to keep the whole undertaking in the hands of either the company or the Corporation. He agreed that that would have the effect of preventing the Corporation from becoming masters of the situation for a much longer time, but that was perfectly sensible and perfectly intelligible. He thought, therefore, he ought to declare on the first point that upon the true construction of Section 35 of the Act of 1882 the effect was not to create any new right in the plaintiffs to purchase the tramways or any of them, but only to restrict or limit the right of purchase existing by virtue of Section 43 of the Act of 1870. On the second or subsidiary point he must declare according to the true construction of Section 34 of the Act of 1882. The purchase there mentioned was not, as regarded the tramways of 1882, confined to a purchase under Section 32 of the Act of 1882, but included purchase under Section 43 of the Act of 1870.

He accordingly made those two declarations.

## EASTBOURNE ELECTRICITY WORKS.

The Lord Chancellor, Lords Macnaghten, Shand, and Lindley, in the House of Lords, have heard the appeal of the Corporation of Eastbourne *v.* the Attorney-General relating to the stamp duty in connection with the purchase by the appellants of the electric light undertaking.

The revenue authorities claimed that the conveyance should be stamped in respect of the whole cost of the undertaking, including both freehold and chattels The Corporation contended that they were not bound to pay the stamp duty on the portion of the purchase which embraced the chattels.

Without calling upon counsel for the respondent, the **Lord Chancellor,** in giving judgment said: I do not mean to go through all the different hypotheses put forward in order to show that plain words in an Act of Parliament have been cut down to an absurdity. The whole question turns upon the word "conveyance," although with some hesitation and considerable elocution the argument for the appellants comes to this, that the only portion of the statute which is intended to apply in this case is that relating to land, or what is the equivalent of land. The whole of that argument appears to me to depend upon the use of the word "conveyance," which they

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say only means, according to the technical view of the question, conveyance of land, or really whether land or not. My answer is that it is not true. The word "conveyance" means what it says—it conveys any property; it is an instrument which conveys property from one person to another, although it may be true to say while you are dealing with personal property it can pass by delivery, it is a very illogical consequence of that proposition to say that it may not pass in any other way and that you may not convey it by an ordinary conveyance. I think you may. When I look at the statute, I am content to apply it to the particular facts of the case with which your Lordships have got to deal. It would be impossible to say that the particular facts with which you have to deal are not included in the language of the statute. I heard a great deal about confusion, and ambiguity, and alternative construction, but when I apply the language of the statute to the transaction with which we are engaged, it appears to me absolutely clear that, in the natural meaning of the words, the statute does apply to the transaction. I decline to go into other hypotheses in cases where it might be supposed that the language is too wide. It is very important to show that the words seem to be absolutely clear, without confusion, or alternative construction, and apply literally and strictly to the transaction in question. Under these circumstances, I move that the appeal be dismissed.

Lords Macnaghten, Shand, and Lindley concurred.

## ELECTRIC TRAMWAYS CONSTRUCTION AND MAINTENANCE COMPANY.

In the Chancery Division Mr. Justice Byrne heard the petition of F. H. Barr and others for the winding up of the above company.

**Mr. Whinney,** for the petitioners, said that the petition had stood over on a previous occasion to allow of amendment. This had been done and the company had now approached his clients with a view to the petition again standing over. The company had offered the petitioners a certain sum, which it was possible they might be able to accept.

**His Lordship** directed the petition to stand for a week.

## CLAIM IN RESPECT OF ELECTRICAL PLANT.

Further evidence was heard at Manchester Assizes in the case of Lloyd's Packing Warehouses, Limited *v.* Veritys, Limited. The facts of the case have already appeared in these columns. Briefly, the plaintiffs are makers-up and manufacturers of packing-cases in Manchester, and the defendants are electrical engineers and manufacturers of electric plant, also carrying on business in Manchester and elsewhere. The plaintiffs' case was that in January, 1902, the defendants entered into a contract for the supply of electrical generating plant at the price of £1,187, such plant to be capable of dealing with the maximum load required or used by the plaintiffs' motors and machinery, and to produce sufficient power satisfactorily to run the whole of the plaintiffs' motors, etc., as then installed or about to be installed. The generating plant was to produce energy at a cost not exceeding 1d. per Board of Trade unit per hour. Plant was installed, in pursuance of the contract, and the plaintiffs paid on account £890. 15s. The plaintiffs alleged, however, that it was incapable of dealing with the maximum load required by their machinery, and that it did not and could not produce electricity at the stipulated cost. The plaintiffs alleged that they had lost the price paid for the plant, and claimed the difference between the agreed price and the cost of a plant equal to it in productive capacity.

Evidence was given in support of the plaintiffs' case by Mr. T. L. Miller, consulting electrical engineer, Manchester, and in support of the defendants' case by Mr. Cottrell, district manager for Messrs. Veritys, and others.

Eventually the case was again adjourned, and the arguments of counsel will be heard in London.

## EMPLOYMENT OF YOUTHS IN ELECTRICAL STATIONS.

At West Bromwich the West Bromwich Corporation were summoned for contravening the Factory Acts by employing a youth at their electrical works at Black Lake on Sunday, Jan. 17.

**Mr. J. Jackson** (factory inspector), who prosecuted, explained that William Shorthouse (17) was employed as a switchboard attendant from 4 o'clock till 10 p.m.

**Mr. A. A. Caddick,** who defended, submitted that the lad was employed owing to a mistake on the part of the engineer in reading the Act of Parliament. The engineer was under the impression that the Secretary of State had issued certain rules exempting electric lighting stations from certain provisions of the Factory Act, but had forgotten that this did not apply to Sunday labour.

The **Stipendiary** accepted this excuse, and said that it was difficult to understand some Acts of Parliament even if the reader had a knowledge of the law. Defendants were fined 5s. and costs.

## ASSESSMENT APPEAL.

At a special sitting of the Kingston Union Assessment Committee last week, the Wimbledon District Council appealed against the increased assessment of £4,357 gross and £2,500 net on their electric lighting station, mains and appurtenances. The former assessment was £3 418 gross and £1,200 net.

**Mr. R. H. S. Butterworth,** for the Council, said that if the committee were prepared to accept a net assessment of £1,500, he would have no further objection to make. In doing that, however, he must say he made the offer entirely without prejudice as to what they made their figures show, and were prepared to prove if they were compelled to take a course which he hoped would not be necessary. Because, although they said £1,500, yet their point was that at that amount they would be considerably over-assessed. Their object, however, was to have the matter amicably settled by the committee. He then dealt at considerable length with the figures as to cost of the undertaking and profits.

**Mr. Cooke** then stated the case in support of his assessment, and argued that the figures as published by the District Council showed an increase profit of £1,341 for 1903 over that of 1902.

**Mr. Butterworth,** in the course of the argument, said that no account had been taken by Mr. Cooke of the retention moneys on contracts. He had gone on returns which had to be sent to the Board of Trade, and had never applied for permission to go into the accounts at the offices, which would have been readily granted. There were some hundreds of pounds which they retained, mainly on machinery for six months, but the Council were only trustees of that money, and though it did not go to the Board of Trade in the returns sent to them, it was included in the following year when the amounts had been paid to the contractors.

After a hearing lasting nearly two hours the committee decided unanimously to reduce the net assessment to £1,700, letting the gross stand.

## NATIONAL ELECTRIC TRACTION COMPANY.

It is notified in the *London Gazette* that a petition for the winding-up of the National Electric Traction Company, Limited, has been presented to the High Court by a creditor, and that the same will be heard on the 23rd inst.

# COMPANIES' MEETINGS AND REPORTS

## LONDON UNITED TRAMWAYS (1901).

The report of the directors for the year ended Dec. 31 states that the operation during the past year has resulted in gross receipts amounting to £280 241, and the working and general expenses and renewals to £176,391, leaving, with the balance brought forward, a net revenue of £108,107 After payment of the debenture interest and the dividends on the preference shares, there remains £49,281, out of which an interim dividend at the rate of 8 per cent. per annum, less tax, amounting to £24,065, was paid in August, leaving an available balance of £25,216. Of this amount it is proposed to appropriate £24,429 in payment of a final dividend on the ordinary shares for the half-year ended Dec. 31 at the rate of 8 per cent. per annum, less tax, and to carry the balance of £787 to the credit of the next account. The extensions of the Company's system to Hampton Court and the Thames Valley were opened in April last, and the results of the Company's operations during the first season, although to be regarded as satisfactory, fall far short of the traffics which would have been secured, without any additional expense, if the weather conditions had been at all normal. The directors had anticipated that under ordinary circumstances the profits of the year would have been sufficient not only for the dividend, but to set aside a very substantial sum to a reserve fund, the establishment of which the shareholders would probably prefer should now be deferred until the next annual account. It is gratifying to know that, whenever the weather conditions favour pleasure travelling, the receipts invariably exceed the estimates which had been formed of this important branch of the traffic. The total number of passengers carried during the year was 45,293,473. For the purpose of facilitating the interchange of traffic at Hammersmith between the Company's tramways and the Metropolitan District Railway, and also with a view to connecting up the Company's authorised tramway from Barnes and Mortlake to Richmond with the main system, the directors are promoting a Bill to authorise underground electric railways to convey the Company's cars from the surface of the street at Hammersmith-broadway and at the south side of Hammersmith Bridge, direct to the platform of the District Railway Company's Hammersmith Station. It is anticipated that when the electrification of the District Railway has been completed, and their proposed reduced fares have been brought into force, the facilities for through booking and exchange of traffic, which will be afforded by the proposed system of underground railways connecting at Hammersmith, will prove of great public convenience and advantage to the companies concerned.

## METROPOLITAN ELECTRIC TRAMWAYS.

The directors in their report for the year ended Dec. 31 last state that the Company holds 78,504 out of a total of 110,923 issued shares in the North Metropolitan Tramways Company, which operates, by horses, 48¼ miles of tramways, under lease from the London County Council. The Company has also acquired about two-thirds of the issued share capital of the Harrow-road and Paddington Tramways Company, and has entered into an agreement for the purchase of that company's undertaking, consisting of 2¾ miles of tramways, situated in the metropolitan borough of Paddington and the urban district of Willesden. An Act of Parliament obtained last year authorised the conversion of these tramways to electric traction, and a Bill has been deposited to confirm the agreement for sale and to authorise certain street widenings. Conditionally upon these widenings being carried out, the Willesden Urban District Council has agreed not to exercise its rights of purchase under Section 43 of the Tramways Act, 1870, until June 25, 1930. The County Councils of Middlesex and Hertfordshire have entered into agreements to construct and to lease to the Company about 49½ miles of light railways, of which 37½ miles have been authorised, and the

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remainder are awaiting confirmation by the Board of Trade; 11½ miles, which are under construction by the County Council of Middlesex, are now being electrically equipped by the Company. The Company's own tramways—8½ miles in length—of which 7½ miles are in Middlesex and the remainder in the county of London, are still worked by horses; but the work of reconstruction for electric traction, which was commenced early last year, is nearing completion. It is anticipated that these 20 miles of tramways and light railways will be opened for public traffic by electric traction this summer. The gross revenue for the period covered by the account amounted to £92,276. The gross traffic receipts from the horse tramways owned by the Company, amounting to £66 973, are satisfactory. After deducting all expenses chargeable to revenue, interest on the £150,000 3½ per cent. debentures of the North Metropolitan Tramways Company and on the bank advance, and writing off £1,319, there remains a net profit of £22 198. The dividend of 5 per cent. on the cumulative preference shares for the year absorbs £20,350, leaving a balance of £1,848, which is repayable to the British Electric Traction Company, Limited, in reduction of the amount of £5,276 provided by them in January, 1903, under their guarantee of the preference dividend.

## NATIONAL TELEPHONE.

The report of the directors for the half-year ended Dec. 31 last states that the income accrued in respect of the business of the half-year amounts to £941,239, as compared with £868,462 for the corresponding period of 1902, being an increase of £72,797. Working expenses for the half-year amount to £527,284, as compared with £473,268, an increase of £54,016. The net result for the half-year, after deducting the Post Office royalties (amounting to £86,236), is a profit of £327,739, as compared with £316,553, an increase of £11,186. Rentals carried forward for unexpired terms of running contracts amount to £827,164, as compared with £771,103, an increase of £56,061. Out of the available balance of £269,422 the Board recommends a dividend for the half-year at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock. It is also proposed to transfer £110,000 to reserve fund, and to carry forward £10,505. The sum of £413,288 has been expended on capital account during the half-year in the erection of 16,891 additional exchange and private stations, and in the construction of underground works.

## METROPOLITAN DISTRICT.

The report of the directors for the half-year ended Dec. 31 last states that, in accordance with the powers conferred upon the District Company and the Great Northern Piccadilly, and Brompton Railway, an agreement has been entered into under which the Brompton Company is now constructing the portion of the deep-level railway from South Kensington to West Kensington, including a junction between the two railways. These works are now in rapid progress. Provision is being made in the District Company's Bill in this session for widening the lines between West Kensington and Hammersmith, so as to provide four lines of railway. A new station is also about to be erected at Barons Court-road. Powers are being taken in the Company's Bill to introduce a system of zone or uniform fares over certain sections of the railway, and the abolition of certain short-distance fares. No alterations are proposed in the Company's obligations with reference to workmen's fares. Electrical traction and equipment is being pushed on with as much rapidity as possible. The power-house at Lots road, Chelsea, is now being roofed in. The subways from Chelsea to Earl's Court are completed. The sub-stations are well in hand. The ducts are completely laid. Contracts for the cables are let. The Company's new depôt at Mill Hill Park has been commenced. An arrangement has been made with the Metropolitan Company as to the electrical equipment of the joint City lines, from Mansion House to Aldgate (High-street), and the work is now being rapidly proceeded with.

## NORTHAMPTON ELECTRIC LIGHT AND POWER.

The report of the directors for 1903 states that the charge for lighting purposes was reduced at the commencement of 1903 from 6½d. and 3½d. to 6d. and 3d. per unit. This and the former concessions in price involve at the outset a considerable diminution of revenue, but will assist materially in building up a larger business, and the development in the supply of energy for motive power is especially marked and satisfactory, the staple industry in Northampton being particularly suitable to the employment of electric motors. The lamps and motors fixed during the year were: lamps 3 403 and motors 4 485 (all reckoned in the equivalent of 8-c.p. lamps), as compared with lamps 2 916 and motors 930 added in the preceding year, making a total of 33,310 lamps and (the equivalent of) 7,545 in motors, together 40 855. The separate consumers in 1901 were 502; in 1902, 580; and in 1903, 704. The annual increase in motive power, measured by horse-power, is thus shown: 1901, 20 h.p.; 1902, 31 h.p; and 1903, 149½ h.p.—the total installed being 251½ h.p. Of these a large proportion, representing 133½ h.p., are the property of the Company, and let out on hire. The units sold for driving motors during the past two years were 40,397 and 103,110 respectively. The mains have been largely extended with the especial object of opening up the important manufacturing and residential districts of St. James's End and Dallington. The increase is 4 miles 78 yards, making a total of 13 miles 313 yards. The necessary steps have been taken to obtain a provisional order for extending the area of supply, which will include not only the added portions of the county borough, but a number of surrounding parishes. It is hoped that the order will be granted by the Board of Trade at an early date, in which case it will be laid before Parliament for confirmation in the ordinary course. It has been found practicable to carry out all extensions and developments up to the present time with the help of borrowed capital, it being obviously undesirable to increase the share capital until it became absolutely necessary. This step cannot, however, be longer deferred, and accordingly a resolution for the increase of capital will be submitted at an extraordinary meeting to be held immediately after the general meeting. The issue of shares will take place as soon thereafter as practicable. Opportunities occurred during the past year for displacing and selling a considerable amount of plant, to a larger extent than would ordinarily or from choice be effected within any period of 12 months. This involves writing off the depreciation fund the sum of £1,760, but with the result that the Company is placed in possession of new and improved boilers, engines, etc., all conducive to profitable working. A sum of £1,200 is now appropriated in augmentation of the depreciation fund. The directors a few months since received an intimation from the Finance Committee of the Town Council that they were instructed to endeavour to reopen negotiations for the purchase of the Company's undertaking, and asking for facilities for inspection of the generating station and mains, and for other information. These facilities and information have been given, and in the event of matters proceeding further, the directors would in due course communicate again with the shareholders. It is now proposed to pay dividends on the 6 per cent. preference shares and on the 5 per cent. preference shares for the half-year, also one year's dividend on the ordinary shares at 4½ per cent., and to carry forward £209.

## NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.

The report of the directors for 1903 states that the installations connected to the Company's mains during the year are equal to 15,361 8-c.p. lamps, bringing the total up to about 101,824, and 2,649,841 units of electrical energy have been supplied, as against 2,107,104 units supplied in 1902. During the past year 9,936 yards of main and branch piping and troughing have been laid, together with 47,780 yards of main and branch cable. The gross earnings for the year amount to £16,330, and after paying the interim dividend and interest on debentures and loans pertaining to revenue account, the directors recommend the usual dividend of 5 per cent. for the half-year ended Dec. 31, which, with the interim dividend paid in August last, makes 8½ per cent. for the year, carrying forward £633. Owing to impending extensions, involving certain capital expenditure, and in order to pay off temporary loans, it is proposed to issue 10,000 new shares, wherefore an extraordinary general meeting will be held immediately after the ordinary meeting to consider and, if approved, pass resolutions in reference to this increase of capital.

## BRITISH ELECTRIC TRANSFORMER.

The directors, in their report for the year ended Dec. 31, state that the result of the first year's working is in their opinion very satisfactory. After placing £500 to the credit of a reserve fund to provide for depreciation, there remains a net profit of £9,714. 12s. 2d. This amount the directors propose to deal with as follows: capital suspense account, £548. 15s. 3d.: payment of dividends of 6 per cent. on the cumulative preference shares, £635. 11s. 3d, and 7 per cent. on the ordinary shares, £3,960. 8s.; reserve fund (exclusive of depreciation reserve), £2,000; amount written off preliminary expenses, £1 000; balance carried forward, £1 569. 17s. 8d. Two large bays, together with the necessary stores accommodation, have been added to the buildings, thus increasing the floor space by nearly 70 per cent. The plant and machinery for these extensions is now being installed, and the offices considerably enlarged, to enable the Company to cope with its increasing business. The directors have during the year invested sums to the amount of £6,000, as shown in the balance-sheet. These are already proving productive in the way of orders.

## BROCKIE-PELL ARC LAMP.

The report of the directors for the 18 months ended Dec. 31 last states that after writing off £632 for depreciation on tools and patterns there remains a debit of £65 to be carried forward. The present depression of trade, and the extremely keen competition both of English and foreign arc lamp manufacturers, have caused a reduced turnover and smaller manufacturing profits. During the period under review the Company has received large (extension) orders for lamps for the lighting of St. Pancras and Partick, besides orders for Glasgow, Shoreditch, Southend, Leeds, Stretford, and West Ham.

## BAKER STREET AND WATERLOO RAILWAY.

The half yearly meeting of the proprietors of this railway was held at Hamilton House.

In moving the adoption of the report, **Mr. T. Julius Hare** (the chairman) said the capital expenditure during the half-year had amounted to £204,175 while the estimated expenditure for the current half-year was £300,000. Satisfactory progress had been made with all the works, and the tunnelling from Waterloo to Dorset-square was completed, with the exception of about 40 yards. It was believed that the work would be finished by the end of the year. Equally satisfactory progress was being made with the Elephant and Castle extension. The railway, when completed, would be as safe to travel upon as it was possible to make it, and when their line was opened it would largely contribute to supply an electric underground system which would bring every part of London into convenient communication, and enable passengers to travel rapidly and cheaply all over the Metropolis.

**Sir Algernon West** seconded the motion, which was carried.

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## NEWCASTLE ELECTRIC SUPPLY.

The directors in their report for the year ending Dec. 31, 1903, state that the total units sold during the year amounted to 9,033,625, which compared with the previous year's figures of 5,537,500 units, shows an increase of 3,496,125. The profit of the year, including the balance of £759. 14s. 4d. brought forward, amounts to £41,826. 18s. 4d., out of which there have been paid interest on debentures and loans, £14,031. 12s. 9d, and interim dividends paid in August last at 2½ per cent. on the amount called up on the preference shares, and 4 per cent. on the amount called up on the ordinary shares, £11,038. 0s. 1d., leaving a balance now to be dealt with of £16,757. 5s. 6d., which the directors recommend should be appropriated as follows: in the payment of a further dividend of 2½ per cent. on the amount called up on the preference shares, and 4 per cent. on the amount called up on the ordinary shares making a total of 5 per cent. and 8 per cent. upon the preference and ordinary share capital respectively; in the payment of a dividend of 5 per cent. for the full year on the preference shares allotted in connection with the purchase of the Walker and Wallsend Gas Company's electrical undertaking; in the payment of a dividend of 6 per cent. for the full year on the ordinary shares allotted in connection with the purchase of the Walker and Wallsend Gas Company's electrical undertaking; leaving a balance to be carried forward of £1,099. 0s. 8d. In view of the large expenditure on the capital account during the past two years, of which at least £200,000 is as yet unproductive of revenue, the directors have not dealt with the general question of depreciation on plant, further than by the transfer from reserve of £100,000 referred to in the last report. They are, however, alive to the fact that when the capital now being expended become revenue-bearing, the question of appropriating profits for the purpose of meeting depreciation will have to be dealt with as circumstances permit. The expenditure on capital account had been increased during the year by £357,256, which included the purchase of the assets of the electricity undertaking of the Walker and Wallsend Union Gas Company, and the outlay on the new generating station at Carville as well as the ordinary extensions to the Company's system. The directors have obtained an interest for this Company in the Priestman Power Company, Limited.

## SMITHFIELD MARKETS ELECTRIC SUPPLY.

The ordinary general meeting of the shareholders was held on the 12th inst. at Winchester House, E.C., Mr. Herbert S. Leon presiding.

The **Chairman** said that he had to express very great regret that within the last few days a serious accident had taken place in Smithfield, which had entailed the loss of the life of one of the Company's men, and the non-supply of current for a few hours to the market. It was the first accident which had taken place at the Company's works, and, so far as could be seen from an examination, no fault could be attributed to anyone. The plant was as well equipped as possible, and he could give no reason for the accident. He wished to be excused saying anything further until an enquiry, which he expected would be made by the Board of Trade, had been held. The general position of the Company continued to give satisfaction. The Company's current was of the finest quality, and its customers grumbled less than those served by other companies. It would be seen from the report that, in spite of the fact that the price of the current had been reduced to a uniform rate, the profits had increased. The number of lamps had also shown an increase, and there were still a few shops in the market to come in, so that it was possible for the Company to make some further augmentation to its profits. There was always a contingency that the price of coal would rise, and that would affect the Company's income the wrong way. The engines and dynamos were in even a better state than when they were bought, and the new engine had enabled the Company to work more economically than previously, but the good results of that engine would appear more in 1904 than the past year. Revenue was debited with £80 for interest on money borrowed from the reserve. He thought the shareholders would agree that it was much better to use the reserve fund for that purpose than to borrow outside at 5 per cent. Although the output of electricity had been 7 per cent. greater, the cost of production showed a decrease of £200. The directors anticipated spending some more money on capital account, because a new boiler was required. The cold-air store was practically completed, but was not yet in working order.

**Mr. Ernest Schenk** said that the accident would not make any difference to the Company in a pecuniary sense. Compensation to the widow was insured against, and the actual damage done to the works would only amount to about £20.

The report was adopted.

## WATERLOO AND CITY.

The half-yearly meeting of the proprietors of this railway was held on the 12th inst. at Waterloo Station, Sir Charles Scotter presiding.

The **Chairman** said that a few of the shareholders might, perhaps, be a little disappointed at the result of the past half-year's working, but there was really no cause for anxiety. The revenue of the railway showed steady progress up to August last. On the 10th of that month the deplorable accident occurred on the Metropolitan Railway of Paris, by which a large number of lives were lost, and there was no doubt whatever that that disaster was the cause of the gradual falling off in the traffic of the Waterloo and City Railway. The decrease continued for about four months, up to November last, but he was glad to say that, as far as they knew, any loss which had been caused by the Paris accident had been overcome, and the traffic again showed steady, if small progress. There was no doubt that the deplorable result of the accident on the Paris railway was caused by the fact that when it occurred the whole of the lights went out—that was to say, the tunnel, stations, and carriages, everything in connection with the railway, was in total darkness. On the Waterloo and City Railway the lighting of the stations and of the tunnel was absolutely independent of the motive power which worked the train, so that, in case of an accident to the train, the lighting of the stations and of the tunnel would not be interfered with in the slightest degree. There was also a gas installation besides the electric installation, and in addition there was an oil lamp in every carriage. In case of an accident on the Waterloo and City Railway, means were provided by which passengers could get out at each end of the carriage, and they could then walk on a pathway to the stations at either end. There would be no risk in doing this of coming into contact with the electricity on the third rail, because means were provided by which every driver on the railway could, in a few seconds, cut off the electricity from the centre rail without communicating with the generating station at the Waterloo end. No danger, therefore, would be incurred if a passenger walked through the tunnel, under the circumstances mentioned, of his sustaining any electrical shock—a fact which was of great importance. Passengers, moreover, had no fear of meeting another train in the tunnel, because every train would stop at once on the driver of the motor cutting off the electricity from the third rail. He might also state that the railway was absolutely well ventilated. There had been a falling off in the revenue of £300, and a slight increase in the expenses, which included an amount of £160 paid as compensation, not to a passenger, but to one of their workmen. Had it not been for this the directors would have been able to pay the same dividend as last year—3¼ per cent. The traffic for the current half-year was growing steadily, and there was no reason why, in the course of time, they should not go on increasing the dividend by small additions. The dividend now proposed, at the rate of 3 per cent. per annum, would leave £354 to be carried forward.

The report was adopted.

## NATIONAL ELECTRIC SUPPLY.

The ordinary meeting of the shareholders in this Company was held on Thursday last week at Preston, Mr. J. Booth presiding.

The **Chairman**, in moving the adoption of the report, congratulated them on the improved position of the Company. The Company kept getting new consumers and they had increased their capital account by laying new mains to the extent of about 5¾ miles. Another important item was a new stores warehouse, battery-room, and workshop which they had erected. To meet this capital expenditure they had issued preference shares and accepted loans at 4 per cent.

**Mr. Curwen** seconded the resolution, which was carried unanimously.

Dividends of 4 per cent. for the year on preference shares and 5s. 6d. per share on the ordinary shares for the half year, making with the interim dividend paid in July, 9s. 6d. per share for the year, also a dividend of £4. 1s. 4d. per share on the founders' shares, were declared.

## METROPOLITAN DISTRICT RAILWAY.

The half-yearly meeting of the shareholders in this Company was held on Thursday last week at the Westminster Palace Hotel, Mr. R. W. Perks presiding.

In moving the adoption of the report, the **Chairman** said that, as most of them were aware, the Company was going through a period of somewhat trying transition, as the railway was being rapidly prepared for electrical traction, and it was impossible to make in some directions those provisions for future extensions which otherwise they might have been disposed to do in the way of additional accommodation for the public. A Bill was being put through Parliament to allow the cars of the London United Tramways Company to come down to the level of the District Company's platforms at Hammersmith. Great progress had been made in the electrification of the line. The South-Western Railway Company had entered into contracts for the equipping of their Turnham Green and Richmond and Putney and Wimbledon lines, and it was guaranteed that they should be finished simultaneously with the District branch and main lines. They expected considerable revenue from power supplied to other companies, and also for cable rents. At Mill Hill they were building a large shed for the storing and repairing of their own cars, and also of those of the tube companies. They had invited tenders from English firms for the whole of the rolling-stock—60 new trains; four were at work at Ealing already. Nearly all the contracts had been let to British firms, and that was the case with the tube railways, too. Some £300,000 had already been spent on equipment, and between £800,000 and £900,000 more would be required to complete the work. He could not prophesy much for the next 12 months, but once the railway was electrified and they could give the public a good article at a cheap price, they would, he was sure, see a good return. During the last 30 years the District Railway had carried more passengers than the entire population of the globe.

**Major L. H. Isaacs** seconded the motion for the adoption of the report and accounts, which was carried unanimously.

A special meeting was subsequently held, at which Bills pending in Parliament were approved authorising the Metropolitan Company to convert and consolidate present capital, and to raise additional capital, and empowering the London United Tramways Company to construct lines between those existing and the Hammersmith stations of the District Railway.

## ANGLO-AMERICAN TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at Winchester House, E.C., on the 12th inst., Mr. Samuel Barber, in the absence of the chairman and deputy-chairman, presiding.

In moving the adoption of the report, the **Chairman** explained that

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the falling off in their traffic receipts during the year was due to the general slackness of trade, the prosperity of telegraphic enterprises naturally depending upon the prosperity of trade. The balance available for dividend resulting from the last half-year's business was £109,628, as against £117,206 for the corresponding period of 1902. Notwithstanding the loss in profit, they were able to pay the preference stockholders their full dividend, while the deferred got 2 per cent. Their renewal fund now amounted to £982,103, though if they were to take that at present market value it would be reduced by £44,000. He could not hold any great hopes for the year now entered upon, as business generally was still very slack in all the branches they had dealings with. Everything would be done to secure traffic, and if they did get it they could carry it.

The report was adopted.

## BRISTOL TRAMWAYS AND CARRIAGE.

The ordinary general meeting of the shareholders was held on Wednesday at Bristol, Mr. George White presiding.

The report of the directors for the year ending Dec. 31, 1903, stated that the gross receipts for the year amounted to £253,150. 5s. 6d., and the working and general expenses and renewals were £164,762. 17s. 8d., leaving a net revenue of £88,387. 7s. 10d. The following amounts have already been distributed—viz : interest on 4 per cent. mortgage debenture stock and temporary loans, £11,301. 11s. 9d. ; dividend on 4 per cent. preference shares, £19,000 ; interim dividend at the rate of 8½ per cent. (subject to income tax) for the half-year ending June 30, £20,098. 19s. 2d.; and it was proposed to appropriate the balance as follows : final dividend for half-year at the rate of 9½ per cent. (subject to income tax), £22,661. 9s. 2d. ; addition to reserve for contingencies fund, £15 325. 7s. 9d. The interest on investments had also been carried to the credit of the contingencies fund, and the values of the investments having been adjusted to market prices at Dec. 31, 1903, the reserve funds now amount to £127,458. 17s. 9d. The receipts from the tramways department show the substantial increase of £14,771, which is equivalent to about 7½ per cent., although the system of tramways operated compares exactly with the mileage open during the preceding year. The receipts of the carriage department also show an increase of £611. The total number of passengers carried during the year on the Company's cars and omnibuses was 44,391,439. A Bill has been deposited by the Company in Parliament to authorise extensions of the Company's system for about 11 miles on several of the main roads running out of Bristol, which, if authorised, should prove of great public advantage.

The **Chairman**, in moving the adoption of the report, commented on the accounts. The reserve fund stood at £112,133, as against £102,056, in addition to which there would be £15,325 set aside that day, making the total £127,458. Each year they carried to the reserve fund the interest earned on investments, and in this case it was £3,529. Their investments, which were of a high-class character, had in common with other securities suffered a diminution in market value, the depreciation being £4 715. The directors had decided to write down the investments to market value.

**Mr. J. Clifton Robinson** seconded the motion, which was carried.

A special meeting was afterwards held, when the Bill above referred to was approved.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cuenia (Spain).**—The Municipality require tenders for the public lighting for 15 years, 5,000 c.p. Tenders by 26th inst. Particulars from the above.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Wrexham.**—The Town Council invite tenders for stores, including various electrical fittings. Particulars from the Borough Electrical Engineer. Tenders by March 12.

**Port Elizabeth.**—The Municipality invite tenders for the supply of telephone material. Specifications, etc., from Davis and Soper, 54, St. Mary-axe, London, E.C. Tenders by Feb. 22.

**Islington.**—The Council invite tenders for supply of electrical stores, etc., for one year. Particulars may be obtained at the Town Hall, Upper-street, N. Tenders by noon on 25th inst.

**Walsall.**—The Electricity Committee invite tenders for extension to the existing boiler-house, also boiler, small engine, and exciting dynamo at the Wolverhampton-street generating station.

**Wiring.** — The May-Oatway Fire Appliances, Limited, invite tenders for wiring various buildings. Particulars from Managing Director, 49, Queen-street, Glasgow. Tenders by 24th inst.

**Newport.**—The Tramways Committee invite tenders for 10 electric tramcars and a motor trolley wagon. Particulars from Mr. H. C. Bishop, M.I.E.E., tramways manager. Tenders by Feb. 22.

**St. Annes-on-Sea.**—The Urban District Council invite tenders for a steam dynamo. Specifications from Mr. J. H. Clothier, Electricity Works. Tenders by noon on 27th inst. See advertisement.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for the year ending March 31, 1905 Tenders by 4 p.m. on March 2 to the Town Clerk. See advertisement in last issue.

**Salford.**—Tenders are invited for various electrical materials for 12 months. Specifications, etc., from the Electrical Engineer's Office, Frederick-road, Pendleton. Tenders by 29th inst. See advertisement.

**Edinburgh.**—The School Board invite tenders for electric light installation at Boroughmuir Higher-Grade School. Specifications may be obtained at the office of Mr. J. A. Carfrae, 3, Queen-street. Tenders by 20th inst.

**Radcliffe (Lancs.).**—The Urban District Council invite tenders for station lighting and wiring to motors, testing instruments and accessories. Specifications, etc., may be obtained from the Clerk. Tenders by 20th inst.

**Kilmarnock.**—The Corporation invite tenders for the various plant in connection with electric lighting and tramways. Specifications, etc., can be obtained from the Town Clerk. Tenders by 29th inst. See advertisement.

**Greenock.**—The Corporation invite tenders for one 400-kw. steam-driven traction and lighting generator. Specifications from Mr. J. A. Robertson, Hunter-place, Greenock. Tenders by Feb. 25. See advertisement in last issue.

**Sunderland.**—The Corporation invite tenders for the supply of travelling crane and storage battery. Specifications, etc., from Mr. John F. C. Snell, M.I.C.E., Town Hall. Tenders by Feb. 26. See advertisement in former issue.

**Manchester.**—The Rivers Committee invite tenders for the supply of various articles for 12 months from April 1, including electrical goods. Specifications from Secretary, Rivers Department, Town Hall. Tenders by 10 a.m. on 29th inst.

**Bermondsey.**—The Borough Council invite tenders for wiring building and supply and erection of fittings for installation of electric light at the generating station. Specifications can be obtained at the Town Hall. Tenders by March 1.

**Kirkcaldy.**—The Corporation invite tenders for the platelaying and permanent way inside the extension car-sheds. Specification, etc., from Mr. O. F. Francis, Electricity Works, Victoria-road, Kirkcaldy. Tenders by noon on 27th inst.

**Gainsborough.**—The Urban District Council invite tenders for telephone instruments, fire alarms, and connecting overhead wires. Specification from Mr. R. W. Fraser, electrical engineer to the Council. Tenders by March 16. See advertisement.

**Salford.**—The Tramways Committee invite tenders for 12 months' supply (ending March 31, 1905) of various stores. Particulars may be obtained from the Tramway General Offices, 32, Blackfriars-street, Salford. Tenders by 3 p.m. on 26th inst.

**Sheffield.**—The Tramways Committee invite tenders for the supply of general stores for 12 months, including electrical supplies. Forms of tender from Mr. A. R. Fearnley, Tramways Department, Town Hall, Sheffield. Tenders by 10 a.m. on 22nd inst.

**Leek.**—The Urban District Council invite tenders for the wiring and fitting-up complete for electric light of their electricity generating station. Specifications, etc., can be obtained from Mr. C. Henshaw, clerk, Town Hall. Tenders by 12 noon on 22nd inst.

**Hammersmith.**—Tenders are invited for the supply of electricity meters, house service boxes, and fuse boxes for the ensuing 12 months. Specifications from Mr. G. G. Bell, 57, Fulham Palace-road. Tenders by 6 p.m. on Feb. 24. See advertisement in last issue.

**Rathmines.**—The Urban District Council invite tenders for the supply of various electrical stores for the 12 months ending March 31, 1905. Specifications from Mr. F. P. Fawcett, clerk to the Council. Tenders by 20th inst. See advertisement in last issue.

**Ealing.**—The Corporation invite tenders for a 750-kw. steam alternator, central surface condenser, etc. Specification from Mr. J. Douglas Knight, M.I.E.E., Electricity Works, South Ealing, W. Tenders by 25th inst. See advertisement in last issue.

**Hanley.**—The Corporation invite tenders for the supply, delivery, and erection of alternators, condensing plant, superheaters, etc. Specifications from Mr. C. A Cowell, Electricity Works, Park-road. Tenders by Feb. 22. See advertisement in former issue.

**Edinburgh.**—The Corporation invite tenders for engine and dynamo for electricity supply station at M'Donald-road. Specifications, etc., from the Electrical Engineer, Dewar place Station. Tenders by Feb. 22. See advertisement in former issue.

**Bury.**—The Tramways Committee invite tenders for the purchase of old tramway rails, fishplates, tiebars, points, crossings, nuts, and bolts from about seven miles of track. Particulars from Mr. A. W. Bradley, borough engineer, Bury. Tenders by 24th inst.

**Cape Town.**—Tenders are invited for arc lamps and accessories for the general lighting of the forthcoming exhibition. Specifications, etc., may be obtained from the Torque Electrical Engineering Company, 20 to 28, Dalling-road, Hammersmith. See advertisement.

**London, E.C.**—The Metropolitan Asylums Board invite tenders for installations of fire alarms and telephones at their asylum. Caterham, Surrey. Specifications, etc., can be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on March 8.

**Blackburn.**—The Electricity Committee invite tenders for supply of various stores for the year ending March 25, 1905. Specifications, etc., from Mr. A. S. Giles, Electricity Works, Jubilee-street, Blackburn. Tenders by Feb. 29. See advertisement in last issue.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Whitehaven.**—The Town Council invite tenders for the supply of various stores during the year ending March 31, 1905, including electric fittings and glow lamps. Forms of tender from the Borough Engineer, Town Hall, Whitehaven. Tenders by 10 a.m. on 23rd inst.

**Stourbridge.**—The Urban District Council invite tenders for engines and dynamos, watertube boiler, balancer booster, overhead hand crane, storage battery. Specifications from Electrical Engineer,

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Town Hall. Tenders by 12 noon on Feb. 26. See advertisement in last issue.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr. J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Halifax.**—The Corporation invite tenders for the supply of engine-room stores and ironmongery and wrought-iron goods required during the 12 months ending March 31, 1905. Forms of tender may be obtained from the Borough Electrical Engineer, Foundry-street, Halifax. Tenders by 12 noon on Feb. 26.

**Hornsey.**—The Town Council invite tenders for stores for electricity works, and cables and cable stores, etc., in connection with their electricity supply. Specifications, etc., on application to Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 4 p.m. on 29th inst.

**Swindon.**—The Corporation invite tenders for the supply and delivery of various stores during 12 months ending March 31, 1905 including ironmongery and electrical fittings and iron castings and lamps. Particulars can be obtained from Mr. H. J. Hamp, Town Hall, Swindon. Tenders by 12 noon on 27th inst.

**Coventry.**—The New General Traction Company, Limited, invite tenders for the construction of about three miles of new tramways and the reconstruction of 5¼ miles of tramways. Specifications, etc., may be obtained from Mr. I. E. Winslow, engineer, 30, Bishopsgate-street Within, E.C. Tenders to the Engineer by March 5, at 1 p.m.

**Aston Manor.**—The Corporation invite tenders for one 750-kw. continuous-current dynamo coupled direct to a vertical cross-compound engine, speed not to exceed 100 revolutions per minute. Specifications from the Electrical Engineer, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on Feb. 22. See advertisement in last issue.

**Manchester Ship Canal.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection of 25 electric hoists and 10 electric fixed cranes for transit sheds. Specification, etc., can be obtained from Mr. W. H. Hunter, M.I.C.E., chief engineer, 41, Spring-gardens, Manchester. Tenders by March 1.

**Battersea.**—The Borough Council invite tenders for the supply of the following materials for the electricity department for one year from March 31: coal, oil and engine-room stores, carbons for arc lamps, electricity meters. Forms of tender from the Electrical Engineer, Electric Light Station, Lombard-road, London, S.W. Tenders by 12 noon on 22nd inst.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**Cambuslang (Scotland).**—The Lanark County Council invite tenders for providing and erecting engines, dynamos, switchboards, lamps, main and distributing cables, and other works necessary to provide a complete system of electrical supply within the lighting district. Specifications, etc., from Messrs. Hunter and Jack, 101, St. Vincent-street, Glasgow. Tenders by 10 a.m. on 29th inst.

**Shoreditch.**—The Council invite tenders for various articles and works during year from April 1 to March 31, 1905, including electric cables and sundries, gas pipe and fittings, and engineers' stores. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender may be obtained from Mr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, Old-street, E.C. Tenders by March 8.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Wimbledon.**—The Urban District Council invite tenders for the supply of engine-room stores, cables, joint boxes and jointing material, transformers, meters, lubricating oils, and incandescent lamps and carbons to the electricity department during the year ending March 31, 1905. Specifications may be obtained from the Chief Electrical Engineer, Electric Light Works, Durnford-road, Wimbledon. Tenders by March 18. See advertisement.

**Islington.**—Tenders are invited for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors and pilot cable, with feeding, junction, and service boxes. Specifications, etc., from the Borough Electrical Engineer, 50, Eden-grove, Holloway, N. Tenders by Feb. 24. See advertisement in former issue.

**Christiania.**—The Board of Trade have received from H.M. Consul-General at Christiania copy and translation of a call for tenders for supply to the Norwegian State Railways of telegraph and telephone material. Tenders for the supply of the following articles will be received at the office of the management—address Styre'sens Expeditionskontor, Statsbanerne Christiania—by 3 p.m. on 26th inst.: 3,000 kilogs galvanised iron wire 2·9mm. to 3·1mm. diameter; 1,000 kilogs galvanised binding wire of iron 1·5mm. diameter; 1,000mm. seven-strand insulated copper cable, 7 by 0·4; 1,000 porcelain insulators; 1,000 carbon plates ("Kulplader") for Leclanché elements; 400 kilogs salmiac (?); 4,000 (3,000 large and 1,000 small) rolled zinc bars for battery zinc. Regulations, etc., at the office of the Inspector of Telegraphs. Apart from the usual customs duties a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

## RESULTS OF TENDERS.

**Windsor.**—The Town Council have accepted the tender of the Electrical Installation Company for public town lighting for five years.

**Barnstaple.**—The Town Council have accepted the tender of Messrs. Alger, at £115, for fitting up the music hall for the electric light.

**Cardiff.**—The Electrical Committee have accepted the tender of Siemens Bros. and Co. for a new engine and generator of 500 h.p., at £3,390.

**Hammersmith.**—The Borough Council have accepted the tender of the British Transformer Manufacturing Company, at £720, for six additional 100 kw. transformers.

**Croydon.**—Messrs. Dorman, Long, and Co., Middlesbrough, have secured the contract for the supply of finished steelwork and other material required in connection with the electrical power station.

**Cape Town.**—The contract for the electric lighting and power at the forthcoming Industrial Exhibition, 1904-5, has been placed with the Torque Electrical Engineering Company, 20-28, Dalling-road, Hammersmith.

**Walsall.**—The Town Council have accepted the tender of Messrs. Arundale and Hobottom, at £974, for electric wiring the new Town Hall, and that of the Walsall Electric Company, at £292. 2s. 3d., for fitting up the telephones.

**Bradford.**—The tender of Messrs. Bolckow, Vaughan, and Co., Limited, Cleveland Steelworks, Middlesbrough, has been accepted for 750 tons of girder steel rails, at £5. 13s. 11d. per ton, and steel fish-plates at £7. 3s. 11d. per ton.

**London County Council.**—The Council have received the following tenders for the reconstruction for electrical traction of the cable tramways between Kennington and Streatham and for the construction of tramways in Tooting High-street and Defoe-road. Total length about eight miles of single track:

| | |
|---|---|
| W. Griffiths and Co., Limited, London* | £86,623 19 11 |
| J. G. White and Co., Limited, London | 95 005 7 4 |
| Dick, Kerr, and Co., Limited, London | 95 751 7 9 |
| E. Nuttall and Co., Manchester | 97,132 13 1 |
| W. Underwood and Bro., Dukinfield | 99,221 0 0 |
| R. W. Blackwell and Co., Limited, London | 104,604 10 6 |
| Pethick Bros, London | 110,142 16 8 |
| J. Mowlem and Co., Limited, London | 111,710 0 0 |
| W. Kennedy, London | 113,896 12 11 |
| G. Law, Kidderminster | 128,587 11 3 |

* Recommended for acceptance.

**Cardiff.**—The Town Council have received the following tenders for the manufacture and supply of about 400 tons of steel tramway rails, also for fishplates, bolts, and nuts: rails and fishplates—Steel, Peech, and Tozer, Limited, Sheffield, 105lb. rails £7 per ton, 111lb. rails £7, fishplates £8. 2s. 6d.; Barrow Hematite Steel Company, Limited, Barrow-in-Furness, £6. 9s. 6d., £6. 9s. 6d., and £7. 9s. 6d.; W. Scott, Limited, Leeds £6. 5s., £6. 5s., and £7. 15s.; North-Eastern Steel Company, Limited, Middlesbrough, £5. 19s. 9d., £5. 19s. 9d., and £5 19s. 9d.; A. Penney and Co., London, £5. 17s., £6. 17s., and £6. 7s.; P. and W. Maclellan, Limited, Glasgow, £5. 14s. 10½d., £5. 17s. 3d., and £6. 7s. 3d.; Bolckow, Vaughan, and Co., Limited, Middlesbrough, £5. 15s., £5. 15s., and £5. 15s. (recommended for acceptance); A. Jochams, Brussels, £5. 11s., £5. 11s., and £5. 11s. Fishbolts—W. Scott, Limited, £18. 10s. per ton; A. Penney and Co., £16. 5s.; P. and W. Maclellan, Limited, £16. 5s.; North-Eastern Steel Company, Limited, £15; Ibbotson Bros. and Co., Limited, Sheffield, £14. 19s. (recommended for acceptance); Phœnix Bolt and Nut Company, Birmingham, £14. 10s.; Wilkes, Limited, Darlaston, £13 5s; E. Aden and Co., Limited, Sheffield, £13; Steel, Peech, and Tozer, Limited, £12. 15s.; Bayliss, Jones, and Bayliss, Limited, Wolverhampton, £12 15s.; Guest, Keen, and Nettlefolds, Limited, Birmingham, £12 15s.; Horton and Son, Limited, Darlaston, £12. 10s.; A. Jochams, £5. 11s.

# BUSINESS NOTES.

## TRACTION.

**Walsall.**—The Town Council are raising a loan of £20,000 for tramway purposes.

**Musselburgh.**—A site for the power station has now been acquired by the promoters of Musselburgh electric tramways.

**Wigan.**—The Borough Council have disposed of 12 of the cars purchased for 3ft. 6in. gauge to the New General Traction Company for £4,000.

**Swindon.**—The work in connection with the construction of the electric tramways is proceeding apace, despite the inclemency of the weather.

**Bristol.**—The Bristol Tramways (Extensions) Bill has failed to comply with Standing Orders, and will accordingly go before the Standing Orders Committee.

**Yarmouth.**—The question of the purchase of the Great Yarmouth and Gorleston tramways has been postponed till the end of the statutory time, which is in August next.

**Rochester.**—Tenders will shortly be invited for the overhead equipment of the section of the new tramways from the city boundary on the New-road to the bottom of Star Hill.

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**Ossett.**—It was stated at the last meeting of the Council that the promoters of the tramline from Wakefield to Ossett held out a prospect of the scheme being completed by Easter.

**British Electric Traction Co.**—The directors have declared the dividend at the rate of 6 per cent. per annum on the 156,437 preference shares of £10 each for the half-year to 15th inst.

**Exeter.**—The City Council have decided to adopt the overhead trolley system for the first two sections of the tramways to be constructed. Tenders for carrying out the work are to be invited.

**Plymouth.**—It is now thought that an amicable agreement will be reached between the Plymouth and Devonport Corporations in reference to the rival schemes for tramway extentions to Crownhill.

**Westminster.**—The Westminster City Council have decided to present a petition against the London County Council Bill, which, among other things, proposes to bring the tramways over the bridges.

**Great Northern and City Tube.**—Quite unostentatiously London's newest tubular electric railway was opened for public use on Sunday morning. The railway has already been fully described in this journal.

**Croydon.**—The Rural District Council have withdrawn the Bill for powers to construct electric tramways from Beddington, along the Brighton-road and Purley-road, to the terminus in the Godstone-road.

**Hampton (Surrey).**—In consequence of the omission of provision for certain widenings in High-street, Hampton Hill, and several other matters, the Council have resolved to oppose the tramway company's Bill.

**South London.**—The electric service from Blackfriars, Waterloo, and Westminster is now complete; and the cars from Blackfriars to New Cross, by way of Walworth, Camberwell, and Peckham, have commenced to run.

**Ipswich.**—The average earnings of the tramways since the opening a few months back have been 7·97d. per car mile. The Tramways Committee have been authorised to incur an expenditure of £6,470 or tramway purposes.

**Perth.**—In connection with the conversion of the tramways to electric traction, additional plant will have to be provided at the power-house at a cost of about £18,000. The estimated cost of the reconstruction is £45,000.

**Wolverhampton.**—A flock of sheep was passing along Tettenhall-road on Wednesday morning, when one of them put his foot on a stud of the surface-contact system and was killed. A dog was also killed and a pony thrown down..

**Durham.**—The County Council have decided that the Bishop Auckland, Shildon, and Spennymoor Tramways Company shall pay a wayleave of £50 annually for those portions of their 10 miles route that run along the main roads.

**Stalybridge.**—Mr. Graham Harris has taken evidence as to the value of the tramways in Stalybridge, which the Corporation are purchasing from the Manchester Carriage and Tramways Company. His award will be published shortly.

**Torquay.**—Opposition will be offered to the Torquay Tramways Bill in committee of the House of Commons by the Torquay Gas Company, who have petitioned the House for permission to be heard against the proposed new tramways.

**Postal Car Service.**—The postal car service for Camborne and Redruth will be inaugurated on Monday next. The tramcar conveying the post-box will give some indication to that effect, and the boxes will be cleared hourly at each end.

**St. Pancras.**—Three out of the four members of Parliament for the division of St. Pancras have refused to back the Bill for the construction of the tramways down Tottenham Court-road. The fourth member has not replied to the request of the Borough Council.

**Shanghai.**—We hear that the Brush Company have given up the right of constructing a street railway at Shanghai, secured by them some time ago. The dispatch adds that hope is entertained in certain quarters of the acquisition by Japan of the above right.

**Wakefield.**—The Wakefield and District Light Railway Company estimate the cost of their proposed tramway extensions, extending to over 25 miles, at £183,918, of which £14,065 will be spent upon street improvements in Pontefract, Normanton, and Castleford.

**Tees-side.**—The senior examiner has found that the Standing Orders of the Commons have not been complied with in the case of the Middlesbrough, Stockton, and Thornaby Tramways Bill, by reason of the fact that the consent of the Corporation of Middlesbrough has not been obtained.

**Aberdeen.**—The Aberdeen County Road Board have approved the plans of the suburban tramways from Aberdeen to Bucksburn and from Aberdeen to Culter. Mr. George Scott, road surveyor, has been appointed engineer to superintend on behalf of the Road Board the construction of the tramways.

**Lorence Marques (S.A.).**—On Wednesday this week the new electric tramways which have been installed at Lorenço Marques by the Delagoa Bay Development Corporation, Limited, began running. The system was formally opened by the Governor. The lines are to be extended to the suburbs at an early date.

**Blyth.**—The Council have discussed a proposed tramway system for the town. It was agreed to write the tramway company enquiring when a start would be made with the scheme, and expressing the disappointment of the authority that so much indifference had already been shown with respect to the claims of Blyth.

**Belfast.**—The report of the directors for the half-year contains the following passage: "The Corporation have deposited in Parliament the Bill referred to in the last report. It provides for the transfer of the company's undertaking to the Corporation on Jan. 1, 1905. The directors will take the necessary steps to oppose this Bill."

**Liverpool Overhead.**—According to a local paper, a fire broke out on Saturday night at the Sandon Dock Station of the Liverpool Overhead Electric Railway. The prompt arrival of the fire brigade prevented any great damage being done, although the fire lasted about 20 minutes, and for the rest of the evening no passengers were landed at the station.

**Glasgow.**—The modified scheme of tramway extension which the Corporation have decided to promote has entered upon the first stage of its parliamentary career. It was found on Monday by the House of Lords examiners that the provisional order had complied with the Standing Orders, and the measure will now be proceeded with in the ordinary course.

**L.C.C. Tramways Bill.**—The Examiners of Private Bills having found the Standing Orders of Parliament not complied with in respect of the proposed tramways through Tottenham Court-road, on Tuesday the Bill was before the Standing Orders Committee, who decided that the Standing Orders of Parliament might be dispensed with and the Bill allowed to proceed.

**Cavehill (Belfast).**—The plans and estimates for the electrification of the Cavehill and Whitewell tramways are all prepared, but the British Electric Traction Company, who are entitled to choose the time, within three years of the passing of the Act of Parliament, at which this work shall be carried out, are of opinion that it is desirable to defer any action for the present.

**Beckenham.**—With reference to our previous notes under this heading, we gather that the difference between the British Electric Traction Company and the Council is as to the form in which the security for carrying out the authorised scheme of tramways in the district is to be given. The Council ask for £10,000 in cash, while the company offer a bond with substantial sureties.

**Leeds.**—Tenders are to be invited for 25 cars with covered upper decks. Mr. J. B. Hamilton reports that the "split-turn" system is working satisfactorily on the three routes where it is already in operation; while its extension to all routes will, he hopes, be accomplished by the end of next week. The Beckett-street to Harehills-lane tramway will probably be opened for traffic in two or three week's time.

**Wardle.**—At the last meeting of the District Council the seal of the Council was affixed to an agreement with the Rochdale Corporation re the tramways. The principal clauses of the agreement are to the effect that the time in which Rochdale shall acquire the tramways in Halifax-road be extended, and that as soon as possible, within six months, after the purchase Rochdale shall commence to lay the lines for the new trams.

**Bideford, Westward Ho! and Appledore Railway.**—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the parish of Northam and the parish and borough of Bideford, in the county of Devon, in extension of the Bideford, Westward Ho! and Appledore Railway, and the working of that railway as a light railway.

**Bath.**—Although the new system of tramways here was opened for traffic on Jan. 1, and has been doing good business since, the formal inaugural ceremony did not take place until Saturday, the interval being allowed to elapse in order that the power station, which was not completed when the cars began to run, might be in proper order for inspection. A luncheon was held in the Guildhall in honour of the occasion.

**Kew Bridge.**—It is announced that, on account of the demands made by the local authorities in Richmond and Brentford, and the apparent hopelessness of concluding satisfactorily the negotiations with the Joint Kew Bridge Committee, the London United Electric Tramways Company have decided to withdraw that part of their Bill which relates to Kew Bridge. The directors promise that the scheme shall be revived next year.

**Swansea.**—A conference took place on Monday between the Sub-Tramway Committee of the Swansea Council and a sub-committee of the Glamorgan County Council with a view to coming to some arrangement with respect to the proposed construction of tramways beyond the Swansea borough boundary at Morriston. No definite arrangement was made, but the county authorities will put certain proposals in writing to the Corporation.

**Eton.**—At the last Rural District Council meeting the Bill of the London United Tramways Company, which provides for the extension of their system to Slough and Taplow, was further considered. The company agreed to all the requirements of the Council except one, and that was the reduction of the time for completion from seven to four years. They still refused to accept this suggestion, and the Council decided to present a petition against the Bill.

**Electrification of Scotch Railways.**—The Glasgow and South-Western Railway directors, at a special meeting of the shareholders on Tuesday, were authorised to proceed with provisional orders for the acquisition of land for the widening of the main line at various points where traffic is becoming congested, and for the equipment and working of any part of their lines by electric power. The estimated capital expenditure in connection with these works is £135,000.

**Lowestoft.**—The enquiry of the Board of Trade into the proposed transfer of the East Anglian Light Railways Order will be held on the 26th inst. Formal approval of the Board of Trade has been received to the line north of the park, and the line at the Suffolk Corner. The general manager reports that the total receipts from July 21 to Jan. 16 amounted to £5,917. 7s. 10d.; passengers carried. 1,305,000; total mileage run, 128,469 miles; average receipts per day, £33. 4s. 10d.; average receipts per car mile, 10·68d.

**Competition.**—Sir Alex. Henderson, presiding over the half-yearly meeting of the Great Central Railway at Manchester, said the company had felt very keenly the effects of tramway competition in the Manchester and Sheffield districts. Twelve months ago competition accounted for 330,000 passengers. This year there was a further diminution of 424,000. Comparing the December half of 1903 with

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the same half of 1891, the company had lost three quarters of a million passengers who formerly used their suburban services.

**Witney Light Railway.**—The Light Railway Commissioners have forwarded to the Oxfordshire County Council a draft order authorising the construction of this light railway by an incorporated company in the same route from Witney through Burford to Andoversford, as was previously proposed by the original promoters, with permission to use electric power if thought expedient. The former scheme of applying to the County Council for financial assistance and obtaining a parliamentary grant has been abandoned. The Council are satisfied that the terms and arrangements in the draft order with regard to roads, bridges, and level crossings are sufficiently provided for.

**Leith.**—The Tramways Committee express surprise and disappointment at the result of the conference with the Water Trust and of other conferences and negotiations on the subject of the provisional order which the Town Council are promoting for the reconstruction and electrical working of the tramways in the burgh. The proposal to carry the Leith line a little above Pilrig, and for a Pilrig and Bonnington route, may, it is stated, be withdrawn if Edinburgh offers opposition, and the Leith Corporation are of opinion that in that case the city would have no *locus standi* in the matter of the tramways provisional order. The Tramways Committee are determined to resist the claims for "electrolysis" clauses.

**Sedgley.**—The inhabitants of Lower Gornal and Gornal Wood are agitating for the construction of a branch electric tramway between Lower Gornal, Sedgley, and Dudley, and there being no proper railway accommodation in the district, the members of the District Council are of opinion that the construction of a tramway would eventually prove to be a successful financial undertaking. The Council have been in communication with the British Electric Traction Company with respect to the matter, and, as the company already possess parliamentary powers to construct a tramway through Dibdale, Bagley-lane, and onward to Shaver's End, it is hoped the much-required provision will be made in the near future.

**Coventry.**—At the last meeting of the Town Council the General Works Committee reported that they had considered the proposals of the electric tramways company for the laying down of further lines in the city, and had approved of route plans for a tramway route from Mount-street to Spon End. They recommended the construction of a double line in Hertford-street, and the proposed double line from Smithford-street into Hales-street. They did not approve of a double line at the Hales-street junction, and as the company were not in a position to make a substantial contribution towards the cost of widening High-street, the committee could not recommend that consent be given at the present time to the construction of a tramway in High-street. This point the Council referred back to committee, but the other recommendations were agreed to.

**Additional Traffic Returns.**—Anglo-Argentine, £1,887 increase; Barcelona Ensanche y Gracia, £72 increase; Barcelona, £136 increase; Brisbane, £210 increase (month of January, £10,425, decrease £224), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £13 increase (month of January, £14,055, increase £962); Calcutta, £349 decrease; Cape Town (month of January), receipts £18,213, expenditure £8 305; Isle of Thanet Electric, £26 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of January), receipts £45,400, expenses £29,000; Perth Electric, £125 increase (for the year 1903: receipts £62,097, expenses £34,871); Port Elizabeth (month of December), receipts £4,674, expenditure £2,962.

**Cuba.**—Cienfuegos has railway communication with Havana, Matanzas, Cardenas, Sagua la Grande, and Caibarien on the north coast, with Santa Clara in the interior, and thence, since the completion of the new Cuban Central Railroad, with Santiago. A project is under consideration for the construction of an electric railway extending from Cienfuegos into the interior, a distance of 30 miles or more, which would give rapid transit between Cienfuegos and several important villages in the sugar-producing belt, these towns now having very inadequate communication with this port. A company has been organised to carry the project into effect, a charter has been applied for and obtained, and only a short time will elapse before the beginning of active work on the grading of the road. If this enterprise is carried out, as seems reasonably certain, it will contribute in no small degree to the material upbuilding of this section of Cuba.

**Wellington (N.Z.).**—It has been decided that the men who are to be employed as drivers of the electric tramcars in Wellington shall be specially well trained for their duties. Each man, before he obtains employment, will be required to possess not only a thorough knowledge of the working of the brakes, etc., but a knowledge also of the principles of electricity. One of the cars is to be fitted up at the Newtown car-sheds under the conditions of ordinary traffic, and here the men will be "coached" in the practical work of motormen. This work will be probably carried out under the supervision of Mr. W. R. Wright, the electrical engineer, and Mr. Stuart Richardson. A course of instruction in electricity will also be one of the conditions to be fulfilled. Furthermore, it will be necessary for each man to pass a medical examination, since, owing to the speed at which electric cars travel, the rush of wind to which the driver is exposed obviously tests the strength of his lungs. The men now at work on the horse trams will be given preference of employment on the electric trams, provided, of course, that they fulfil the necessary conditions.—*New Zealand Mining Journal.*

**Motor 'Buses.**—Speaking at the half-yearly meeting of the London General Omnibus Company on Tuesday, the Chairman said, with regard to motors, they were six months nearer their adoption than when he last addressed the shareholders, and although the experience gained since that time had been somewhat of a negative character, yet he was a firm believer that a great factor in the solution of the difficulties which the London Traffic Commission were now sitting at Westminster to solve would be found in free running stage carriages, and not in trams. The directors were watching the matter very closely, but they did not want to waste too much money in experiments.—Mr. J. Howard Moore, at the meeting of the London Road Car Company, said that, as showing the growth of the omnibus traffic of London, and how little the opposition of "tubes" was felt after the novelty had worn off, the shareholders would be pleased to note that in Oxford-steet, below which, as they were aware, the Central Railway ran, the number of omnibus journeys run by the vehicles of the various proprietors prior to the opening of that railway in 1899 was 2,292 per diem, while to-day the number of such journeys was 2,416. In reply to questions the Chairman said that they hoped in a short time to have two or three motorcars on the road. He had great faith in the motor as their trump card in the competition between the tram and the omnibus. The perfect motor, he thought, would beat all trams running on fixed rails, and it would not be long before they were able to show the perfect motor. He did not think the report of the Royal Commission on Traffic would prove unfavourable to them. Omnibuses were an established public need.

**North-Eastern Railway.**—Speaking at the half-yearly meeting of the company, Lord Ridley, the chairman said they had suffered severely from competition in certain districts with the tramways. This was one of the problems which would have to be faced, and they could not expect always as railways to have a monopoly of carrying. In the Newcastle suburban district the figures were very startling, the decrease in the number of passengers carried by the company having been no less than 61 per cent. The directors believed and hoped that by electrifying some of their suburban lines they would to a certain extent solve the problem. Another direction in which they hoped for improvement was in their branch line service. They did not think this could be done by steam locomotion, but they were relying largely upon a system of single-coach autocars. A series of trial runs began on Tuesday over the lines between Newcastle and Tynemouth with the electric cars, in order to familiarise the drivers with their work, and also to form a basis for a time-table for the new trains. The journey is now made in 16 minutes, as compared with 26 minutes with steam locomotives. A large meeting of all grades of locomotive men, representing branches of the Amalgamated Society of Railway Servants in the Tyneside district, has been held at Gateshead to consider the proposed scale of pay for motormen and conductors on the newly electrified Tynemouth branches of the North-Eastern Railway. The new scale gives motormen from 32s. to 36s. a week, conductors from 27s. to 29s., and assistant conductors from 21s. to 23s. This alteration would mean for locomotive drivers accepting motormen's work a drop of from 12s. to 15s. per week. Resolutions were passed protesting against the proposed scale, and urging motormen to desist from applying for posts on the North-Eastern Railway system until the rates of pay are altered.

**London County Council.**—The last remaining section of the old system of tramways in South London is about to be taken in hand. As will be seen from our "Tenders" columns, the Council have accepted the tender of Messrs. Wm. Griffiths and Co., of London, for carrying out the electrical equipment of the cable section between Kennington and Streatham and two small pieces of line in Tooting High-street and Defoe-road. The total length of line involved is about eight miles of single track, and the work is to be completed in three months from March 31 next. It will cost £86 624 as compared with the engineer's estimate of £93,926. Messrs. Griffiths and Co. are now carrying out the reconstruction of about eight miles of tramways in the boroughs of Southwark and Bermondsey. In the present case, Messrs. Griffiths and Co. have undertaken that they will take special measures with a view to the convenience of the frontagers and the general public along the route of the tramways, and they have also given an assurance that the work shall be completed within the time specified in the contract, which is a matter of great importance to the Council in view of the large amount of summer traffic on the Streatham tramways. Messrs. W. Griffiths and Co. propose to sublet certain portions of the work. In consequence of promises of the necessary contributions towards the cost of the street widenings involved not being forthcoming from the local authorities, the Council decided not to proceed with the application to Parliament for powers to construct a tramway on the south side of Clapham Common by way of Battersea-rise and the north side of Wandsworth Common to East-hill, Wandsworth, and a Deptford tramway by way of Blackheath road and hill and Shooter's Hill-road to the Herbert Hospital, Woolwich. It is hoped that it will be possible to revive these proposals at some future date when the borough councils concerned shall agree to make the necessary contributions. Upon the reception of the report of the Highways Committee some members asked questions in reference to the purchase of railway materials by the Government for Indian and Colonial railways. Mr. Goodrich asked Mr. Benn if he could tell the Council what the cost per car mile was for the electric tramways; and, if so, whether it had exceeded the estimates? Answering these and other questions, Mr. Benn said that Mr. Brodrick refused to give particulars of the purchase of foreign rails by the Government. As soon as the committee obtained the information they would give the Council the report asked for some time ago in respect to foreign tenders for Government supplies. In regard to the position of the North Metropolitan Tramways Company in the matter of electrification, the company were aware that the Council were obliged, owing to the demands of the borough councils, to put down the conduit system, but they had done nothing to help the Council, although they had asserted that the electrification of the lines ought to be proceeded with. Mr. Cousins asked if any information could be given as to how British manufacturers were handicapped by the Council's conditions of contract, which were inoperative in Belgium. Mr. Benn said he hoped to bring the report on the subject before the Council next week. Mr. Goodrich pressed for a reply as to

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whether the cost per car mile of running the electric cars largely exceeded the estimates. Mr. Benn said he must not take it that the cost largely exceeded the estimates. The cars were doing well now.

**London United Tramways.**—Mr. Jeune, examiner of Standing Orders, had before him the London United Tramways Bill and the London United Tramways (Railways) Bill. Mr. Pritt, agent to the company, said that the promoters had dropped all the lines referred to in the former Bill except tramway No. 2, from Hounslow to Staines, a distance of nearly 5¼ miles. Formal proof of compliance with the regulations of Parliament in reference to this line having been given, the Bill was allowed to proceed to first reading. In regard to the London United Tramways (Railways) Bill, Mr. C. E. Browne appeared in support of the memorial of the London County Council against the Bill. He said the memorial alleged non-compliance with a considerable number of Standing Orders, and practically the one point to be considered was whether the works described in the Bill as "railways" were correctly described, or whether they should not have been described as tramways and tramroads. The Bill was promoted by the London United Tramways Company, which was possessed of a tramway undertaking on the north of the Thames and one on the south of the Thames. The scheme was to connect the two by means of two works, one wholly in the metropolitan borough of Hammersmith, beginning below the ground on certain private property and terminating upon the surface of the street in The Grove, Hammersmith, by a double junction with the existing line of tramways there. The other work would begin by a junction with the already authorised tramway in Lonsdale-road, Barnes, on the surface of the street, which it would leave after a distance of about three chains, and then pass on to private property and dip down into a tunnel, and pass, in tunnel, under the River Thames and form a junction underground with the first work. The Bill, in order to be consistent with the description adopted of "railways," incorporated certain parts of the Railways Clauses Consolidation Act of 1845; but the promoters of the Bill seemed to have been at considerable labour to discover which of the sections of that Act could be applied to the proposed works—which were harmless for tramway purposes, and which so specially related to railways as to be inapplicable to the proposed works. The Bill incorporated only a small number of the sections of the Railways Clauses Acts. The promoters seemed to have said to themselves, "It does not matter if our lines do go through streets. Let us call them 'railways,' and they had accordingly called them 'railways.'" The calling of a tramway a "railway" would, if it were allowed to stand, relieve the promoters of the necessity of getting local consents. It would also deprive the local authority of control over the rate of speed. Moreover, there was no provision for empowering the local authority to purchase the undertaking after a certain interval. Mr. Pritt said the question was one very largely of degree, as to whether the portions of the lines which were on the surface of the streets could properly be treated as tramways within the meaning of the Standing Orders, or whether they were not part of a through scheme (practically the whole of which was not a tramway), and must therefore necessarily be treated as part of that scheme. It was true they used the surface of the road to form junctions, but they only used the surface for as short a length as possible, and when they got upon private property they sought power to make what he contended was properly described as a "railway," though it was to be used as a tramway. Mr. Jeune said Parliament had not stated what was a railway and what was a tramway, and therefore it was left to simple common-sense to decide whether a line was a railway or tramway. It appeared to him that this was almost obviously a tramway. He found that the portions of line which ran on the public road were a tramway and subject to the Standing Orders applicable to tramways, and therefore, that certain Standing Orders had not been complied with. The case will therefore be reported to the Standing Orders Committee, who will decide whether or not the orders applicable shall be dispensed with.

## LIGHTING AND GENERAL.

**Blackpool.**—A reduction in the charges for current is proposed.

**Kirkcaldy.**—The electric light is to be introduced into the parish church.

**Pembroke.**—The Town Council are considering the electric lighting question.

**Swansea.**—It is proposed to introduce the electric light into the borough fever hospital.

**Ipswich.**—The Town Council have decided to borrow £2,438 for electric lighting purposes.

**Tiverton.** The Town Council have decided on an electric lighting scheme estimated at £13,000.

**Marple.**—The Urban District Council propose to apply for an electric lighting provisional order.

**Armagh Lunatic Asylum.**—The governors have resolved to expend £380 for a supply of electric light in the old building.

**Perth.**—It is proposed to borrow £13,000 for extensions at the station, both for tramways and lighting area extension.

**St. Annes.**—An enquiry is to be held on Feb. 25 into an application for £4,000 for electric lighting mains and services.

**Widnes.**—The proposed extension at Stocks Well pumping station is to be proceeded with at an estimated cost of £14 000.

**Llantarnam.**—The Urban District Council are negotiating with an electric power company with a view to lighting the district.

**Leeds.**—Current for lighting the streets will now be supplied at 1½d. per unit, which is stated to be 1¾d. less than cost price.

**Lindsey.**—The County Council intend to apply for sanction to borrow £5,571 for the cost of heating and lighting the Bracebridge Asylum.

**Dunfermline.**—The Town Council are about to refer to an expert a draft agreement proposed by the Fife Electric Power Company, Limited.

**Exeter.**—Mr. H. A. Willey's gift to Exeter Cathedral—viz., in the installation of the electric light through the entire building—is now completed.

**London County Council.**—On Tuesday sanction was given to the borrowing by the Kensington Borough Council of £27,098 for a dust destructor.

**Paignton.**—The Board of Trade have approved of the system of electric lighting submitted to them by the Council and their contractors.

**St. Pancras.**—At the next Council meeting the Electricity and Public Lighting Committee will report upon the King's-road electric power station.

**Plant for Sale.**—The Metropolitan Electric Supply Company in another column announce a sale of transformers and alternating-current motors.

**Sheffield.**—The City Council are receiving complaints of grit and dirt coming out of the chimney of the electric light department in Commercial-street.

**Kensington.**—A notice from the Notting Hill Electric Lighting Company relative to a proposed extension of their mains in Ledbury-road has been agreed to.

**Swanage.**—With regard to their proposed application for a provisional order, Messrs. Pressland and Fippard are about to have an interview with the Urban District Council.

**Change of Address.**—The Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester, have removed to larger offices at Victoria-mansions, 28, Victoria-street, Westminster.

**Cleethorpes.**—The Urban Council has received an offer from the Grimsby Street Tramways Company to sell their Cleethorpes power station for £19,000, allowing the Council 7, 14, or 21 years for payment.

**China.**—The *Japan Times* says that the Commercial Department of the Chinese Government has given sanction to the establishment at the capital of an electric light company projected by some native capitalists.

**Walsall.**—The electricity undertaking for the year ending Dec. 31, 1903, shows a profit on the year's working, after payment of interest and sinking fund, of £313. 15s. 7d., as compared with a deficit of £244. 2s. 3d. for the previous year.

**Halifax.**—The new engine which has been installed at the Corporation electricity works was officially started by the chairman of the Tramways and Electricity Committee (Alderman Thomas Hey) in the presence of the committee yesterday.

**Bournemouth and Poole Electricity Co.**—The directors recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum for the year ended Dec. 31 last, carrying forward over £3,000, after providing for depreciation, etc.

**Dundee.**—The Town Council have remitted to a special committee the arrangements in connection with the securing of a provisional order for the following public works: electricity, £20,000; gas, £20,000; water, £23,500; improvements, £25,000.

**Colne.**—During the quarter ending December 33,868 units of electricity were sold for power and lighting purposes, as against 19,709 units sold during the corresponding quarter of 1902. The above is exclusive of 19 313 units sold to the tramway company.

**B E T. Second Debentures.**—With regard to their recent issue of second debenture stock, the British Electric Traction Company, Limited, inform us that, although the public did not take the whole stock, the issue was entirely underwritten by responsible firms.

**Walton-on-Thames.**—The Council have consented to the Walton-on-Thames electric lighting order, the Board of Trade having recommended that an order should be granted, provided that the amendments which the Council considered necessary for their protection were inserted.

**Nantwich.**—The Council have referred to a committee a letter from the Southern District Electricity Corporation with regard to the provisional order held by the Council for electric lighting. The company proposed terms for the equipment and running works for the supply of electricity.

**Preesall.**—A letter from Mr. Oswin Hansom, resident engineer to the Fleetwood and District Electric Light and Power Syndicate, suggesting a scheme for the electric lighting of the Knott End and Preesall districts, is before the Highways Committee of the Urban District Council.

**Colwyn Bay.**—The electric light manager's last report states that the units generated for the past month numbered 14,978; number of consumers connected up to date, 176. He had made an arrangement with the gas manager to supply 1,000 tons of coke at 13s. per ton, cartage extra 1s. per load.

**Lincolnshire Electric Power Bill.**—The Committee of Selection on Tuesday decided that the Lincolnshire and Yorkshire Electric Power Bill should stand in a group of Bills, the consideration of which by a Select Committee will not commence until after Easter. There are 33 petitions against the Bill.

**Kingsteignton (Devon).**—The Newton Rural District Council will offer no objection to the Edmundson's Electricity Corporation, Limited, applying to the Board of Trade for a provisional order authorising them to light Kingsteignton with electricity providing the mains are laid as directed by the Council's surveyor.

**Poole.**—The Town Council have concurred with the proposal for the establishment of a competitive telephone service in what is called the Bournemouth area, comprising Bournemouth, Poole, Branksome, and

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Christchurch. The International Electric Company will take all the onus of the creation of the area, etc., under the license of the Postmaster-General.

**Ilford**.—The Urban District Council have reduced the charges for electric current as follows: flat rate, ½d. per unit to 4½d.; maximum demand, 2d. per unit to 6d. for first hour's use and 2d. per unit for all in excess; public lighting, 5s. on all ordinary lamps to £4 a year. A profit of £1 800 is expected, which the committee intend putting to the reserve fund.

**Westminster Electric Supply Corporation**.—After allowing for depreciation, sinking fund, etc., the net balance is £49,585, from which must be deducted the second half year's preference dividend, leaving a balance of £46,239. The Board recommend a dividend at the rate of 14 per cent. per annum for the past half-year, carrying forward £9,494.

**Huddersfield**—At 7.30 p.m. on 11th inst. there was an interruption to the electric lighting supply at Huddersfield, due to a fault in the feed-water arrangements. We gather from reports that an obstruction in the main feed pipe necessitated the drawing of all the boiler fires. The supply was resumed partially by 9 p.m., and by 10.15 the full demand was again met.

**Bermondsey**.—The Council have decided to petition against the East London and Lower Thames Electric Power Bill. This Bill proposes to form a company with £2,000,000 share capital, and to supply electric current and energy in the boroughs of Hackney, Bethnal Green, Stepney, Poplar, Deptford, Woolwich, Greenwich, and Bermondsey, also in West Ham and certain Essex districts.

**Dorking**.—The Urban District Council have adopted a report by Mr. James Lemon on the question of the sewerage of Pixham Valley. The report pointed out that a deep sewer scheme, with pumping arrangements at the sewage disposal works, would cost £1,450, and recommended the adoption of an ejector scheme, at an approximate estimated cost of £800 exclusive of contingencies.

**Lowestoft**.—The resident electrical engineer's last report stated that during the past month four new consumers were connected to the mains, representing 197 8-c.p. lamps. There are now connected to the mains 462 consumers, representing 22,698 8 c.p. lamps. The engineer has received only six applications for current at the flat rate. The matter of the supply of current for the Oulton Broad district has been deferred.

**Arbroath**.—It is reported that the Empire Electric Light and Power Company, Limited, to whom the Town Council some time ago agreed to transfer their electric lighting order, desire to have certain modifications effected in the terms of their agreement, but the Electric Lighting Committee of the Town Council do not see their way to accede to the wishes of the company, and in the meantime matters are at a standstill.

**Maidstone**.—The Electricity Committee have made arrangements to lay a cable to supply a 6 h.p. motor at an estimated cost of £40, and also to supply a ¼-h.p. motor on the usual terms. A motor-transformer for charging motorcars is to be purchased and fixed at a cost of £12, and a subway for taking cables into the street from the works will be constructed, in accordance with plans prepared by the surveyor, at an estimated cost of £40.

**Hammersmith**.—Mr. Bell is to prepare for the Guardians the specification for electric light, electric lifts, and machinery, and supervise the work of the engineer who would be in charge of the work. Since the last Council meeting 21 additional consumers have been connected, representing a maximum of 935 8-c.p. lamps; two consumers have been disconnected; and the present number of consumers taking current from the mains is 1,409.

**Agencies**.—Messrs. Frank Jordan and Co., 15, George-street, Mansion House, E.C., inform us that their agreement with Messrs. Daniel Adamson and Co., of Dukinfield, having terminated by the effluxion of time, they will act as sole agents in London and the south-eastern district for the sale of the Lancashire, Cornish, and vertical boilers of Messrs. Holdsworth and Sons, Croft Boiler Works, Bradford. Their other agencies will remain as hitherto.

**Huddersfield**.—The minutes of the Electricity Committee, which were adopted on Wednesday, showed that the income from electricity for the year ending Dec. 31 last had amounted to £26,005, against £23 159 in the previous year. The expenditure was £12,627, against £10 4.4. After paying various charges the surplus was £3,915, against £2,945. The surplus goes to the depreciation and contingencies account, which now stands at £11,853.

**Widnes**.—At the Council meeting on Tuesday, it was decided to apply to Parliament for an extension of the Widnes electric light order of 1901 with special provision for transfer. It was also decided to delegate the power to generate electricity to the Mersey Electric Supply Company under conditions which were described as possibly the best obtainable, and which, it was pointed out, still left it open to the Council or a company to introduce electric trams.

**Ilfracombe**.—The Urban District Council have accepted an offer of the electric light company to provide 280 Nernst lamps of 120 c.p. at £2. 15s. and 36 at £1. 10s. per annum, to include an ornamental bracket on the present standards, to keep the posts and brackets painted, to supply with current and to light and to extinguish the lamps. The company will put up six standards for these lamps at their own cost, and run the lamps for three weeks free.

**Alloa**.—The Town Council are submitting the following alternative proposals to the directors of the British Electric Plant Company—viz: (1) that the company reduce the price of current per kilowatt to £6; (2) that the company charge a flat rate for all current supplied; (3) that the Town Council negotiate with the company with the view of taking the supply into their own hands; (4) that the company undertake the electric lighting supply of the town in place of the Town Council.

**Hornsey**.—The total cost per unit of electricity sold in Hornsey for the past quarter is reported to be less than 1½d. Combining the three running quarters, the total cost per unit sold works out at 2·19d. Taking into consideration the large sum spent in the first two quarters on smokeless coal, and the comparatively small output, the result should be considered satisfactory. During the past month distributing mains were laid in Crouch Hill-road, Park-road, and Muswell Hill-road.

**Blackheath and Greenwich Electric Light Co**.—At an extraordinary meeting of the Blackheath and Greenwich District Electric Light Company, to be held after the ordinary meeting on Friday next, the shareholders will be asked to confirm agreements between the company, the Crystal Palace District Electric Supply Company, the Electric Construction Company, and others, relating to the purchase by the Blackheath Company of the whole undertaking and assets of the Crystal Palace Company.

**Electrical Exhibition**.—The arrangements for the holding of the proposed electrical exhibition in the Christchurch Schoolrooms in Edison-road, Crouch End, by the Hornsey Borough Council from Tuesday, March 1, to the Saturday following, inclusive, have now been made. The exhibition will be opened on the Tuesday at 6 p.m., and on the other four days at 3 p.m., remaining open until 10 p.m. on each day. The latest returns for the past quarter show that the cost of electricity sold amounts to less than 1½d. per unit.

**Hanley**.—The accounts of the Electric Lighting Committee for the past year show a gross profit of £7,507, out of which £2,554 has been paid for interest, and £2,509 for sinking fund and redemption charges, leaving a net profit of £2 442 for the year. The committee's report recommending that £2,356 be repaid to the district fund account, being the amount now standing there to the debit of the electric lighting revenue account, and that £194 be carried forward, has been adopted. The sinking fund now stands at £15,858, and the capital account at £88,014.

**Cablemakers' Association**.—This association has received a new adherent in the Anchor Cable Company, Limited, which has just become a member. The other members are as follows: the British Insulated and Helsby Cables, Limited; Callender's Cable and Construction Company, Limited; Connollys Bros., Limited; the India Rubber, Gutta Percha, and Telegraph Works Company, Limited; the London Electric Wire Company, Limited; Siemens Bros. and Co., Limited; W. T. Glover and Co., Limited; W. T. Henley's Telegraph Works Company, Limited.

**Luton**.—The electrical engineer's last report states that since Jan. 1 19,709 units had been generated, an equivalent to 271 8-c.p. lamps and two motors of 4 h.p. connected, making a total of 149 consumers with 9,970 lamps and 39 motors of 113 h.p., and over 473 additional lamps and five motors of 43½ h.p. were being wired. The number of units generated showed an increase of 50 per cent. over the number generated during the corresponding period of last year. It has been decided to extend the cable so as to supply current to the Bute Hospital and other premises, at an estimated cost of about £26.

**Newport**.—The recent failure of the electric light was only upon one circuit, and affected only a portion of the Caerleon and Chepstow-road districts. It was caused by heavy floods outside the Maindee Hall in the Chepstow-road district. Three times during the last week the Corporation workmen have been called out to cope with the water in this district, and in one case four men who were put to bale out a box took out 600 bucketsful without making the slightest impression upon the water. Endeavours are now being made to get rid of the water sufficiently to put an extra protection on the cables, which will minimise, if not altogether prevent, such accidents in future.

**Eastbourne**.—The electrical engineer (Mr. J. K. Brydges) estimates that the laying down of condensing plant will result in a net saving in coal and water of £358, notwithstanding that the first cost of the works will run to £3,105, made up as follows: surface condenser for 1,000 i.h.p. with steam-driven air, hot-well and condensed water, and motor-driven oil and circulating pumps, and oil separator, £1,265; foundations for above and alteration to engine-room floor, £200; cooling tower for 2,000 i.h.p. and foundations, £950; exhaust, steam, circulating water, drain piping, and valves and feed-water filter, £380; iron handrail, ladders, wiring for motor, £30; contingencies, 10 per cent., £300 - total, £3,105.

**Greenwich**.—At the last meeting of the Guardians a letter was read from the architects congratulating the Board "on the small total of the extras," amounting to but 2¼ per cent., on the total of the Sidcup children's home building and subsidiary contracts. They pointed out that the comparison on outlay compared favourably with the only other completed modern metropolitan scheme—that of the Woolwich children's homes—as follows: Sidcup, final total, including land, well, electric light, furnishing, etc., £242 per head; Woolwich, £272. The Sidcup homes included swimming-bath, gymnasium, well supply, and electric light, none of which are comprised in the Woolwich example. "Revised, therefore, for true comparison, the cost of Sidcup would be £210 per inmate, as against Woolwich £272."

**Llandudno**.—At the meeting of the Urban Council on Tuesday the chairman called attention to the Bill now pending in Parliament for empowering the North Wales Power and Traction Company to construct generating stations and supply electricity in certain parts of North Wales. He thought the interests of the town demanded the exclusion of Llandudno from the area of the proposed operation of the company. A discussion followed, in the course of which it was stated that the Bill would be also opposed by the Flintshire and Carnarvonshire County Councils, and by the Town Councils of Rhyl, Colwyn Bay, Conway, Bangor, and Carnarvon. He moved that the Council oppose the Bill, and that the expense of such opposition should be defrayed out of the general improvement rates. The resolution was adopted.

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**Islington.**—The Borough Council have agreed to the transfer from the electricity account to the general rate for the next half-year an amount of £12,000 to provide for carbons and labour in connection with the street arc lighting. The object of this move is to enable the Lighting Committee to properly discharge the obligations placed upon them with regard to the arc lighting, irrespective of the cost of the current, so that the borough itself as a consumer can be treated in the same way as outside consumers. At the present time the borough is charged 3½d. per unit, and this does not include the cost of carbons and labour, while outsiders are charged 4d., 5d., and 7d. according to the supply. The committee want to place the electric lighting undertaking on a proper commercial footing, and provide a sinking and reserve fund.

**Hampton.**—The Twickenham and Teddington Electric Light Supply Company are quoting the District Council for street-lighting Twelve gas lamps and 12 electric lamps are to be erected and lighted by this and the gas company in Waldegrave-road, Teddington Park-road, and Langham-road for the purposes of comparing the merits of the respective lights. The Hampton Wick and district electric lighting order includes part of the river, and contains a clause for the protection of the Conservators' interests without, however, any reference to towpaths. The insertion of the word "towpaths" is required, and it is suggested that the words "without the previous consent of the Conservators," also be added. The Council are taking steps to secure the insertion of such an amendment in this and in the Maldens and Ham and Coombe electric lighting and Walton electric lighting orders.

**Swinton.**—The Swinton and Pendlebury Ratepayers' Association have forwarded to the District Council the following resolution: "That in the opinion of this committee we think it advisable that the District Council should dispose of the present electric lighting order on the best terms possible, and on no accounnt should they make arrangements to take electricity in bulk, and the terms must be that the purchasers take the whole responsibility of supplying the electricity and collecting payments for same; and that a copy of this resolution be forwarded to the District Council." The Council's committee have interviewed the Salford Corporation Electricity Committee and the Lancashire Electric Power and Suburban Tramways Company with regard to the supply of electrical power, and the matter is now under the consideration of Mr. Miller, their electrical expert.

**Crediton (Devon).**—The Urban District Council on Friday discussed the provisional order applied for by Christy Bros. and Middleton, of Chelmsford, for lighting the town with electricity. The Chairman said the Board of Trade had given him to understand that 8d. per unit was not too large a maximum for the first hour, considering the consumption of electric light would not be very great, and that they wanted something to attract capital. With regard to the conditions of purchase, it was pointed out that to attract capital into an enterprise the period within which purchase could be obtained had been raised from 21 years to 42 years, and that if they wanted to get compulsory powers they ought to pay at least the amount expended and an excess of 15 per cent. The Council agreed to the maximum charge of 8d. per unit for the first hour and 4d. afterwards, on condition that the underground system was adopted.

**London Gazette.**—The first meeting in the estate of the Electrical Contracting and Maintenance Company, late of 3 and 4, High-street, Ilford, Essex, will be held at 12 noon on Feb. 26 at Bankruptcy-buildings, Carey-street, London. The partnership subsisting between Joseph Foxcroft and Woolmore James Victor Duncan, carring on business as electrical engineers at 24, Queen's-road, Dalston, London, under the style or firm of Foxcroft and Duncan, has been dissolved by mutual consent. A petition for the winding up of the National Electric Traction Company, Limited will be heard on Feb. 23 at the Royal Courts of Justice, Strand. Persons intending to appear must send notice to Messrs. Laytons, 29, Budge-row, Cannon-street, E.C., before noon on 22nd inst. At a general meeting of members of the Automatic Telephone Company (1903), Limited, it was decided to wind up the company. Mr. James Cheves, 16, South-street, Finsbury, London, E.C., was appointed liquidator.

**Swansea Telephones.**—The Council have passed the following resolution: "That, in view of the fact that the number of the lines originally provided for was 750, that the lines in actual working order now are 618, that orders are still in hand to the extent of 216, and that fresh orders are being received at the rate of 40 or 50 a month, the committee recommended the Council that sanction be obtained for the borrowing of a sum not exceeding £15,000 for the purpose of doubling the capacity of the existing system." The manager (Mr. Mackie) in his last report stated that the number of subscribers' lines connected was 618; number in hand still to complete, 216; total number of instruments and lines working, 685; 62 more instruments were working now than last month; and 91 subscribers' lines had been connected in the month. Between December and February they had added 152 subscribers, whilst the orders in hand had only been reduced by 36, which meant they had had 120 fresh orders.

**Coatbridge.**—Mr. Cullen, architect for the library, is to act as consulting electrical engineer for the lighting of the building. A letter from the Under-Secretary for Scotland was read at the last meeting of the Town Council relating to the exceptions recently taken on behalf of the Secretary as to items of expenditure as shown in the annual statement of accounts last under audit. One of these was that the Town Council had declined to state the nature of the amount received from the Scottish House-to-House Electricity Company, Limited, and the Under-Secretary said he was asked to explain that the statement should be explicit on such a matter. The Town Clerk said this referred to the £1,000 received from the tramway company, and that the Council's reply to the enquiry from the Scotch Office was to the effect that it was no business of theirs to deal with that, as it was of the nature of a common good. The communication, which also dealt with the sinking fund, was remitted to the Finance Committee.

**King's Lynn.**—The electrical engineer in his last report stated that applications for 259 additional lamps of 8 c.p. or equivalent were received during the past month, making a total of 18,048 from private consumers, and that there were 446 consumers. The engineer also submitted the following statement—viz.: units generated, December, 1903, 59,014 (1902, 49,918); units sold to private consumers (light and power), 25,326 (21,052); units sold at power rates, 5,629 (3,300); cost of fuel, stores, repairs, and wages at station, £156. 7s. 6d. (£133. 19s. 2d.); cost of units generated, 0·6356d. (0·643d.); wages of lamplighters and outside staff, £20. 17s. 10d. (£22. 12s. 10d.). Mr. S. Roseveare, second engineer-in-charge, has resigned his appointment. The filling of the vacancy has been left to the chairman and engineer. An enquiry was held on Tuesday into the Council's application for sanction to borrow £11,500 for electric lighting purposes.

**Grimsby.**—Mr. W. A. Vignoles (electrical engineer) in his last report states that the total number of units sold for the past month for traction was 34,438, an increase of 5,967 units as compared with the corresponding month of last year; 11,529 for public lighting, an increase of 834; and 31,586 for private consumers, an increase of 7,068. For the nine months ending December last the units sold were 569,957, as compared with 461,774 for the same period of 1902; whilst the revenue had increased from £5,084 to £6 217 for the same periods. The cost of production had been reduced, and would, he thought, work out on the year at less than 1·3d. per unit, as against 1·4d. last year. On the above figures he estimated a gross profit of about £4,200 would be made, as against £3,277 last year. This would be at the rate of about 5 or 6 per cent. on the average capital expended. This would be available for payment of interest and sinking fund, but would not, he was afraid, be sufficient to meet these charges. The amount of the deficit would depend on the terms on which the money was obtained and repaid. The actual cost of the sub-balancing station in Riby-square had been £743. The estimate was £754.

**Cardiff.**—A petition to the Cardiff Electrical Committee urging the Broadway should be electrically lighted is before the Council. The electrical engineer (Mr. Ellis) in his estimate of expenditure and receipts for the year ending March 31, 1905, gives the expenditure as £22,382, compared with £16,386 estimated for the current year and £11,271 actual expenditure in 1903. The receipts for next year are estimated to reach £37,750, leaving a profit balance of £5,181. A sum of £3,000 has been allocated to the relief of rates and £2,181 to reserve. For the current year the amount allocated to relief of rates is £2 900. In the month of January 987 business premises were connected with the mains, equivalent to a total of 105,528 8-c.p. lights. The number of consumers have increased 33 per cent. The revenue from street-lighting was estimated to produce £482. 7s 6d., and from private consumers £3,761. 2s. 6d.—making a total of £4,243. 10s. The total estimated revenue in January last year was £3 287. 8s. 6d., so that there was an increase of 29 per cent Mr. Ellis has also presented a report showing that £38 000 would be required for extensions of cables and feeders, including the municipal buildings and law courts.

**Tunstall.**—At the last meeting of the Urban District Council a discussion arose upon the proposal that Burslem should supply electricity in bulk to Tunstall. Upon this a communication was received from the town clerk of Burslem enclosing a letter from their parliamentary agents, and asking whether Tunstall would unite with Burslem in making application to the Local Government Board for their approval of the proposal. Messrs. Sharpe and Co. (Burslem's parliamentary agents), in their letter, stated there were conflicting opinions of counsel as to whether a local authority, having power to supply electricity in their borough, could supply electricity therein for use outside. In their opinion, there was very little doubt that an agreement between the Corporation and the Tunstall District Council for the former to supply electricity in bulk to the latter, even if the supply were actually given within the borough or at the boundary, would be *ultra vires*. They should, therefore, have considerable hesitation in advising the Corporation to enter into an agreement, which might be declared by the courts to be void, without further powers. The clerk was instructed to join with the town clerk of Burslem in forwarding to the Local Government Board a letter setting out the particulars of the proposed electrical supply, and stating that the two Councils were desirous of carrying out this arrangement, as they believed it would be mutually advantageous.

**Fulham.**—The first annual dinner of the staff of the Fulham Borough Council electricity department took place on Feb. 9 at the King's Hall, Fulham. The chair was occupied by the consulting and borough electrical engineer, Mr. Arthur J. Fuller, A.M.I E E., and the vice-chair by Mr. G. T. Hook, A.M.I.M.E., the dust destructor superintendent. Replying to the toast of his health, Mr. Fuller said it was with some fear and trembling he entered upon his duties just 11 months ago that day, fears which, however, had been long since dispelled. In all his 15 years' experience as a central-station engineer he had never met a more loyal staff or better set of men. The progress of the undertaking had more than exceeded his expectations. Eighteen months ago there was a total of 680 consumers connected to the mains now there were 1,100, or nearly double. The demand for motive power had increased in the same ratio. From a small 30 h.p. it had risen to one of nearly 400 h.p. This, no doubt, was due to the very low rate of 1d. per unit, which made the cost of electricity as a motive power 20 per cent. cheaper than gas. He had every hope in the undertaking, and felt sure that it would very soon come to the relief of the ratepayers. Mr. Fuller's report on lighting the side streets is still under consideration. The annual cost for 250 lamps is given as follows: gas at present, £754; incandescent gas, £862 (capital outlay £555); incandescent electric, £879 capital, £437); Nernst, £1,024 (capital, £6,671. Mr. Fuller considers the gas company's estimate of eight mantles per year as too low, and says should the Council adopt incandescent gas lighting the company ought to take the risk as to mantles.

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**St. Marylebone.**—At the special meeting of the Borough Council held last week the resolution to confirm the propriety of promoting the Bill was carried, 41 voting for it and 4 against it. The following letter was received from the clerk to the London County Council: "London County Council, Parliamentary Branch, County Hall, Spring-gardens, S.W., Feb. 10, 1904. Sir,—St. Marylebone Electric Lighting Bill.—The Council has had this Bill under its careful consideration, and is desirous of placing as little difficulty as is possible in the way of the Borough Council. In view, however, of the near approach of the time for depositing petitions in Parliament, the Council feels obliged to deposit a petition in order to safeguard its position and with a view of securing certain amendments it desires. I am, however, to express a hope that it may be possible to adjust any such amendments, and to say that they shall in due course be submitted to your Council, and I may add that when the proper time arrives I shall be very happy to discuss any points with you should you so desire.—I am, Sir, your obedient servant, G. L. GOMME, clerk to the Council." Mr. White's three resolutions, already referred to, were again on the agenda for last night's meeting.

**Chippenham.**—The observations of the Town Council upon the memorial to the Board of Trade by the ratepayers' association *re* the Corporation electric lighting scheme, and the reply of the association to the observations, have been issued. The Corporation submit (1) that the objectors have no right to be heard in opposition to the order, as the general body of ratepayers are bound by the Corporation seal; (2) decline the "Bermondsey clause," which has been refused by the Board of Trade in every case; (3) that the outstanding debt is only £6,376, and after allowing for the proposed sewage scheme, there will be ample borrowing powers left; (4) that the scheme can be worked on a commercial basis to the advantage of the town, and that the opposition is got up in the interests of the few; (5) that the ratepayers' association do not understand what would be the effects of what they are asking for, and that the Corporation should not be more hampered than the gas company, in whose solicitor's office the objection, it is believed, was formulated. The objectors reply (1) that the Council is in opposition to the great majority of the ratepayers; (2) that it is desirable that the Bermondsey clause should be inserted; (3) that the total debt, reckoning sewage and prospective waterworks loans, will amount shortly to £30,876, and there is probability of the total rates being 9s. in the £, and that many electric light schemes in small towns are a source of loss; (4) that the opposition to the order is emphatically not in the interests of the few, and the insinuation that it is unduly influenced by the gas company is unfounded, the ground of objection by the association being quite distinct from that of the company.

**Beckenham.**—The clerk's report on the subject of free wiring, recommending that the Council confine themselves to an immediate expenditure of £2,000 on free wiring and reconsider the question when this money is expended, has been adopted. The subject of exercising the option secured to the Council by their Act of last session under the agreement with the British Electric Traction Company, Limited, of supplying current from the electric lighting station for the working of the Beckenham and Penge tramways has also been considered. The clerk and surveyor having reported the result of negotiations with the British Insulated and Helsby Cables, Limited, for the extension of their lease, including the generation of current for tramway traction, this phase of the question stands deferred pending the receipt of a written offer from the company. Meantime, the committee think it desirable to obtain an independent opinion as to whether, under the circumstances of this particular undertaking and having regard to the provisions of the Council's agreement fixing the price of current, the adoption of the tramway load would be profitable and a safe course for the Council to take, and they ordered that a case be submitted for the opinion of one or two firms mentioned to their clerk. In exercise of the Council's option to purchase that part of the Crystal Palace Electric Lighting Company's undertaking which is in Beckenham parish, a notice has now been served on the company requiring them to sell. The electrical engineer is to report upon the plant, etc., to be taken over and the value thereof with a view to negotiations for the settlement of price. An application from the Kent House and District Improvement Association asking the Council to extend the electric lighting in Beckenham-road is also left over until the question of the tramways is dealt with, but other cables are to be extended at a cost of £60 and £500 respectively on the 20 per cent. guarantee.

**Barnstaple.**—On Tuesday the Mayor (Mr. H. Barrett) presented a statement relative to the financial result of the first year's working of the electric light enterprise. In the revenue account to Jan. 28 the items on the debtor side were: coal, including freight, discharging, and all expenses of placing it in the station, £453; water, £156; oil, waste, and engine-room, £75; wages at generating station, £343; distribution, £82; repairs and maintenance of machinery, etc., £4; rent, £30; rates and taxes, £91; insurance premiums, engineer's salary, £180; stationery and printing, £40; general establishment charges, including accountant, etc., £41; bad debt, £2—total, £1,487, and with a profit balance of £676 a total of £2,163. On the credit side of the account the items were: sale of current to 97 consumers from Jan. 28 to March 25, 1903, at 6d per unit, £137; 105 consumers from March 25 to June 24, £174; 124 consumers from June 24 to Sept. 29, £243; 159 consumers from Sept. 29 to Dec. 31, £625: 168 consumers from Dec. 31 to Jan. 28, 1904, £203—a total of £1,384; public lighting from Jan. 28 to June 24, 1903, £278; to Sept. 29, £138; to Dec. 31, £225; to Jan. 28, 1904, £97—a total of £740; meter rents, £28; stores in hand, £11—a total of £2,163. The Mayor said the members would have noticed that a steady progress in the number of consumers and sale of current had taken place every quarter. On March 25, 1903, they numbered 97, and on Jan. 28 last 168, an increase of 71, which was very satisfactory. The amount received for current sold was £2,124. Relative to the items making £610, for coal and water, he had reason to believe that as soon as the condensing plant was at work a very considerable saving in these items would be effected. A reduction in the other items could not be immediately anticipated, especially as several were fixed amounts. The effect of the revenue account was that there was a balance of £676 towards interest and repayment of principal. The interest for the past year had been £591, thus leaving £84 towards principal. All the items in the account were ascertained, and not estimates. Through mains being laid in the outside area additional consumers would be connected, and as there would be no material further cost for the generation an increased revenue must result. He thought, therefore, having regard to that and to the effect of his statement, a reduction in the price of current could safely be made, and, subject to the consideration by the Electric Light Committee, he recommended that it be reduced to 5d. per unit from Jan. 28, 1904, when the meters were last read. The matter was accordingly referred to that committee.

**Burslem.**—Mr. A. Bremner, the electrical engineer, in a report dealing with the proposed electrical supply to Burslem, Wolstanton, and Tunstall, states that he proposes to adopt the three-wire continuous current system, at 440-460 volts pressure at the dynamo terminals and 220 volts pressure at the consumers' terminals, arc lamps and motors being most effectively worked off this supply. By the provision of accumulators, enabling the running plant to be shut down from about 11.30 at night until noon the next day, only one shift of men would be required, whilst the wear and tear of plant, and the cost of fuel, water, etc., would be proportionately reduced. He recommended that a steam plant be installed, more especially as it would be possible to so design the station buildings that any steam raised by the refuse destructor could be utilised for the generation of electricity, the necessary power required to produce the forced draught in the destructor being supplied by the electrical works. He proposed to instal two sets of 100-kw. dynamos coupled direct to compound double-acting vertical engines. The battery should be of 300 ampere-hours capacity, which he believed would be large enough for the ultimate requirements of the district. The boilers, which would be of the water-tube type, would be sufficiently large for the addition of one other dynamo set of the same size as now proposed. His estimate provided for distributing mains to be laid on the solid system in wooden troughs connected up by feeders where required. He proposed that 20 arc lamps of 1,000 c.p. each be provided. On each of the lamp posts a connection for incandescent lamps would be fixed so that the arc lamps need not be lighted after 11.30 p.m. The engineer submitted three schemes. Scheme A provided for the supply of electricity for Burslem and Wolstanton only. Scheme B provided for the supply of electricity for Burslem, Wolstanton, and Tunstall. Scheme C provided for the supply of electricity in Burslem and Wolstanton and a supply in bulk to the Tunstall Urban District Council at the boundary in Scotia-road. The Council have agreed to the Electric Lighting Committee's recommendation that the scheme for a steam-driven plant sufficient to afford a supply of electricity in bulk to Tunstall, referred to in the engineer's report as Scheme C, be adopted, and that the works be erected at the site in Scotia-road agreed to be acquired as a site for the proposed destructor. As a result of further negotiations with the Tunstall Urban District Council, the committee recommended that if the Tunstall Urban District Council will agree to take not less than 50,000 units per annum for a period of not less than seven years, the prices for the supply of electricity in bulk be as follows: (*a*) 2d. per unit up to 100,000 units; (*b*) 1½d. per unit for each unit over 100,000 and up to 200,000 units; (*c*) 1d. per unit for each unit over 200,000 units; that if the Tunstall switchboard is fixed at the central station in Burslem, the extra charge for switchboard attendance at Burslem be £75 per annum; that Mr. Bremner be allowed to act as electrical adviser to the Tunstall Urban District Council and to supervise the laying down of electric mains, etc., in Tunstall on terms to be arranged by him with the approval of this committee; that the question of Mr. Bremner or the electrical engineer for the time being acting as electrical engineer to the Tunstall Council be considered by the Town Council if the above terms are satisfactory to Tunstall.

**Bath.**—The electric light inspector, Mr. J. W. Gatehouse, reporting on the recent electric light failure, states that a fault was developed in the arc circuit, where one of the old mains was protected by a brick conduit at a bend. Heavy traffic, combined with the recent disturbance to the roadway, had caused the earthing of one of the cables at this spot, thereby shutting off the current from the 16 lamps included in the circuit. The next evening the same lamps were again out from 6 p.m. on account of another fault, which developed on the opposite side of the road in the exact spot where a fault occurred on July 17, 1900, and the pitching was afterwards displaced on Aug. 8 by a heavy steam traction engine. This crushing undoubtedly weakened the insulation of the recently-laid cable, but not sufficiently for a breakdown to occur at the time. Mr. E. Manville, the consulting engineer, recommends a further capital outlay upon the electric light works of £16,598 in order to fit them to bear the anticipated next winter's load. The Works Committee do not recommend the acceptance of the proposal. Their report says: "In reporting against the recommendations of your expert adviser, your committee feel that although it is desirable to provide sufficient spare plant and to prepare as far as possible for every contingency that may arise, yet they are compelled to have regard to the very heavy capital charges which the undertaking has already to bear; and that if it is to be a financial success it will be necessary for the department to take the ordinary risks to which an undertaking of this kind must always be liable in order to keep the capital charges within reasonable limits." Mr. Manville, in the course of his communication, says: "The rate at which the new buildings have been approaching completion is, unfortunately, very slow, notwithstanding all the efforts that have been made to induce Messrs. Long and Sons to proceed with this work in accordance with their contract at a reasonably expeditious rate, and it is apparently impossible by ordinary means to induce them to pay due regard to their obligations in this respect. Invariably, as a result of my repre-

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sentative's visit to Bath to inspect the progress of the works, etc., they have placed further men on the work for a few days, but have on each occasion gradually reduced the number again, with the result that the work has proceeded as slowly as it well could. It is now so near completion that it is perhaps not worth while to take any extreme steps with this firm in the direction of informing them that unless they proceed more expeditiously the work would be taken out of their hands to be completed by some other firm of contractors at their expense, but I think, in order to ensure speedy completion, it would be well if you would send them an official letter through the clerk informing them that in view of the excessive delays experienced by the committee at their hands, the committee intended to enforce all the penalties provided for under the contract, and that, therefore, each week they further delayed would involve them in extra expense. You are aware that a portion of the switchgear was installed temporarily to enable the new balancer and feeders to be manipulated. The rest of the switchgear is ready for installation, but owing again to the dilatoriness of Messrs. Long and Sons there is no gallery at present in existence to erect it upon, and it must perforce wait until the gallery is in readiness. A certain amount of danger I must point out is incurred in the use of the switchgear as at present temporarily erected, and at least it introduces some menace from the fire point of view."

## COLONIAL NOTES.

**Dunedin (N.Z.).**—The British Westinghouse Electric and Manufacturing Company, Limited, have received an order from the Dunedin branch of Messrs. Noyes Bros. for a 5,000-volt alternator of the rotating field type, with direct-connected exciter. The enquiry, quotation, and order followed in quick succession by cable.

**Christchurch (N.Z.).**—A satisfactory test was made with the electrical machinery at the Drainage Board's auxiliary pumping station last month, in the presence of Mr. E. Cuthbert, engineer to the Drainage Board, and Mr. L. Birks, the City Council's electrical engineer. Water was pumped into the tank from the river, and then pumped by electricity out of the tank to the main sewer at the Worcester-street bridge.

## PROVISIONAL PATENTS, 1904.

FEB. 8.

**3040. An improved intercommunication telephone system.** August Eckstein and Francis George Bell, Peel Works, Adelphi, Salford, Manchester.

**3045. Improvements in make and break electrical contacts for induction coils.** Fredrick Harold Hall and Constance Hall, Unity Works, Highgate-street, Birmingham.

**3059. An improved electrical fire-alarm.** John Scott and William Clark, 33, Turner-street, Shieldfield, Newcastle-on-Tyne.

**3072. Improvements in cut-outs for electrical conductors.** George Howard Nash and Thomas Eedes Eschus, Florissant, London-road, Enfield, Middlesex.

**3087. Improvements relating to apparatus for amalgamating and coating metals or alloys of metals with metals or alloys of metals by the aid of electricity.** Henry Maurice Wilton Pitt Johnson, 11, Southampton-buildings, Chancery-lane, London.

**3101. Improvements in apparatus for rapidly making and breaking and varying the circuit of electrical currents through the coils of induction apparatus or apparatus of like kind.** William Ironside Bruce, 65, Chancery-lane, London.

FEB. 9.

**3169. Improved suspension chain for electroliers and gas chandeliers, whereby the electric wires, flexible metallic and rubber gas tubing is screened, and which is an improvement on the ordinary ornamental and suspension chain.** Frederick Thomas Cash, 58, Gordon-road, New Wanstead, London.

**3205. Improvements in electrical measuring instruments and apparatus for use therewith.** William Clark Fisher, 24, Albany-road, Ealing, London.

**3211. Improvements in and relating to electric railway systems.** Harold Emmons Bradley and Eugene Francis Bowen, 7, Southampton-buildings, Chancery-lane, London.

**3212. Improvments in flexible conduits for electric conductors.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (James Soule Wilson, United States.) (Complete specification.)

**3216. An improved fuse box for electric cables.** W. T. Henley's Telegraph Works Company, Limited, and William Henry Nichols, 53, Chancery-lane, London.

**3221. Improvements in electric telegraph apparatus.** Sidney George Brown and Alexander Robertson Hardie, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**3236. Improvements in tremblers for electrical circuits.** Walter Gordon Wilson and Wilson and Pilcher, Limited, 77, Chancery-lane, London.

**3243. Improvements connected with electric arc lamps.** Louis Carl Henry Mensing, 173, Fleet-street, London.

**3244. Induction transformer for wireless telegraphy receiving stations.** Eugène Ducretet, 72, Cannon-street, London. (Complete specification.)

**3251. Prevention of arcing in electrical apparatus.** Charles Edward Blood, 40, Chancery-lane, London. (Complete specification.)

**3261. Improvements in valves.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

FEB. 10.

**3264. An improved combination switch and fuse.** John Bush, 90, Lausanne-road, Peckham, London.

**3292. An improved electric lighting arrangement for shops and other places.** Robert Sinclair, 100, Wellington-street, Glasgow.

**3300. Improved means for automatically reversing the trolley of an electric car.** Reginald Hewitt Pearson, 31, Southgate-street, Bath.

**3323. Improved telephonic repeating system.** George Clement Downing, 8, Quality-court, Chancery-lane, London. (Merritt Gally, United States.) (Complete specification.)

**3325. An improved method of connecting up telephone instruments for use on the intercommunication system.** Hendrik Philip Hartog, 22, Maxilla-gardens, North Kensington, London.

**3328. Improvements in switches for electric lighting, heating, etc.** Andreas Peter Lundberg and Gustaf Charles Lundberg, 477, Liverpool-road, London.

**3334. Improvements in wireless signalling.** Louis Heathcote Walter, 81, High Holborn, London.

**3337. Improvements in dynamos.** Pierre Antoine Joseph Lapeyrade, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Feb. 10, 1903, being date of application in France. (Complete specification.)

**3342. Improvements in or relating to telegraph apparatus for ships or other purposes.** Peter Ronald Keppie, 6, Lord-street, Liverpool.

**3344. Improvements in the electric transmission of power for autocars and automobiles.** La Société de Champrobert et Cie., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Feb. 11, 1903, being date of application in France.) (Complete specification.)

**3356. Improvements in and connected with electric and other lifts and hoists.** Eugène Chaudoir, 173, Fleet-street, London.

FEB. 11.

**3385. Improved automatic telegraph transmitter.** Donald Murray, 3, Lombard-court, London. (Complete specification.)

**3388. A new or improved method of making electrical contacts for obtaining rectilinear reciprocating action in electric hammers and for other purposes.** Ernest Digby Hopcroft, 5, Corporation-street, Birmingham.

**3414. An improved method of breaking the electric circuit in the overhead wires of electric tramways and railways and in other suspended conductors and apparatus therefor.** Cecil Charles Hewett, 185, Fleet-street, London.

**3426. Improvements in electric switches.** Wesley Duncan, Richard MacDiarmid, and Edward Bruce Bates, 33 Cannon-street, London. (Complete specification.)

**3429. Electrical tube-welding machine.** Robert William Leach, Greswolde, Old Meeting-street, West Bromwich.

**3431. Improvements in telephones.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

**3440. Improvements in joints or connections for wires or conductors of electrical energy for telephonic and other uses and in apparatus employed therein.** William Heatley, 55, Chancery-lane, London.

**3449. Improvements in or relating to electric clocks.** Henri Alfred Campiche, 111, Hatton-garden, London.

**3453. Improved construction of secondary battery or accumulator.** Giraldus Jones, 22, Southampton-buildings, Chancery-lane, London.

**3454. Improvements in electric lamps for use in mines.** Giraldus Jones, 22, Southampton-buildings, Chancery-lane, London.

**3469. Reverse-current circuit breakers and indicators for alternating currents.** Leonard Andrews, 14, College-land, Deansgate, Manchester.

**3471. Improvments relating to the charging of accumulators or secondary batteries for electric ignition and other services.** Thomas Herbert Marsh, 18, Southampton-buildings, Chancery-lane, London.

FEB. 12.

**3492. An improved method of fixing the covers to electrical switches and other articles.** John Henry Tucker, Sampson-road North, Birmingham.

**3508. Improvements in subscribers' call signalling devices for telephone exchange systems.** John Macfee, 65, Chancery-lane, London.

**3523. Improvements in hand telephones.** Albert Friedlaender, 14, Lindenstrasse, Berlin, Germany.

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**3540. Improvements in alternating-current wattmeters.** Frank Conrad, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 20, 1903, being date of application in United States.) (Complete specification.)

**3547. Improvements in or connected with electric switches.** William Kingsland, 33, Chancery-lane, London.

**3581. Improvements in incandescent electric lamps.** The E. E. L. Syndicate, Limited, and George Sweetser, 11, Southampton-buildings, Chancery-lane, London.

**3588. Improvement in alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3589. Improvements in alternating-current electric motors** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3590. Improvements in means for controlling electric motors.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

**3603. Improvements in electric controlling apparatus for electric circuits.** Henry Leitner and Richard Norman Lucas, Lynton, Dartnall Park, Byfleet.

FEB. 13.

**3613. A new bracket to be used for the purpose of carrying electric lighting lamps, and which may also be used for displaying goods.** Ernest Gladstone Taylor and Rufus Leonard Ratcliffe, Old Market-chambers, Yorkshire-street, Rochdale.

**3631. Improvements in circuit controllers for induction coils.** William George Heys, 51, Deansgate-arcade, Manchester. (The Varley Duplex Magnet Company, United States.) (Complete specification.)

**3640. Improved means or apparatus for steadying direct-current arc lamps.** Arthur Brunel Chatwood, 17, Hanover-street, Keighley, Yorks.

**3660. Improvements relating to magneto-electric ignition gear for internal-combustion engines.** Rudolf Hennig, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**3665. Improvements in motor controllers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3666. Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3677. Improvements in regulators for alternating-current motors.** Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 14, 1903, being date of application in France.) (Complete specification.)

**3690. Improvements in anti-vibration hangers, especially applicable to Nernst electric lamps.** Percy Alfred Spalding, 322, High Holborn, London.

**3691. Improvements in or relating to electric bell circuits and switches.** Herbert Sefton-Jones, 322, High Holborn, London. (Hermann Schor, France.)

**3692. Improvements in electric bells or gongs.** William Arthur Heyes and Lancelot Ovid Heyes, 6, Lord-street, Liverpool.

**3694. A new or improved coherer for wireless telegraphy.** Fernando Ortega, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Feb. 16, 1903, being date of application in Spain. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 3, 1904.*

1903.

**3170. Electric brakes for cars.** James. (Algonquin Electric Brake Company.)

**3658. Motors and regulating devices for electrically-propelled vehicles.** Raworth.

**3888. Contact stud and fixing for use with surface-contact systems of electric traction.** Griffiths and Bedell.

**4393. Electrical appliances for the prevention of the racing of marine engines.** Maclean.

**4442. Rail bonds of electric railways.** Bauer. (Helios (Elektricitäts-Aktiengesellschaft.)

**4698. Electrical measuring instruments.** Ferguson and Kelvin and James White, Limited.

**5989. Electric sparking devices especially intended for firing the charges in internal-combustion engines.** Bradley and Edmunds.

**6484. Alternating electric current transformers.** Carolan. (General Electric Company.)

**6487. Alternating electric current induction motors.** Carolan. (General Electric Company.)

**6488. Alternating electric current transformers.** Carolan. (General Electric Company.)

**6497. Electric railways.** Carolan. (General Electric Company.)

**6500. Dynamo-electric machines.** Carolan. (General Electric Company.)

**6892. Rail bond for electric tramways and light railways.** Zealander and Cummins.

**7140. Electric railway apparatus.** Carolan. (General Electric Company.)

**7455. Boxes for electric conductors.** Carolan. (General Electric Company.)

**7639. Standards and trolley boom controlling apparatus for electric tramcars and the like vehicles.** Hindley.

**7960. Electric pumps.** Ellis. (Automatic Electric Pump Company.)

**7983. Electrical insulation of metal pieces.** Davy.

**8810. Electric cables.** Claremont and Beaver.

**8883. Circuit-breaking fuse.** Dixon.

**12193. Ozoniser of high frequency adapted to be directly connected to a dynamo.** Otto.

**18181. Apparatus for determining the length of waves and observing the oscillations in electric oscillation systems.** Franke.

**23750. Electric signalling apparatus for railways.** Danneels.

**23876. Autographic and other telegraph systems.** Korn.

**26783. Electrically-operated points and switches for electric railways.** Breedlove and Grant.

**27734. Safety device for the switches of electrically-driven suspended railways.** Hearson. (Adolf Bleichert and Co.)

**27900. Telephone systems** Hardegen.

**27924. Safety devices for electric railway systems.** Gibbs.

1904.

**291. Electric incandescent lamp.** Regnart.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-12b,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | ⅜-4½ xd |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 3 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-93,261 | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ⅛-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | ½-1⅛ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¼-9½ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 12-13 |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 108-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 18-19 |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | .. | 33-36 |
| —— 5 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | .. | ¾-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 9¼-10¼ xd |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10¼-11¼ xd |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10¼-10¾ |
| —— 7 per cent. Preference | 5 | .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 6-7 |
| —— Nos. 20,001-30,000 | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 14½ |
| —— " " £10 Ord. | 6 | .. | 10¾ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7⅞-8¼ xd |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 103-105 |
| Chelsea Electricity Supply | 5 | .. | 5¼-6¼ |
| —— 4½ per cent. Debentures | 100 | .. | 106-109 |
| City of London, Ordinary | 10 | .. | 10¼-11 |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 8-9 |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11¼-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3-4 |
| —— 5 per cent. Debenture Stock, Red | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 99-102 xd |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7½-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. | 100 | .. | 103-106 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅞-10⅛ |
| London Electric, Ordinary | 5 | .. | 1⅞-2⅛ |
| —— 6 per cent. Pref. | 5 | .. | 5¼-6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | .. | 17½-18½ |
| ——4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| ——3½ per cent. Mortgage Debenture, Red. | 100 | .. | 96 99 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 88 101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs ,Nos. 1-500 (Reg.) | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and -14,310 | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 97-100 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | – | 96-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | – | 3½-3⅝ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| South London, Ordinary | | – | 3⅜-4¼ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 xd |
| ——5½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4⅛-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4⅞-5⅛ |
| Westminster, Ordinary | 5 | – | 12½ 13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6½ |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 93-96 xd |
| —— 4 per cent. Pref. | 100 | .. | 96 99 xd |
| —— ,, ,, deferred | 100 | .. | 87-90 xd |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | .. | 110-115 |
| City and South London, Consolidated Ordinary | 100 | – | 50 53 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 123-126 xd |
| —— ,, ,, ,, '96 | 100 | – | 119-122 xd |
| —— ,, ,, ,, '01 | 100 | .. | 118-121 xd |
| Liverpool Overhead, 5 per cent. Pref. | – | – | 13-13¼ |
| —— Ordinary, 1-50,000 | – | – | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 102-104 |
| Waterloo and City, Ordinary | 100 | – | 91-94 |

## Electric Tramways.—

| | | | |
|---|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | – | 4⅜-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | .. | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | .. | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | .. | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 80-83 |
| —— Non.Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10-10⅛ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9½-10⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10-11 xd |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 3-3½ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5¼-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 104-107 |
| —— Prov. Cert., all paid | 100 | – | 98-101 |
| Cape Electric Tramways ,Nos. 1-480,000 | 1 | – | 1⅜-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— Debentures | 100 | – | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12¼-13¼ xd |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | – | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | – | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | £0 93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 3¾-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11½-11⅞ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | .. | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | .. | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | .. | ¾-1⅛ |
| New General Traction, Ordinary | 5 | – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1½-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 10½-10⅞ |
| —— 5 per cent. Cum. Pref. | 10 | – | 11½-12⅛ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | .. | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8¼-8½ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 8¼ 9½ xd |
| —— 4½ per cent. Debenture Stock | 100 | – | 102-105 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,132 6 per cent. Preference | 1 | – | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 102-104 |
| —— Deferred Stock | 100 | .. | 78-81 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 13¼-14½ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 14-15 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5¼-5⅜ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 96 97 |
| —— 4 per cent. Deb. Stock. Red. | 100 | – | 100-102 |
| Oriental Telephone and Electric Company | 1 | – | ¼ 1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | Receipts per | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Pas-s'nger | Car mile. | Mile of track. |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 13 | 1,034 | 815 | + 278 | + 8,856*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 13 | 162 | 157 | + 5 | + 167 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 13 | 302 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 12 | 768 | 669 | + 99 | +38,818 | 24 | 24 | March 25*a* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 11 | 299 | 310 | – 11 | – 231 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 13 | 185 | 188 | – 2 | – 16 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 14 | 1,579 | 1,532 | + 47 | + 8,922 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 10 | 863 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 14 | 3,359 | 3,205 | + 154 | +19,320 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 14 | 709 | 752 | – 43 | + 2,634*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 12 | 4,604 | 4,323 | + 281 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 13 | 889 | 668 | + 221 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 14 | 302 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 13 | 1,912 | 1,565 | + 347 | +22,537 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 13 | 170 | 140 | + 30 | + 192 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 6 | 6,994 | 7,038 | – 44 | + 74*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 14 | 3,297 | 3,107 | + 190 | – *h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 11 | 377 | 399 | – 22 | + 30 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 12 | 210 | 197 | + 13 | – 217 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 13 | 169 | 171 | – 2 | + 50 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 14 | 93 | 90 | + 3 | + 36*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 12 | 3,672 | 3,659 | + 13 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 12 | 701 | 759 | – 58 | | | | | | | | | | | |
| Dundee City Tramways | ,, 10 | 800 | 782 | + 18 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 13 | 593 | 514 | + 84 | + 8,182 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 13 | 12,684 | 12,630 | + 54 | +52,104*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 10 | 2,195 | 2,074 | + 121 | + 6,303 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 13 | 1,077 | 1,043 | + 34 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 13 | 2,039 | 1,715 | + 324 | + 6,764 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 10 | 126 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 10 | 188 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 13 | 4,902 | 4,852 | + 50 | — | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 6 | 9,648 | 9,128 | + 520 | + 2,634 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 14 | 1,481 | 1,482 | – 1 | + 354*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *e* |
| London County Council | ,, 7 | 9,373 | 8,043 | +1,330 | +77,356 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Jan. 30 | 125 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Feb. 13 | 91 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 13 | 3,477 | 3,059 | + 418 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 13 | 1,373 | 1,205 | + 168 | + 5,335 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | Jan. 25 | 103 | 93 | + 10 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Feb. 11 | 407 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | Jan. 18 | 3,443 | 2,628 | + 815 | +45,400 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | Feb. 14 | 4,160 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,326,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 11 | 893 | 820 | + 73 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 14 | 1,078 | 1,011 | + 67 | + 2,608 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 13 | 571 | 523 | + 48 | + 3,790 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**The Northampton Institute.**—To-night Lord Kelvin is to distribute the prizes at the above institute at Clerkenwell. The programme gives promise of a most successful function.

**Electricity in Mines.**—In reply to a question in the House of Commons last week, Mr. Akers-Douglas said that the departmental recommendations of the Electricity in Mines Committee would be open for discussion when the vote for the Home Office was under consideration. He did not think there was any reason to depart from the ordinary parliamentary procedure in the matter in order to arrange for a special discussion.

**The Electro-Harmonic Society.**—At the "Ladies' Night" concert to be held at the King's Hall, Holborn Restaurant, this evening, the chair will be taken by Lord Claud Hamilton. A good programme has been arranged. The vocal music will be provided by Mrs. Helen Trust and Mr. Robert Hilton. For the instrumental music Messrs. T. E. Gatehouse, B. C. Goodhead, and A. E. Izard are responsible, and they will be assisted by the usual orchestra. Mr. Ernest Cherry, Mr. Ulph Smith, and Mr. J. M. Campbell will contribute several character and humorous sketches.

**Municipal Electrical Association.**—We are pleased to hear that the Incorporated Municipal Electrical Association have petitioned the Local Government Board on the question of allowing the metropolitan borough councils to become members of the association. These councils are supporting the petition, which will find favour with business men. We trust that on receipt of it the Local Government Board will issue instructions to the auditors that expenses incurred by the councils due to the membership of this association shall not be surcharged, as they have been in the past.

**The Carnegie Trust.**—The annual report of the Carnegie Trust for the Universities of Scotland, presented at the annual meeting held in London last week, shows clearly the good work being done under the scheme for assisting education financed by Mr. Carnegie. The details of the report would occupy more space than we have at our disposal, but we are pleased to see the scheme of endowment for post-graduate study and research has actually commenced. Five fellowships and 15 scholarships have been awarded, besides smaller grants to 50 applicants. This research work, if properly controlled, will be of great service to the country at large.

**St. Marylebone Lighting.**—The Mayor of Marylebone, in a courteous and statesmanlike letter, has urged the ratepayers of St. Marylebone not to oppose the Bill which the Council have now the authority of the ratepayers to bring before Parliament. In the letter he points out that efforts should rather be directed towards the amendment of the Bill, as whatever happens, parliamentary sanction to a Bill even in an amended form will be required. He details the various possible results of negotiations for the management of the undertaking, and shows that at the worst the inhabitants of St. Marylebone will not be nearly so heavily rated as the extreme opponents to the Bill have led one to suppose.

**The American Institute.**—The November number of the *Transactions* of the American Institute of Electrical Engineers has reached us. It contains an important paper with discussion on "The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service," by Mr. Cary T. Hutchinson, and another describing "A Graphic Recording Ammeter," by Mr. A. H. Armstrong. The other two papers printed in this volume are "The Electric Conductivity of Commercial Copper," by Mr. Lawrence Addicks, and "The Comparative Behaviour of Floating and Booster-Controlled Batteries on Fluctuating Loads," by Mr. L. Lyndon. The present issue has been considerably delayed by the fire which, as reported a week or two ago, destroyed the institute print shop on Dec. 28 last.

**Electricity in Coal Mines.**—Mr. George H. Winstanley gave an interesting address before the members of the Manchester Geological and Mining Society recently, in which he spoke in favour of electricity as being an ideal form of energy for mining purposes. He concluded that the application of electricity on proper lines was no more dangerous than the application of energy in any other form. As a rule the plant was not so costly as compressed air, and the cables were much more convenient to instal than the air-pipes. Mr. Winstanley said that he had investigated a number of so-called accidents which had occurred in coal mines, and was satisfied that it was not electricity that was to blame. It was too frequently the employment of unsuitable appliances or the misuse of proper appliances, and in some cases the result of woeful and unpardonable ignorance.

**Physical Society.**—At the annual general meeting of the above society on Friday, the 12th inst., the following officers and council were elected for the ensuing year: president—R. T. Glazebrook, D.Sc., F.R.S.; vice-presidents—those who have filled the office of president together with T. H. Blakesley, M.A., C. Chree, D.Sc., F.R.S., Prof. J. D. Everett, D.C.L., F.R.S., and J. Swinburne; secretaries—W. Watson, D.Sc., F.R.S., and W. R. Cooper, M.A.; foreign secretary—Prof. S. P. Thompson, D Sc., F.R.S.; treasurer—Prof. H. L. Callendar; M.A., F.R S.; librarian—W. Watson, D.Sc., F.R.S.; other members of council—C. V. Boys, F.R.S., W. Cassie, M.A., W. B. Croft, M.A., H. M. Elder, M A., Prof. J. Perry, D.Sc., F.R.S., A. W. Porter, B.Sc., W. A. Price, M.A., Prof. F. T. Trouton, Sc.D., F.R.S., W. C. D. Whetham, M.A., F.R S., S. A. F. White, M.A.

**The Metric System.**—Lord Belhaven and Stenton in the House of Lords on Tuesday introduced a Bill founded on the report of the Select Committee of the Commons of 1895, which seeks to render compulsory, after a certain delay, the adoption of the metric system of weights and measures. In a long oration the mover described the alleged disadvantages and complications of our present system, and spoke in enthusiastic tones of the advantages of the metric. He was strongly supported by Lord Kelvin, who held that compulsion in this matter would not create difficulties, but would make difficulties easy for the world. Lord Colchester, Lord Wolverton, Earl Spencer, the Marquis of Lansdowne, and the Earl of Rosebery joined in the subsequent discussion, which was generally favourable to the measure, and it was read a second time and referred to a Select Committee.

**Electrical Developments in Austria.**—The British Consul at Trieste reports that the Kerka (Dalmatia) electricity works, developing 20,000 h.p, will be opened shortly. A great part of the power generated will be transmitted to Sebenico, where a calcium carbide works has been erected. The transmission line will be 7½ miles long. The central station at Jaruga contains two 3,500-h.p. sets, and it is anticipated that the annual production of carbide will be 5,000 tons. The consul states further that the company formed for the utilisation of water power of Dalmatia, under the name of the Società Romana, has also commenced operations on the Manojlovac waterfall, from which it is hoped that 25,000 h.p. will be obtained. There

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will be altogether 30,000 h.p. from the four Kerka falls, and the annual production of calcium carbide will be 30,000 tons. The electric works will when completed absorb a capital expenditure of about £150,000.

**Electrical Coalcutters.** — Mr. H. Cunningham, writing to this week's Society of Arts *Journal*, adds to what he previously said in the discussion of Prof. Boys's paper on "Thermit." He now says that in the design of electrical coalcutters he believes English engineers are in advance of the Germans. He also considers that the efforts now being made will result in our reconquering the electric power industry in the same way as we are now reconquering the motorcar industry. The recent reports which have been abstracted in our columns show the keenness with which the mining engineers in the North of England have taken up the question of electrical coalcutters. It will be remembered that the report of a special committee appointed to look into this matter was in favour of three-phase motors for driving these coalcutters. It was shown that with the three-phase system the jambing of the cutter, which is unavoidable in certain seams, does not involve the damage to the motor which it does on a direct-current motor. English manufacturers are now taking up keenly the supply of three-phase plant, so that work need not go out of the country.

**Competition in America.**—For some years the heavy electrical engineering work in the United States has been in the hands of two large firms. These firms, after crushing all rivals, made a working agreement between themselves, and have thus had a free hand in their home market. This agreement went so far as to secure community in patent rights between the two companies. Now there is news of another large firm, well known as steam engineers, taking up electrical manufacture on an extensive scale. We refer to the Allis-Chalmers Company. The manufacture by the electrical firms of steam-turbines is said to have led to this step. The Allis-Chalmers Company will now make a steam-turbine, and have also secured new designs for a gas-engine of the Nürnberg type. Hydraulic turbines will be another departure, the designs for these being obtained from Messrs. Escher, Wyss, and Co., with sole manufacturing rights in the States. The electrical side will be under the supervision of Mr. John F. Kelly and Mr. W. Stanley, jun. It will be interesting to see how this new departure will be met by the two companies most affected. We should not be surprised to hear of extensive patent litigation being resorted to.

**Vapour Tube Telephone Receiver.**—The *Electrical World* records a patent issued to Mr. Peter Cooper-Hewitt describing an important application of the vapour tube for reproducing variations of current in an electric circuit, the latter being either wholly independent or a branch of a divided circuit. The striking feature of the principle is that it enables the production in the secondary circuit of electrical variations of greater magnitude than the original electrical variations in the primary or transmitting circuit. In other words, it offers a solution to the problem of the telephone repeater. As illustrated and described, a magnet in the telephone transmitting circuit is in close proximity with a vapour tube, and the telephone receiving dovice is in series in the vapour tube circuit. In one form shown the core of the magnet in the transmitting circuit embraces the vapour tube. It is stated that the amplification of the electrical variations in the secondary circuit is due to the fact that a given magnetic variation may cause a wider fluctuation of effective resistance in the gas or vapour than the fluctuations of electrical energy producing the variation of the magnetic field of force. Accordingly, by employing the vapour tube the vibrations of the circuit are magnified, not by induction effects, but by varying the ohmic resistance of the circuit in which the apparatus is placed.

**High-Speed Steam Railway Service.** — As an indirect consequence of the Marienfelde-Zossen high-speed electrical railway trials, experiments are being made on a number of German railway lines with a view to investigating the working conditions of a steam railway service with increased speeds. On the Cassel-Hanover line, for instance, the trains tested are made up of gigantic high-speed locomotives and solidly connected six-axle cars, warranting a mean speed as high as 81 miles per hour. This speed would enable the journey between Berlin and Hamburg to be completed in about two hours, and it is stated that two such trains would be sufficient to cope with the present traffic. In the case of these experiments giving satisfactory results, it is thought probable that already next summer some specially suitable lines will be arranged for a similar increased speed service, the more so as the Berlin-Zossen trials have shown existing permanent ways (provided they be fitted with heavy rails) to be fully suitable for a similar service. Even in the case of the introduction of electric high-speed railways being postponed for economical reasons, a material improvement in the German high-speed railway service may therefore be anticipated as far as lines with specially dense traffic are concerned.

**Electricity and Fires.**—The records kept by insurance companies in Canada and America clearly show that electrical work is not so well organised from a safety point of view in those countries as in England. For instance, the Fire and Light Committee of Montreal for the last three months of 1903 record no less than 150 electrical fires. An analysis of the Montreal report shows that 22 fires were due to crosses of telephone, telegraph, and low-potential wires with high-tension circuits. Seven pole and tree fires are also recorded. It is clear that underground wires would have prevented these fires. Nineteen were due to wires grounded on gas-pipes; 11 to defective wiring of fixtures: five by flexible cords wrapped round gas-pipes, the current having punctured the pipe and the gas had ignited; three by short-circuits in mouldings; three to open link fuses in porcelain cut-out bases; 15 to overheated resistance coils and heating devices, and nine to incandescent lamps coming in contact with inflammable material. It will be seen that all these fires were due to preventable causes, and this fact emphasises the necessity of adopting some method of better supervision in the carrying out of electric light fitting and wiring, and also of educating the public in exercising proper care in the use of electrical apparatus. It will be seen also that a large number of these fires, the cause of which could be traced, were due to the use of overhead distribution systems, which are not allowed, as a rule, in this country.

**London Traffic Commission.**—Sir Theodore Martin's evidence before the Royal Commission on London Traffic dealt largely with the question of parliamentary procedure in the promotion of new lines in and around London. His experience as a parliamentary agent for nearly 60 years makes his opinion valuable, even if somewhat biassed in favour of things as they are. Thus Sir Theodore Martin saw no reason why any fresh tribunal should be appointed to consider the lines that might be so proposed. No efficient tribunal could be constituted without creating additional expense. To be effective, the members of such a tribunal must be men of large experience, probably men in the receipt of large professional incomes, and any decision they might come to must, he thought, be open to revision by Parliament. The interference with property was so serious that no decision but a parliamentary one would give satisfaction. The amount of capital involved would also be so

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great that it seemed to him to be peculiarly the function of Parliament to deal with this question and to secure the interests of the public, as well as those whose property might be interfered with, and also not only to see whether the object proposed could be obtained at the estimated expense, but whether it would not be obtained with too great an interference with property and at too great a price. That being his view, he considered that the present system of submitting all projected railways to the arbitrament of parliamentary committees could not be improved upon.

**Institution of Mechanical Engineers.**—The annual general meeting of this institution was held last week. Mr. J. Hartley Wicksteed, the president, occupied the chair. The secretary presented the report of the council for the past year, from which it appears that the number in all the classes of membership on the roll of the institute at the end of 1903 was 4,211, thus affording a net gain of 319 during the year. Since the institution took possession of its present home in St. James's Park the numbers have shown a most satisfactory increase, the advance in membership being 238 in 1899, 243 in 1900, 325 in 1901, and 402 in 1902. The total number of members of all classes elected during the past year was 442, the difference between this total and the net gains being made up by the removal of names through death and other causes. Among the losses of membership through death must be mentioned Sir Frederick Bramwell, who joined the institution 50 years ago, and was president in 1874 and 1875; Mr. F. C. Marshall, the well-known Tyneside marine engineer; and Mr. G. B. Lloyd, who was elected in 1854. The balance sheet showed a satisfactory financial position. Reference was made in the report to the work of the Alloys Research Committee, of which we have previously made mention. Other research committees are engaged on investigating the problems connected with the steam-engine, Mr. W. H. Maw being chairman and Prof. D. S. Capper reporter; the gas-engine; and the value of the steam jacket, Prof. T. Hudson Beare being the reporter.

**Relations of Righi Vibrator.**—To the *Physical Review* for last month Messrs. Harley R. Willard and L Elmer Woodman contribute a lengthy article describing the results of a study of the radiations emitted by a Righi vibrator. The experiments were undertaken for the purpose of determining, first, the nature of the radiation emitted by a Righi vibrator, and, secondly, the dependence of the length of a linear receiver upon the wave-length with which it is in resonance. This problem, however, resolved itself into (1) the measurement of the energy received from the same vibrator by resonators of different lengths, and (2) the measurement of the wave-lengths obtained from different resonators. These experiments were successful in bringing out several useful points. In the first instance, the measurement of energy with a linear receiver of definite length showed the existence of a fundamental and upper partials; secondly, that the relation of the receiver lengths for fundamental and the successive upper partials stand in the relation 1, 2, 3; and, thirdly, that the wave-length and receiver length are connected by the relation indicated in the formula $\lambda = K(l + a)$. Again, the interference curves show that the damping in a Righi vibrator is less than the theoretical value computed by Thomson for the radiation from a single sphere. Another point brought out was that the grating space of the separating surface does not affect the wave-length measured. The character of the emission of a Righi vibrator, as shown by the experiments, may be accounted for by a modified statement of Sarasin and De la Rive's hypothesis, but is more rationally explained, in the opinion of the authors, on the basis of the hypothesis of Bjerkness and Poincaré. The results of the present experiments are, however, too limited in extent and too uncertain to give conclusive evidence in favour of either view.

**Synchronous Driving.**—We understand that two French engineers have gone into the question of driving a phonograph and a cinematograph simultaneously, so as to reproduce at the same time a moving picture and the sounds accompanying the same. For instance, a statesman could be represented delivering his speech, so that when the speech was heard on the phonograph his actions in delivering the same could be exactly followed. In order that this may be done, it is necessary that there should be absolute synchronism in the driving of the phonograph and the cinematograph. These engineers, Messrs. Gaumont and Decaux, found it advantageous to drive the cinematograph by electric means from the axis of the phonograph. This they did by fixing a ring of metal contacts round the axle of the phonograph and sweeping them by fixed metal brushes, as in the commutator of a dynamo. The brushes are joined in circuit with the field magnets of a motor, which are in sections like those of a Gramme ring, and the contacts with a source of electricity, so that as the axle of the phonograph revolves the current is sent through one brush and one section of the ring after another. The revolving bobbin of the motor, which resembles a Siemens armature, is thus pulled round inside the ring, and its motion works the cinematograph synchronously with the phonograph. This means of producing synchronism with a revolving field is wonderfully successful. It has been employed in this country in connection with electrical steering gear made by a well-known firm, and has proved very accurate.

**New Books.**—"The Phase Rule and its Applications," by Alex. Findlay, M.A., Ph.D., D.Sc. (London: Longmans, Green, and Co. 5s.) This work belongs to the series of text-books of physical chemistry edited by Sir William Ramsay, K.C.B. In an explanatory note it is stated that the proposal is to issue several short manuals, so that each may individually be brought up to date independently of others. Sir William Ramsay has written a general introduction to the series under the title, "An Introduction to Physical Chemistry," and this has also been included in Mr. Findlay's book on "Phase Rule." This latter, which is dedicated to Francis R. Japp, LL.D., F.R.S., runs into over 300 pages of text, which is amply illustrated by some 120 figures.—"O'Gorman's Motor Pocket-Book," by Mervyn O'Gorman (Westminster: Archibald Constable and Co., Limited). 7s. 6d. The author of this work has qualifications which place him in a unique position for writing a handbook of advice, instruction, and "tips" on motoring. He was one of the judges in the Automobile Club's Irish events in 1903, and in the Auto-Cycle Club's 1,000 miles reliability trials, and he is also a member of the Racing Committee and Driving Certificates Committee of the Automobile Club, and of the Auto-Cycle and Motor-Cycle Executive Committees. The book is directly aimed at the owner of a recently-acquired car, who wants to know all about the machine he drives. Thus there are brief articles on "Alcohol as a Source of Power," "Indiarubber," "Fire Insulation," "Differential Gear," an explanation of the spark intensifier (under "High-Tension Current"), and countless other matters. Good advice is also given on "Fault Finding" and "Breakdowns," and altogether the book should be of great use to amateur motorists. It is fully illustrated.—"Entropy; or Thermodynamics from an Engineer's Standpoint," by James Swinburne (Westminster: Archibald Constable and Co.) 4s. 6d.—"The Law Relating to the Telegraph, the Telephone, and the

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Submarine Cable," by Evelyn G. N. Carmichael (London: Knight and Co.). 10s. 6d.

**Our Patent Laws.**—Mr. G. A. Lowry, writing to the Society of Arts *Journal*, makes the bitter complaint that the patent laws effect the repression of the British inventor. His statements lead one to conclude that he is an American. Thus he writes: "There is neither encouragement, hope, nor incentive for the inventor under your patent laws. Your patents convey no sense of ownership nor evidence of the applicants having invented anything. It is simply a certificate of registration of the applications, drawings, and claims, and that they conform to the requirements of the office. To give a patent any tangible or marketable value it must first be fought through the courts to a decision in its favour—even if the inventor's means should permit him to do so, and he should live to set the end of the litigation, the term of his patent would probably have expired, or been materially reduced—and if he is defeated in even one claim, though he has 50 others that are good, his whole patent is declared invalid. The English inventor is asked first, 'Have you a United States or German patent?' Unless you have one or both of these the English patent carries no weight, and his interest ceases. Is it justice to your inventors that they must seek from a foreign country protection in their own?—these foreign patents are practically a guarantee that 'you are the sole and original inventor of a new and novel device'; those who wish to invest feel safe, and those who infringe do so at their peril." The new regulations by which a search is made over the past 50 years' record do not satisfy the writer, who favours the American patent system. Of this system's faults he says nothing, nor of the idiosyncrasies of the German Patent Office. It seems to us that no law can give a patent a tangible and marketable value. The value is in the process patented, and if that is a commercial success, the courts must always be the final arbitrator as to the priority of its invention Perhaps, after all, Mr. Lowry will find the English system has advantages when looked at from this point of view.

**A Novel Radiation Phenomenon.**—Mr. J. J. Taudin Chabot (*Physikal. Zeitschrift*, No. 4, pp. 103-104, 1904) some time ago experimented to find whether selenium in its modification as a conductor, being sensitive to light, may give rise to radio-active phenomena. To this end he used a selenium cell of the Shelford Bidwell type, the effective mass of which was uniformly distributed on the surface of a platinum wire. After having been in the dark for many weeks, the platinum-selenium surface was covered under a red light with a sheet of silver bromide jelly, to which an ingredient absorbing the yellow and green rays was added. An aluminium strip bent at right angles was interposed between the wire and sheet. After the whole system had been kept in the dark for another 48 hours the same experiment was repeated, using a fresh silver bromide film, while a current of about 110 micro-amperes traversed the selenium. Now the following results were observed on the developed films. In the first case some bright spots, corresponding apparently to the outline of the aluminium strip, were noted on a dark background; whereas, in the second case, a dark silhouette of the whole of the bent strip was reproduced on a bright background, some brighter narrow transverse lines being visible at the same time. These bands were produced more clearly in the case of repeated exposures, thus showing that they are due either to the parallel platinum wires or to the selenium interposed between each two of these, or, finally, to the points of contact between the platinum and selenium, where the Peltier effect must give rise to an evolution of heat either positive or negative on the passage of the current. On continuing these experiments, Mr. Chabot noted the fact that the back of the plate bearing the platinum-selenium wire was equally capable of affecting the silver bromide film, dark silhouettes on a bright background being then obtained. As to the question whether these results are an evidence of the existence of some novel radiation, or else an emanation from the surface of conductors, the author hopes to publish in due course some further investigations allowing of more definite conclusions being drawn.

**Radium.**—M. Curie delivered a lecture on radium on the 18th inst. at the Sorbonne, under the auspices of the Société des Amis de l'Université. From the report of this lecture in the *Times* we take the following interesting statements. After referring to M. Becquerel's discovery of the rays which bear his name, M. Curie explained that polonium, radium, and actinium emit rays a million times more intense than those given out by uranium and thorium. Radium constitutes a new element, which he and Madame Curie have isolated in the state of a pure salt. No screen is absolutely opaque to the rays of radium, which cause the phosphorescence of a large number of bodies. Phosphorescent substances are little by little altered by the prolonged action of radium rays. They become less excitable and are less luminous under the action of the rays. Salts of radium are spontaneously luminous, and it is possible to obtain them sufficiently luminous to be visible by daylight, when their light resembles in colour that emitted by the glow-worm. The luminosity of the salts of radium diminishes with time without ever disappearing completely, and, at the same time, the salts, at first colourless, assume a grey-yellow or violet colour. Radium rays render the air they traverse a conductor of electricity. Salts of radium possess the curious property of continually giving out heat sufficient to melt their own weight of ice in an hour. The salt of radium thus utilised seems always to remain in the same state. A salt of radium placed in an opaque box of pasteboard or of metal, nevertheless, acts on the eye and produces the sensation of light. To obtain this result the box containing the radium may be placed before the closed eye or against the temple. In these experiments the middle of the eye becomes luminous by phosphorescence under the influence of the rays of the radium, and the light perceived has its source in the eye itself. Radium is an example of a body which, while preserving its condition, gives rise to an emission of continuous and considerable heat. This fact appears to be in disagreement with the fundamental principles of energy, and different hypotheses have been proposed to avoid the contradiction. In conclusion, M. Curie mentioned that recently a new fact of great importance had been discovered by Prof. Ramsay and Mr. F. Soddy. They had found that the emanation of radium gives rise at the time of its disappearance to the production of the gas helium, of which the presence had been ascertained by spectrum analysis. Thus it would appear that we are for the first time in the presence of the phenomenon of the formation of an element. It is possible that radium may be an unstable chemical element and that helium may be one of the products of its disaggregation.

**The Shallow Tunnel Subway.**—It will be remembered that the London County Council are authorised to provide such a subway for electric tramcars under the new "Kingsway." Last week the members of the Civil and Mechanical Engineers' Society visited the work in progress under the guidance of Mr. W. R. Morris, the resident engineer. The subway, starting from a spot close to the New Gaiety Theatre, will pass under the western arm of Aldwych and then north under Kingsway to Holborn. It

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will then pass under Holborn to Southampton-street, where it will come to the surface at a slope so as to join up with the existing tramway lines that concentrate at Theobald's-road. On each side of the tramway tunnel there will be two subways, which will accommodate gas and water pipes, electric mains, etc. Below each of these side tunnels there will be a sewer. The visitors were first taken into the short length of tunnel at the Strand end, which is nearly completed. Near here, close to the site of the old Olympic Theatre, there will be a station, which will be reached by staircases, but the whole scheme includes a continuation of the tunnel as far as the Embankment. The width of the tunnel will be 20ft., and the height from the crown of the arch to rail level 14ft. The pipe subways on each side of the main tunnel will be 12ft. The depth of the tunnel beneath the surface varies from 6ft. to 14ft., the greater depth being where the work passes under Holborn and the Strand. At these places the main tunnel will be divided into two smaller tunnels for convenience of construction. The whole work is of a very substantial nature, and when once it is completed there is no prospect that the roadway will be disturbed for many years to come, so that, except for actual repair of the surface of the road, Kingsway is never likely to be "up." Special precautions have been taken to preserve the brickwork from decay by damp, there being a lining of asphalt ¾in. or more thick. The electric tramways will be equipped on the conduit system. The tunnel is lined with tiles or enamelled bricks, and it is proposed to illuminate it throughout by electric light, although it will only be available for passenger traffic by the electric cars. The difficulties that have been met with in regard to water and gas pipes and electric mains have been considerable, and have required the exercise of the utmost ingenuity to overcome them without accident or stopping supplies. Entirely new mains have had to be temporarily laid whilst the work is in progress, and these will ultimately be superseded by other new mains laid in the subways. At the Holborn end the sight is a remarkable one, the electric cables, gas-mains, and water-pipes being suspended from timber supports or strutted up to keep them in line in mid-air. When the work is finished, however, the trouble will be at an end. Arrangements are made for house connection, and, great as the expense of this system is at first cost, when it is once completed the saving will be enormous.

**Electrical Power in Workshops.**—At the meeting of the Rugby Engineering Society held on the 18th inst., Mr. J. T. Irwin read a paper on the above subject, in which he gave full particulars of the electrical equipment of the Niclausse Boiler Works. Messrs. Willans and Robinson, when designing these works, went most carefully into the relative advantages of alternating and continuous currents. The load is principally made up of motors driving pneumatic hammers, hot and cold saws, rolling mills, and other heavy machinery involving severe usage, and, therefore, favouring the alternate-current three-phase system. Other considerations, however, including that of cost, turned the scale in favour of a continuous-current supply. With the system finally adopted the main supply is at 410 volts from three shunt-wound generators, two of which are 220-kw. machines and one a 90-kw. machine. Working in parallel with the generators, and in conjunction with a Highfield automatic reversible booster, is a battery of 197 E.P.S. cells. The cells are able to give a discharge of 125 amperes for three hours. Instead of installing the ordinary three-wire system, where there is equal voltage on each side of the middle wire, a balancer is installed to give at the machine three times the voltage on the one side to that on the other. This machine has two windings and two commutators on the same armature core, and gives 308 volts on one side and about 102 volts on the other. The reason for this division is, in the first place, to supply current at 100 volts for arc welding; secondly, to allow of single arc lamps being run where two lamps would not be necessary; and thirdly, to allow, where required, of a large range of speed, as, for instance, on coring machines. Thus, by keeping the field of the motor across the 400-volt circuit, and by putting the armature successively across the 100, 300, and 400 volt circuit, the speed will vary in the ratio of 1 : 3 : 4. Immediate speeds can be obtained by field regulation if necessary. It will be seen that the above offers a very wide range of speed on the machine without complication or expense. The main arc lighting is carried out from the 400-volt circuit, partly by enclosed lamps and partly by open-type lamps, according to the requirements of the shop. The enclosed lamps are run four in series and the open-type lamps eight in series. One of the problems to be solved was that of driving the rolling mill and tube-drawing benches without disturbing the lighting supply, which was taken off the same mains. For this work a 275-b.h.p. motor was used, running at 360 volts. The motor is compound wound, and drives by ropes the mill shafting. The rope pulley on the shaft is 15 tons in weight, and it is due to the kinetic energy stored in this flywheel that satisfactory driving is obtained. When the load comes on the motor, due either to the passing of a billet through the mill or to the drawing of a tube, or to both, the speed of the motor drops and the rope pulley acts as a flywheel, giving out energy. When the load comes off, the motor takes some time to accelerate the flywheel up to the normal speed again. The author states that it is interesting to watch the ammeter needle on this motor, to see the amperes gradually rise and then, when the load has gone off the mill, to see them gradually fall. This, in conjunction with the battery and the automatic booster, has rendered possible the running of the lighting circuit in parallel with the motor circuits. The larger cranes are worked with three motors, one for each motion, supplied from the 400-volt mains. The small single-motor cranes are supplied on the 100-volt circuit, but the author thinks it would have been more desirable to have all the cranes supplied at 400 volts. The alternative scheme which was considered, but not adopted, was that of having a combined three-phase and continuous-current supply. Double-current generators were suggested, with 400 volts between phases and 650 volts across the commutator. The author considers that the advantage gained from the accumulators and Highfield booster is very considerable at works in which such wide variations of load occur. In the conclusion of his paper he gives particulars showing the advantage of roller bearings over plain bearings for shafting. Experiments were made on a line of shafting—first, when fitted with cast-iron swivelling bearings 14¼in. long, and, secondly, when fitted with patent roller bearings 16¾in. long, so constructed as to allow of a certain amount of elasticity. The shafting is 124ft. long, 3½in. diameter, and supported by 13 bearings in each case. The shafting drives 25 machines (lathes and boring mills chiefly), and is driven by a 15-b.h.p. motor through chain gearing. Experiments showed that when the shafting alone was running on the plain bearings, it took 14 b.h.p. to start it and 1·9 b.h p. to keep it running. With the roller bearings, it could be started with 10 b.h.p. and kept in motion by 1·2 b.h.p. With the countershafting also at work, the figures for the plain bearing became 20 b.h.p. at the start and 6·8 b.h.p. when running, as against 15 b.h.p. and 5·5 b.h.p. for the roller bearings. These figures show a distinctive gain from the use of the roller bearings.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A M.I.C.E., ETC.

*(Continued from page 291.)*

### I.—Earth Conduction Systems.

The success of these systems depends on the fact that when one terminal of a battery or dynamo is connected to earth at a point A (Fig. 4) near to it, the other at a distant point, B, the current does not all flow back from the distant point through the earth or water to the battery by the most direct path, but part of it takes circuitous routes, and may be detected by a sensitive receiver even at distances of a few miles from the straight path. Some of these "stray" currents may be caught by a second wire, C D, preferably nearly parallel to the first, at a distance from it which varies with the conducting power of the earth or water at the place and the kind of apparatus employed to generate and detect the currents.

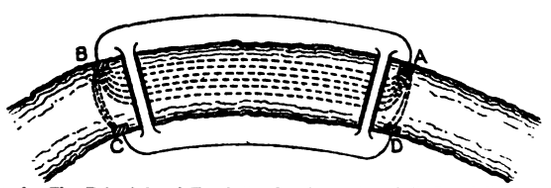


FIG. 4.—The Principle of Earth-Conduction. A and B, C and D, metal plates sunk in a river; A and B are connected by an insulated wire; so, too, are C and D.

Looking at the matter from the historical point of view first, we see that this system is comparatively old. Mention has already been made of Lindsay's experiments, and the method has been practically employed in emergencies on several occasions. A storm having destroyed the cable connecting the island of Mull with the mainland, the ends of the overhead land wire on the island were dipped into the sea, and at Oban on the mainland a wire 1½ miles long was laid along the shore and immersed in the sea at the two ends in a similar manner. Telegraphic communication was thus kept up for over a week across two miles of sea until the cable was repaired. The introduction of the telephone by Graham Bell in 1877-8 provided experimenters with a very sensitive receiver. The work of Prof. Trowbridge has already been referred to, and Prof. Dolbear, of Boston, in 1883 introduced an induction coil having in its primary circuit a microphone transmitter, with its secondary coil connected to earth.

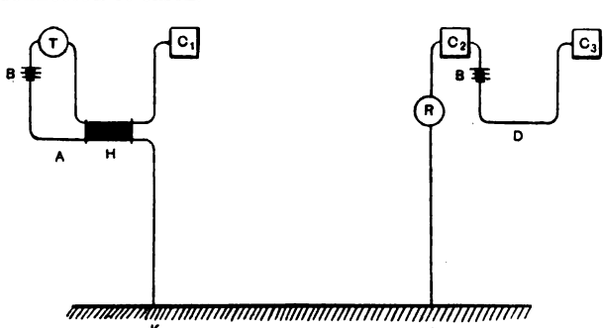


FIG. 5.

*Prof. Dolbear's Method.*—Dolbear's method, interesting mainly from the use of condensers and, in some cases, elevated antennæ or aerials, is represented, as regards its use of the apparatus employed, in Fig. 5. According to his patent specification published in the *Scientific American* Supplement of Dec. 11, 1886, Dolbear used a telephone transmitter, T, with a coil, H, and condensers, $C_1$, $C_2$, and $C_3$. The vibrations of the diaphragm of the transmitter, T, disturb the electric condition of the coil, H, varying the potential of the ground at K, which causes corresponding variations at L, and the receiver, R, reproduces sound spoken into the transmitter as if the wires, K L, were in contact instead of being earthed or connected to gas or water pipes. K, which is connected to the secondary coil of H, may be "electrified with a positive potential of 100 volts or more"; L will then be at a corresponding negative potential—at least, this is the explanation of the action given by the professor. The condensers, $C_1$, $C_2$, and $C_3$, are used with good effect. $C_1$ is charged to give the desired potential; $C_2$ and $C_3$ are not essential, but are of value. Prof. Dolbear prefers to charge all three. He found, furthermore, that heightened effects were obtained by grounding one wire from one terminal of the induction coil and projecting the other into the air free, using a kite to carry the free end of the wire. Thus even in 1883 the modern vertical antenna or "aerial," so much used by Marconi and others, was tried with good effect by at least one experimenter, though his method is quite different from Marconi's. The distance of signalling was, as might be expected, small. To show the utility of a long base line in such cases, it may be mentioned that Prof. Rubens and Dr. Rathenau in 1894, using a base line 550ft. long, transmitted signals for three miles across the open waters of the Wannsee, near Potsdam, obtaining the current from 75 accumulators, using a rotating interrupter and a telephone receiver; and this is probably near the limit which can be practically attained in shortening the base lines.

With leakage induction methods a long series of experiments were conducted by Sir W. Preece between the Isle of Wight and the mainland, at Penarth and between Kintyre and the Isle of Arran. Messages were transmitted to distances of from four to six miles, but the base lines were longer than those of Profs. Rubens and Rathenau.

Prof. Silvanus P. Thompson in 1898, struck by the fact that an accidental "earth" at the Ferranti electric light station at Deptford caused disturbances, easily detected as far north as Leicester and southwards to Paris, offered, if £10,000 were forthcoming to establish proper base lines and generating apparatus, to telegraph to the Cape without using a connecting metallic conductor. If the conduction method were employed, however, he pointed out, serious interference with existing electric agencies might result from the powerful stray currents in the neighbourhood of the transmitter.

The earth conduction system is, as a rule, not economical, and these experiments are interesting mainly from the historical point of view.

*The Armstrong-Orling System.*—This is a system which in some quarters has lately attracted considerable attention. Whether the writer is correct in classifying the system with those in which earth conduction is the feature it is difficult to say, for the inventors claim that "by a make-and-break mechanism forming part of the transmitter" (which has not yet, so far as he knows, been fully described) they are able to combine with simple earth conduction currents "high-tension discharges which vastly enhance the capabilities of the apparatus." The system is the device of a young Swedish electrician, Mr. Axel Orling (inventor of the Orling dirigible torpedo), who in conjunction with Mr. James Tarbotton Armstrong, a well-known London electrical engineer, has formed a company to supply apparatus, and, it is said, to bring the advantages of wireless telegraphy and telephony within the reach even of those who can only afford to pay the modest royalty of, say, £1 per annum. No very expensive or bulky apparatus are required, and aerials are not used for distances under five miles. The method of proceeding in telegraphy is to run a pair of wires from the terminals of the transmitter—which only requires a few cells giving a pressure of about eight volts—to two iron stakes driven into the ground some 10ft. or more apart (according to the distance to be traversed), connecting the receiver to earth in the same way. In telephony the transmitter is connected to the gas or water pipes, the receiver being similarly connected. How the many disturbing "stray currents" which are usually meandering round—at least in most of the thickly populated parts of this country—will affect the telephone, one is not told, but it may be that the apparatus is constructed to get over this and other difficulties.

The important part of the invention seems to be the new electro-capillary relay, which is shown complete in Fig. 6 and in section in Fig. 7. This comprises a coherer, relay, and decohering device. By this apparatus, it is said, the most feeble electric impulses are able to operate a receiving apparatus. The liquid (shown in Fig. 7) is mercury, and a means is provided of maintaining the level of the mercury in the chamber *c*, and of adapting the apparatus to operate a relay. A lever, *k*, is delicately poised at a point, *l*, near

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the delivery end, *h*, of the siphon, *f*. One of the ends of the lever (marked *m*) extends beneath the surface of dilute acid in the chamber *b*, so that any mercury delivered by the siphon, *f*, may fall upon *m*, and so cause its other end, *n*, to make contact at *o*, and thereby close the relay circuit, *p*, which may operate a Morse instrument. Both ends of the siphon, it will be seen, are constricted to prevent the mercury from continuing to flow after the electro-capillary

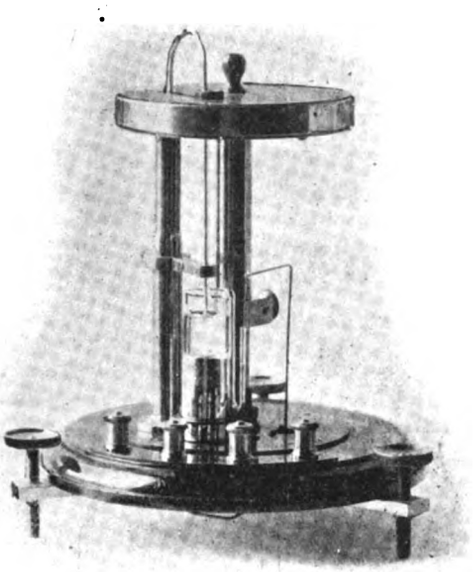

FIG. 6.—Armstrong and Orling Receiver, with case removed.

force set up by the passage of the current has ceased When the current does flow, electro-capillary force is set up, which displaces the fluid from positive to negative, and the lever is actuated, the relay being brought into action as described. To preserve the level of the mercury, *e*, in chamber *c*, a reservoir, *r*, is provided, which has two tubular legs, *s t*, the former of which extends beneath the surface, where its lower extremity is constricted to prevent

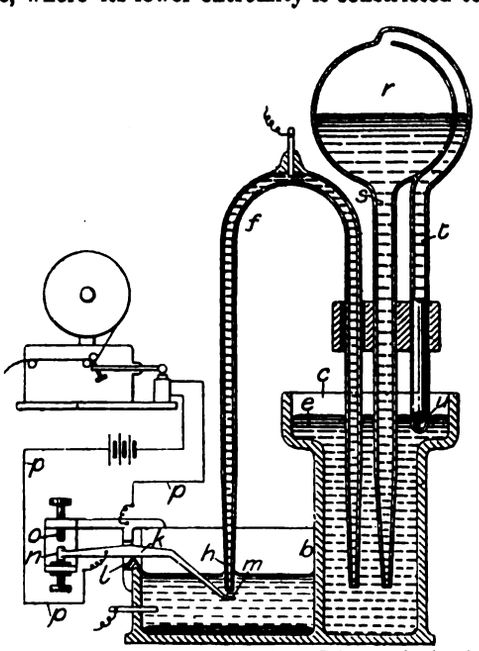


FIG. 7.—Receiver Working with a Morse Printer. *b*, chamber filled with dilute acid; *c*, mercury chamber; *e*, level of mercury in *c*; *f*, siphon; *h*, delivery end of siphon; *k*, lever; *m* and *n*, ends of *k*; *o*, point of contact; *p*, relay circuit; *r*, reservoir; *s* and *t*, legs of reservoir; *u*, aperture.

too rapid flow of the mercury, whilst the latter is shorter and terminates with an oblique or V-shaped aperture, *u*, in order that it may gradually open as the level of the liquid falls. The mercury in the reservoir, *r*, is retained by the partial vacuum, which is gradually destroyed as air is admitted through *t*, owing to the fall of the mercury in chamber *c*. By this means sufficient mercury is allowed to leave the reservoir, *r*, to maintain the level in *c* and close the vent in *t*. Other arrangements are adopted in which the fine droplets passing out of the hole make a momentary contact between two metallic points, so causing the relay and receiving instrument to work. The droplets, after passing the points referred to, drop on the lever, which performs the function of *de-cohering*. This instrument has been worked before numerous observers through a high resistance with an extremely small current, and it is said that its sensitiveness is very remarkable. The working of a receiver with Morse printer is shown in Fig. 7, whilst a receiver to be used for long-distance telegraphy (in which, by the way, elevated aerials and a system of relays at given distances apart are employed) is being experimented with. Fig. 8 shows the form of capillary receiver designed for cable work, in which the moving masses (mercury, etc.) have been very much reduced so as to admit of high speed in signalling.

There is an ingenious application of the system for the purpose of preventing collisions at sea The writer believes, however, it is assumed that all ships likely to collide with that carrying the apparatus specified are equipped with similar apparatus, so that communication may be effected within a given range of distance. Before Press representatives and others demonstrations of the use of the apparatus referred to above have been given. Mines have been fired at a distance, a boat has been steered,

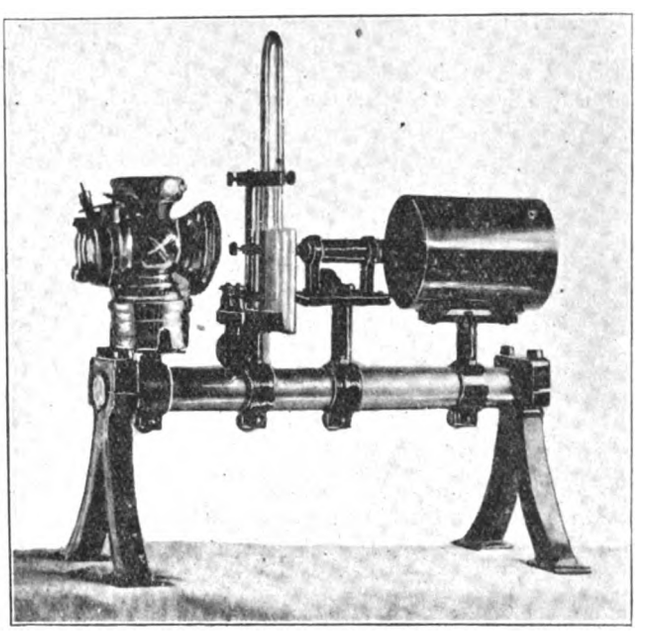

FIG. 8.—Latest Capillary Receiver as arranged for Cable Work.

railway signals worked, an unseen volunteer firing party communicated with, and, in fact, some very wonderful things have been accomplished. The writer is not aware, however, of what success has been attained where greater distances have been attempted. It seems to him that, in all earth conduction systems, to cover considerable distances long base lines are necessary, but the mention in the patent of the use of aerials show that the inventors have not overlooked the possibility of greater success in the Hertz wave domain. With these sensitive relays at given distances apart, and by the use of ether waves for the transmission of signals, there seems to exist some ground for anticipating greater success than has hitherto been achieved.

*(To be continued.)*

## SOME USES OF THE OSCILLOGRAPH.

BY D. K MORRIS, ASSOCIATE MEMBER, AND J. K. CATTERSON-SMITH, BOWEN SCHOLAR.

The following is a paper read before the Birmingham Local Section of the Institution of Electrical Engineers on Jan. 27.

1. *The Recording of Magnetisation Curves of Transformers during Working.*

The registration of the behaviour of the magnetic cores of transformers when working on the mains is a matter of

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considerable practical interest, but has hitherto proved a difficult problem from the experimental point of view. There is the well-known method of obtaining the loop by comparing the waves of current and E.M.F. at no load; then the Braun vacuum tube has been applied so as to record the instantaneous magnetisation curves; and, finally,

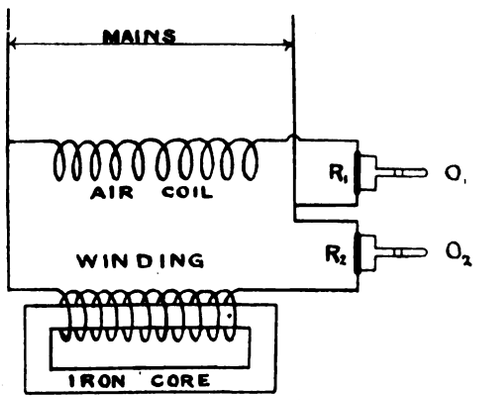


FIG. 1.—Connections for obtaining B H Loop Curve on the Oscillograph.

the curve of magnetisation has been obtained by slowly varying the magnetising current at such a rate that the induced E.M.F. was kept constant throughout the change.

The method described in the following note is an application of the double oscillograph—that used was one of the Duddell pattern—and the device consists in passing

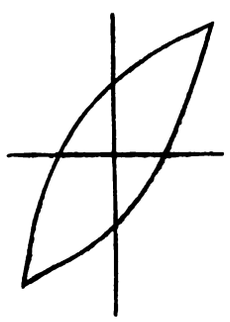

FIG. 2.—B H Loop obtained as described.

through one of the oscillograph strips a current proportional to the magnetising force, and through the other a current proportional to the induction density. A parallel beam of light from an electric arc is reflected from the mirror attached to the one strip, so that the reflected beam is subject to an angular vibration in a horizontal plane

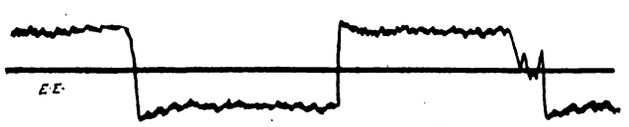


FIG. 3.—Current under normal conditions.

proportional to the magnetising force. This reflected beam is received on one of the smaller faces of a right-angle prism, placed so that its large surface is inclined at 45deg. The vibrations of the beam are thus transformed into movements in a vertical plane. The light is then received on a silvered lens (acting as a concave mirror of about 18in.

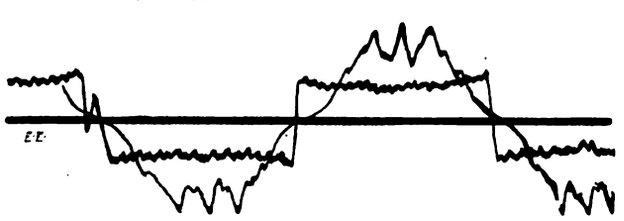


FIG. 4.—E.M.F. and Current under normal conditions. The peaked form arises from the presence of copper damping pole-pieces.

radius) and focussed back on the second oscillograph mirror, so that the final reflected ray partakes of both vibrations as co-ordinates in the usual manner of B H curves.

The no-load current of a transformer is a measure of the magnetising force applied to the core, and except for the demagnetising action of the eddy currents, it measures the value of H for the iron in the core. The principle of the method employed in obtaining a current which shall be proportional to the induction density, B, is extremely simple. A large coil having no iron core, and of inductance and resistance as nearly as may be comparable with that of the transformer at no load, is placed in parallel with the transformer winding.* Assuming $r_1$ and $r_2$ to represent

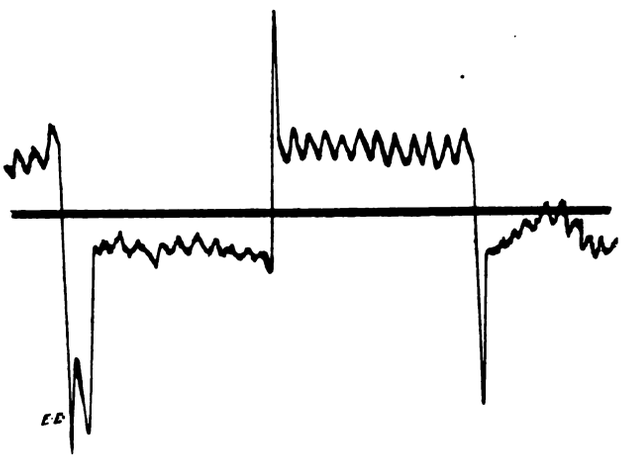


FIG. 5.—Current with brushes shifted forward.

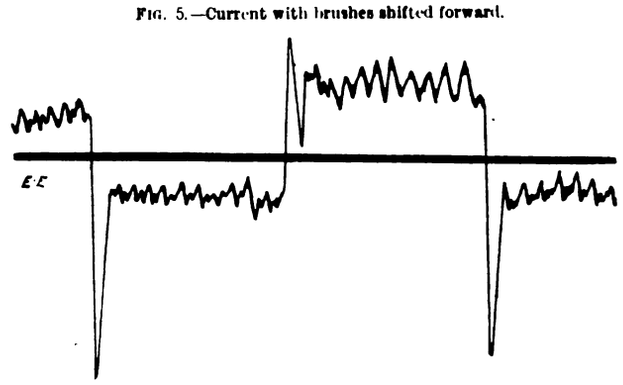


FIG. 6.—Current with brushes shifted backward. Both of the above show the heavy short circuit which occurs when the brushes are in a false position, and they show that heavy irregularity sets in at the same time.

the resistance of the two circuits repectively, and $L_2$ the inductance of the latter, then the following equation must hold at every instant:

$$r_1 c_1 + \frac{n s}{10^8} \cdot \frac{d B}{d t} = r_2 c_2 + L_2 \frac{d C}{d t^2},$$

where $n$ is the number of turns, and $s$ the sectional area of the iron in the transformer core. The first term of each side of this equation is a vector approximately at right angles in phase to the vector representing the second term,

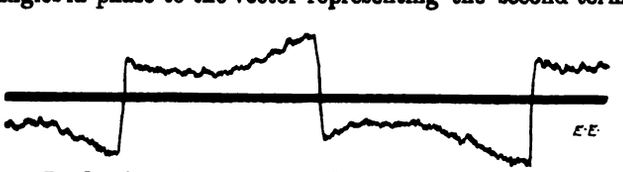


FIG. 7. Alternating current about 40 ⌒ and sufficient to rais the main alternating current supply from 16 to 24 amps.

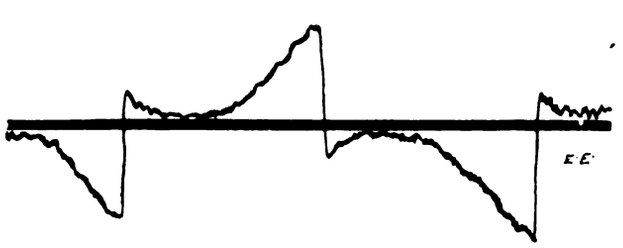


FIG. 8.—Greater alternating current load than above, direct current increased to 28 amps.

so that if $r_1 c_1 = r_2 C_2$ then $C_2$ is proportional to B. Owing, however, to the irregular form of $C_1$, it is necessary not only to have the ohmic drops equal, but that both should be small relative to the second terms; otherwise the curve obtained requires an irregular correction, which, though

* Should this voltage be excessive, it is practicable without sensible error to transform it down, and so allow the use of a smaller coil,

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not impossible to estimate, is very troublesome. The condition, therefore, for successful B H curves is that the ohmic drop in both circuits shall be equal and also small in amount.

The method is applicable to the determination of eddy currents, for without altering the apparatus the same values can be obtained (taking account of the ratio of the impedance of the two circuits) from a direct-current supply, and can be varied cyclically. The reduced values of H will then give at once the demagnetising action of the eddy currents. The method of superposing the vibrations of two oscillograph strips in planes at angles is also applicable to the estimation of small power factors, since a straight line can only be obtained as the resultant vibration when the two waves in these strips are exactly in phase. Any departure from this condition results in an ellipse more or less elongated. The authors hope to give the results of measurements with the above method at a later date.

2. *Note on the Currents in a Direct-Current, Shunt-Wound Motor and in a Rotary Converter under Varying Conditions of Load.*

The experiments, of which the following are illustrations, were made with a 110-volt Westinghouse 7½-kw. converter, used first as a shunt motor and then loader on the alternating-current side. A special attachment, consisting of three heavy copper slip rings, suitable insulated, was supported on a frame bolted on to the revolving part.

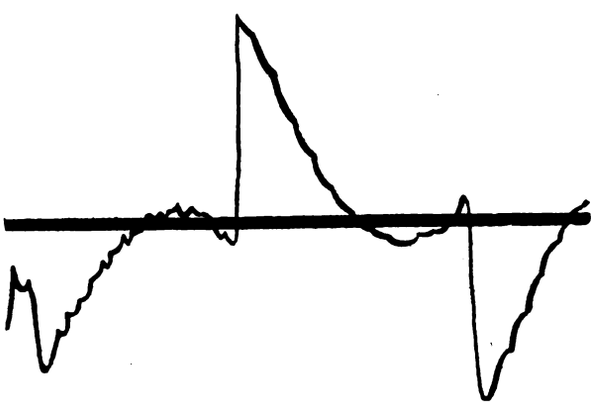

FIG. 9. Still greater alternating current load, direct current increased to 33 amps.

The armature winding, which was of the ordinary four-pole series type, with only two paths for the current to flow from positive to negative brushes, was cut at one place on the side furthest from the commutator, and the exposed ends led by stout short connections to two of the slip-rings. From one of these slip-rings a No. 26 silk-covered wire was led along the coil, which had been cut as closely as possible, threading it under the binding wire and returning in a similar way to a third slip-ring. Thus, when the brushes on slip-rings 1 and 2 were short-circuited by a suitable low-resistance shunt, the potential across this shunt was a measure of the current flowing in one half of the armature, and the potential between the second and third slip-rings was directly proportional to the voltage in the armature coil. A Duddell oscillograph of the double high-frequency pattern was arranged to measure these two potentials. It should be mentioned that the results are so far subject to error in that the current in the first two slip-rings was less than half the external current by an amount which was probably about 5 per cent. This arose from the resistance of the measuring shunt.

In conclusion, we would like to express our indebtedness to Messrs. F. B. Carmichael, A. W. Lambourne, and the departmental assistant, Mr. Bird, without whose energetic assistance we could not have given this demonstration.

**Willesden Polytechnic Electrical Engineering Society.**—The members of this society on Saturday afternoon paid an interesting visit to the electrical installation at the Hendon Infirmary of the Central London Sick Asylum. The party met at the institution at 3.30, and were shown over the engine and battery rooms and boiler-house, etc., by the chief engineer, Mr. Sumner. The various details and the system of working having been explained, a hearty vote of thanks was passed to the engineer for the valuable information afforded by the visit.

## THE GENERAL ELECTRIC COMPANY'S DINNER.

The fourteenth annual dinner of the General Electric Company, Limited, was held at the Empire Hall of the Trocadero Restaurant on Saturday last, when between 300 and 400 partook of the hospitality of the company. This function has now become a recognised event in the electrical world, and amongst those present were the leading representatives of all departments of electrical engineering. The dinner has all the attractions of the annual Institution dinner as far as meeting electrical engineers is concerned, and from its less formal character is a more enjoyable function.

This year, again, the chair was taken by Mr. G. BYNG, who in fitting words proposed the Royal toasts. He then gave the toast of "The Army, Navy, and Auxiliary Forces."

Colonel R. E. CROMPTON, in reply, commented on the success of the Japanese navy, and said that we had confidence in the readiness of our own navy. He considered that the reform in the army by instituting army corps had been on the right lines, and that these corps would not need to be reorganised in consequence of the present changes at the War Office. The Electrical Engineer Volunteers, under the able command of Major Erskine, were in a better position than other volunteer corps. They were satisfied with the treatment they received, and were doing exceedingly good work.

Mr. G. BYNG then rose and proposed the toast, "The Health of the Staff." He said he was delighted to again preside over the annual dinner, especially as the year was practically the silver wedding of the business, which was formed in 1879. He was exceedingly sorry that this year they were unable to include ladies in their large list of invitations. Looking back over the past 25 years, they seemed to him like a fairy tale. They had been years of uninterrupted progress, and he was glad to say that last year had added its quota to this advance. These years had given him pleasure, but not leisure. Mr. Hirst, his brother Max, and he had to work, perhaps, a little harder than they did 20 years ago. They had to rely upon the members of the staff for success. Their policy was decentralisation, and this policy had made advances last year. They had established new branches abroad, and the different branches in this country which were not on their own footing had been made independent, and they relied upon the managers of those branches, giving them more responsibility and more authority. The London staff had worked well, but the main feature of the situation was the works. Their works were the "Little Marys," who wanted feeding—they were always hungry. Manchester had done well, and their Peel Works had made good progress under the able management of Mr. Eckstein, who was well seconded by Mr. Brooker, Mr. White, and a most efficient technical staff. The Robertson Lamp Works were last year largely increased, and the Union-street Works, as well as the Ileene Works in Birmingham, had done well. Witton—their great enterprise, however, in the way of works—was in the centre of their thoughts, and he was pleased to give cheerful news about Witton. Mr. Railing, aided by Mr. Ide, had put great energy into the Witton Works, which were now doing well, and making some of the finest machines and largest dynamos and motors in the country. He had recently inspected some Witton-made plant working side by side with American and Continental plant. The Witton plant more than held its own, and the feature was that they had manufactured it at Witton below Continental prices and yet made a profit. In view of the newness of their works, they were proud of this achievement. Speaking of the carbon works at Witton, Mr. Byng remarked that the establishment of these works had interested the electrical world during the past year. The manufacture of carbons for electric lighting used to be an English industry. The old guard of 25 years ago—or 22 years ago—remembers the Sivertown Works down the river and the J. and P. Works making carbons; but soon the Germans took up the manufacture, and gained the monopoly. Efforts had been made at times to re-establish the industry in this country, but unsuccessfully until the

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General Electric Company put down large works. He acknowledged it was an uphill fight—they all knew how they had been treated by foreign competitors—but he was glad to say that they had in the last year received great encouragement throughout the country. The Government, the municipalities, and many electrical engineers had given them large orders, and encouraged them in every way to persevere. They had made good-quality carbons, and would carry on the fight in the hopes of getting the protection which was due to them and without which no new enterprise could start in this country. After some jocular remarks about some fictitious reports as to the progress of the General Electric Company, Mr. Byng confirmed the report that Mr. Hirst had obtained an order for 320 40-h.p. motors for the electric lifts of the Underground Railway. This order was the more gratifying because it had been placed with them by an American firm in spite of strenuous competition from American manufacturers. Coming, then, to the fiscal policy, Mr. Byng said that he would only give the tenets of the fiscal creed of the company. They were: firstly, the directors of the General Electric Company were of opinion that they had the right to speak out at the present moment upon this great question. They had the right to be heard, as they had large responsibilities—it has been computed that at least 15,000 persons depend for their daily bread upon the weekly wages paid by the General Electric Company. This great responsibility would be apparent when he said that in their opinion the livelihood of these people was in jeopardy through that unrestricted foreign competition which was now prevailing. The second tenet was this: it was their opinion that every shilling's worth and every sixpence worth of electrical machinery and electrical apparatus which had been imported in this country during the last few years, could have been made in this country. The third tenet was that, with the exception of a few articles, such as carbons, imported into this country with the distinct object of killing British industry, this electrical apparatus could not only have been made in this country, but made and sold as cheaply as it was being sold now. He knew he should be criticised for saying this, as he had been called by his friends the *Electrical Review* a selfish, voracious monopolist. He pleaded guilty, as he certainly would not take 19s. for an article if he could get 20s. for it; but under a proper system of protection he, as a manufacturer, would be able to effect such economies, both in his factories and in his commercial establishments, as to enable him to manufacture at a cheaper rate than he was manufacturing now, and he believed, speaking from experience and knowledge, that there was and always would be sufficient internal competition in this country to keep the level of price—the difference between cost of production and selling prices—on such a basis as not to impose upon the consumer. In support of his words, after due deliberation, the General Electric Company was now ready or would hereafter take orders from Government offices, municipalities, large and small contractors, etc., for articles which they now manufacture, or for similar articles now imported, to be delivered in reasonable time after protection comes, at prices not only as cheap as those now ruling, but 5 per cent. below them. He finally exhorted his staff to continue to work hard to overcome the handicap to which they were unjustly and wrongly exposed by a system of competition which the country had no right to impose upon them. His staff had done good work not only for themselves and the firm, but also for the country, and it was his firm belief that the time would soon come when the Government would right the injustice inflicted upon them at the present time.

Mr. S. D. WHITE responded for the staff, and in a humorous speech proposed "The Health of the Directors," to which toast Mr. MAX BYNG replied.

Mr. H. HIRST, in giving the toast of "The Guests," said they could safely leave the fiscal question in the hands of Mr. G. Byng, Prof. W. A. S. Hewins, and Mr. Joseph Chamberlain. He attributed the success of their undertaking to the fact that they succeeded in making friends of those with whom they did business. They had done well in the past, and with the friendship of those present they hoped to do even better in the future. The English used to lead in electrical matters, and he looked forward to the time when the lead in electrical matters would again be in English hands. He concluded with some humorous remarks as to the recreation they proposed to provide at Witton for those who came there to inspect electrical machinery.

The toast was responded to by Mr. R. W. WALLACE and Mr. E. MANVILLE.

The rest of the evening was devoted to a concert, which was enjoyed by all present. The artistes were Miss Nina Wood (comedienne), Miss Beatrice Nelson (contralto), Mr. Arthur Davenport (comedian), Mr. Julian Fredericks (musical sketches), and "The Follies," who gave a selection from their celebrated Pierrot entertainment.

## MANCHESTER CORPORATION TRAMWAYS: THE PERMANENT WAY, OVERHEAD EQUIPMENT, AND ROLLING-STOCK.

BY J. M. MCELROY.

The following are a few extracts from the above paper, read last week before the Manchester Local Section of the Institution of Electrical Engineers. The paper commences with a brief history of the Manchester tramways, and with the changes necessary in the permanent way when converting for electric traction. A thorough examination of the whole of the track was made, and a report was presented to the Corporation showing clearly that not only were the rails too far worn, but the joints were not nearly strong enough for mechanical traction. The Corporation thereupon determined to reconstruct the permanent way of the entire system, and the work has been carried out by the tramway department's own staff. The new section of rail adopted for the work weighs 102lb. to the yard, and its general dimensions, compared with the old section, are as follows—viz.:

| | Old section. | New section. |
|---|---|---|
| Depth | 7in. | 7in. |
| Base | 7in. | 7in. |
| Tread | 1 5/16in. | 2in. |
| Width of groove | 1/2in. | 1 1/8in. |
| Depth of groove | 1/2in. | 1 1/8in. |
| Guard | 5/16in. | 5/8in. |

Although the new section weighs only 4lb. per yard more than the old section, it is superior from every point of view. It has a wider tread, a wider and deeper groove, and, what is most essential, shoulders which give a good bearing for the fishplates. In the reconstruction work the most difficult problem was how to relay the important junctions in the city without causing serious public inconvenience. An enterprising United States firm then offered to send their engineer over to take the surveys and make the necessary plans, and they undertook to supply the special track work for the junctions in such a condition that all the Corporation had to do was to fix the same in position in the streets. At that time no firm in this country were in a position to undertake this work, and, consequently, orders to the extent of £80,000 were placed by the Manchester Corporation in America. Since then the British manufacturers have wakened up, and one or two British firms were now in a position to undertake this class of work, and they have placed some orders with them. The laying of all the important junctions in the city was done on Saturday nights and Sundays. The work at each junction was commenced at, say, 11.30 on Saturday night—after the last car had gone—and by six o'clock on Sunday evening the whole of the junction was laid and paved up. Very few citizens were aware of what was going on, and the public inconvenience was reduced to a minimum. All the curves at the junctions and elsewhere were spiralised, thus ensuring easy running of the cars. The points and crossings were provided with hardened steel renewable centres. The wear and tear of the rails, especially at junctions, was very great. Their estimate of the average life of the track was 10 years. In arriving at this estimate they include all roads—those of light as well as those of heavy traffic.

The overhead equipment was almost entirely span wire construction with side poles. Their experience was that,

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except for very wide roads, the span wire system was the best. The objection to centre poles was not urged from a tramway point of view. It was urged from the point of view of those who use the streets for ordinary vehicular traffic, who maintain, with some amount of force, that centre poles form an obstruction, and that they transform a good street into two bad ones. They have adopted triple insulation throughout the whole of the overhead construction—namely, an insulator bolt at each ear, with globe strains, and Brooklyn strains at each span wire terminal. In consequence they were well protected against leakage. Guard wires had been erected as required by the Board of Trade. They were a source of trouble, but under an agreement with the National Telephone Company all telephone wires except those belonging to the Post Office were to be placed underground. Thus most of the guard wires could be scrapped shortly.

With respect to the rolling-stock Mr. McElroy gave many details, of which the following are of special interest. They had not adopted the reversed stairway, which is now in common use on cars in other towns. This type of stair was not new. It was a revival of a type adopted many years ago. Their main objections to it were two: first, it obscured to some extent the motorman's view, and prevented his obtaining the fullest possible view of the road and side streets; and, secondly, it formed an obstruction to passengers coming into and leaving the car, the outside passengers being jammed against the inside passengers. The bogie trucks were of the maximum traction type. In some the pony wheels lead and in others the driving wheels were leading. He preferred the latter. When the pony wheels led there was a tendency for the truck to leave the track at curves. They had had trouble with bogie cars coming off the track. One of the principal causes had been a defect in the points. When the pin at the heel of the points became loose and the front bogie passed over it, there was a tendency for the toe of the point to be moved from its position before the hind bogie reached it, and, if this occurred, the hind bogie took the wrong track. They were, however, remedying this defect in the points by an apparatus which would hold the points at the toe.

Generally speaking, their experience of maximum traction trucks—used as they were in a city with no severe gradients—was not at all unfavourable. All the wheels used, until recently, had been chilled cast iron. During the past few months, however, they had been experimenting with steel-tyred wheels, and these had given very good results. A remarkable fact regarding the wheel question was that in America nothing else but chilled cast-iron wheels were used, but on the Continent chilled wheels had been given up, and steel tyres taken their place. Their short experience with steel tyres led to the belief that they were more satisfactory than chilled wheels. The steel tyres stood for a greater mileage, were better for braking, and did not wear in flats. The car equipments were of two well-known types—the British Thomson-Houston and the Dick-Kerr; 305 cars were equipped with the former, and 137 with the latter.

Each small car was furnished with two 25-h.p. motors, and each bogie car with two 35-h p motors. They were single-reduction four-pole motors, enclosed in strong water and dust proof steel frames. They stipulated for the usual insulation and efficiency tests, and demanded an efficiency of 82 per cent.

As regards lifeguards, they had adopted at the commencement what was termed the "cow-catcher" lifeguard, and the statistics showed that these had been on the whole successful in operation. They had saved a number of persons who had been knocked down by the cars from getting under the wheels by pushing them on one side clear of the track. In one or two instances it had failed, but the percentages of successes showed that it was by no means an unreliable guard. In compliance, however, with the wishes of the Board of Trade, they had discarded the "cow-catcher" in favour of the "swinging gate" or "trigger" lifeguard, which was now used on almost all the tramway systems in the country. In most instances where persons were knocked down and killed by cars the lifeguard was not called into service at all, the persons being fatally injured, generally on the head, by being thrown on to the hard pavement. The best lifeguard was a good brake. Their cars were equipped with the ordinary hand brakes and rheostatic brakes, which answered their purpose very well. On the Stockport route, where the worst gradient was, the cars were equipped with the Westinghouse magnetic track brake. In this brake the brake shoes acted on the tramrails as well as on the car wheels. The current for magnetising the brake shoes was furnished by the motors acting as generators.

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### Discussion.

The **Chairman** (Mr. E. W. Cowan), after mentioning that the new Students' Local Section was now an accomplished fact, with dates fixed for papers within the next month, passed an encomium upon the local tramway service. He queried the effects of expansion upon solid-welded rails, and hoped that improvements in controllers might be made to obviate the present jerking of cars going up hill.

**Dr. Rhodes** commented upon the curve radii, and thought that with the 5ft 6in. wheel base on the 35ft. curve serious grinding action must take place. He calculated that a 36ft. 3in. curve was the minimum allowable for this wheel base. The mixing up of straight line hangers and double pull-offs on some routes he thought were peculiar to Manchester. He coincided as to the futility of reversed staircases, from the standpoint of interference with driver's vision, and the weighting of the ends of the car tending to hump the middle frame. The cowcatcher guard he considered dangerous on account of the large clearance possible with cars unevenly filled. On the matter of brakes (and strictly without prejudice), wheel brakes were a nuisance, as they produced flats and also damaged the track. He preferred some type of track brake, with soft-iron shoe to avoid wearing the rails.

**Mr. A. S. Giles** mentioned that a certain tramway undertaking once used 1¼in groove rails, but found this too wide, cyclists leaving their machines standing in them. He asked for statistics as to wear at points; life at sharp curves heavily trafficed; if Manchester meant to solid weld; and why one-mile lengths of wire were specified if Board of Trade said cut at half-mile intervals. He thought that section insulators were now made sufficiently strong. As to the original improvements mentioned in the cars, he could not see how a wider rocker and narrower waist panel affected the matter much, although as a general thing narrow waists were often much to be desired. He believed that they would never see the day when brakes were substituted for lifeguards, as the human factor had to be considered; and thought that the thin-lath Manchester seats would harbour snow.

**Mr. C. C. Atchison** mentioned that the excess of pitch in last summer's sett grouting made the brakes inoperative frequently by getting on the wheels. He warned against having too much tackle on the section insulators to produce trouble when the trolley wheel came off. He thought that ladies objected to reversed staircases, as they had to go up and down steps which are in line with the windows—and the people's eyes. The question of pony wheels was of little account, as whichever was leading on the foremost truck was trailing on the back truck. He preferred to keep hand-brakes, as drivers liked to feel the car's progress with them. The trigger lifeguard he considered safe, and had heard of people taking free rides on them.

**Mr. C. D. Taite** congratulated the Corporation on having been able to square matters with the Telephone Company as to their wires being put underground. Centre poles, he thought, guided the traffic, and so were advantageous. He preferred standard cars, as used at Liverpool and Salford, and reversed stairs as protection from falling off and as a cover to employés. Salford had adopted four-motor cars, which was very advantageous to the electricity supply department, as double the current was taken by them.

**Mr. Geo. Hill** preferred not to speak, as he was "only a contractor.'

**Dr. Bowman** asked for the current consumption of the cars, and explained that so much of the surface of the rails was buried as to prevent atmospheric differences from affecting the body of the rail when welded solid. He spoke of the excessive grinding action at curves, gave some reminiscences of earlier days, and desired an explanation of his once being kept waiting for three-quarters of an hour for a car.

**Mr. B. S. Giles** was ruled out of order for bringing up the overcrowding nuisance, the same being a severe test on his chivalry as regards standing lady passengers.

**Mr. A. N. Moore** asked for an explanation as to digging he had recently seen at rail joints; thought that tests on the conductivity of the rails would be useful; suggested the use of single rolled poles against three-section poles; queried the positions of section insulators when put halfway up hills; asked for tests of cars, current consumption, and the life of bearings; recommended wattmeters being used on cars; and instanced the practice of Mr. Fell, at Sheffield, going around the districts with a wattmetered car filled with sandbags, in order to secure data for the proper consideration of the ½d. fare question.

**Mr. Knowles** enquired for details of snow-ploughs.

**Mr. McElroy**, in reply, said his practice was to lay rails with ends touching, which was almost a solid joint, but no trouble had been experienced. He expected the curves to wear to 2in. grooves, and mentioned that although the Board of Trade stipulated for 1⅛in., he put down 1¼in. at curves without ill-effects. Street traffic wore rails greatly. The feeding arrangements were not in his department, so that he could not explain all stoppages. Section insulators were, maker's word notwithstanding, the weak link in the chain. Snowstorms were too occasional to make special seats for. He did not want to alter his section insulator anchoring arrangements to the present Board of Trade fashion lest it should change its mind again. As regards the safety of the old type of stairs, out of 2,000,000 passengers carried only one man fell off the

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back, and he was not worth troubling about. Centre poles were an impediment to light, fast traffic, as they prevented the overtaking of slower vehicles. The current consumption per car mile on small cars was ·9 unit, and on large cars 1·4 units. The Corporation were going to experiment with the Thermit process at Moss Side. The electric welding process was seemingly equally satisfactory, but the Lorain Company, who owned the only plant in England, would only work on an all-day and all-night agreement, and so the matter fell through. The taking up of rails mentioned was to anchor the joints. He believed in a thorough and frequent inspection of the overhead line to prevent accidents. He tackled snow on the track with a salt sprinkling car, the Cleansing Department doing the actual removing of snow.

A hearty vote of thanks to Mr. McElroy concluded the meeting.

## THE ELECTRIC LIGHTING OF THE AUTOMOBILE SHOW AT THE CRYSTAL PALACE.

The very large number of entries at this show, and the space occupied by the exhibits, rendered the lighting of the same quite beyond the capabilities of the usual electric supply system. In consequence, temporary plant had to be laid down. This work, with the provision of the distributing system, was placed with the Electric Lighting Boards, Limited, of 80, York-road, King's Cross, who specialise in exhibition lighting. Over 10,000 8-c.p. lamps were installed by the company on upwards of 150 of the exhibitors' stands, in addition to a large number of motors for driving exhibits. The current was supplied by the company, who put down at short notice a complete electric lighting plant in the Palace grounds, including the necessary building of the power-house. The plant consisted of the following: one Marshall 80-h.p. portable engine driving by belt a Crompton 250-ampere 220-volt dynamo; one 35-h.p. vertical open-type engine driving a Crompton generator by belt; two compound, open-type, vertical engines direct coupled to Messrs. Johnson and Phillips's 35-kw. shunt-wound generators; two simple engines direct coupled to dynamos as above. In addition to the steam plant, three 40-h.p. gas-engines were added, each driving generators by belts. Steam was supplied at 100lb. pressure by three locomotive-type boilers, and flexible steam-piping was used from the boilers to the engine connections.

Cables were taken from the generators to a switchboard fixed in the Egyptian Court, and made to order by Messrs. Nalder Bros. and Thompson, Limited. This switchboard was of white marble, and consisted of nine dynamo panels, each having a shunt-regulating switch, double-pole switch and fuses, and ammeter and voltmeter. The distribution panels provided for 13 100-ampere feeders, each protected by double-pole switch and fuses, and with an ammeter in circuit with each feeder. All the nine generators were run in parallel, and, despite the variety of plant which was employed, little difficulty in regulation was experienced. From the feeder panels cables were taken to distribution points under the floor of the Palace. From each distribution point cables were taken to the various stands, the looping system being adopted in the case of the smaller stands. The whole of the distribution cables were of the E.L.B. type, and every stand in the show was wired on the E.L.B. system, which has so many advantages for temporary illumination on a large scale.

The plant and apparatus was practically erected in the three weeks before the opening of the show, while owing to the backwardness of the stand-holders in completing their stands, the whole of the wiring was practically done during the three days prior to the show. The work was carried out by the E L.B Company's representatives and a large temporary staff without a hitch, and is considerably the largest temporary installation of its kind ever erected in the time. The work was carried on night and day during the 10 days prior to the opening of the show. We might mention that the Paris Automobile Show and the New York Automobile Show were lit on the E.L.B. principle, which is also being employed at the St. Louis Exhibition this year.

**Static Electricity.**—"Simple Experiments in Static Electricity for Students and Amateurs," by Percival G. Bull, M.A.(Oxon.)—Percival Marshall and Co.—form the subject of No. 18 of the Model Engineer Series (6d., illustrated).

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

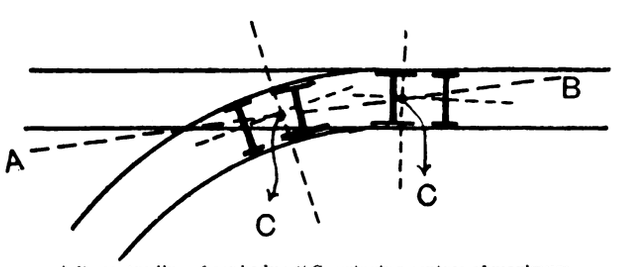
665. In a three-phase three-wire transmission scheme the power supplied to the sub-station is measured by two recording wattmeters of the motor type One wattmeter is connected in each of the outer mains with its shunt connected between the inner and outer. It is found that in starting the motor-generator set at the sub-station one of the meters rotates rapidly forward in the normal direction, whilst the other rotates slowly backwards. As the set runs up to speed this latter meter stops, reverses its direction of rotation, rotating in its normal direction.—H. W. J.

666. It is considered difficult to design continuous-current generators driven by high-speed turbines to operate sparklessly. Account for this. Explain, with sketches, arrangements adopted to overcome this difficulty.—J. K.

### ANSWERS.

*Question No.* 657.—In maximum traction trucks the pony wheels are sometimes fitted leading and in other cases trailing. Discuss the causes of their variation in position. Compare the advantages and disadvantages of both cases. According to modern practice, which is the better position?

*Best Answer to No.* 657 (*awarded* 10*s.*).—Pony wheels were originally fitted trailing on the leading trucks. The primary reason for altering this arrangement was twofold—the platform of the car could be lowered, to the greater convenience of passengers, and also the pony wheels could be run under it, thereby either gaining a longer total wheel base for a given car, or allowing shorter cars to be fitted with bogie trucks to avoid the pitching so often met with on single trucks. After this had been done it was found that other advantages were gained—viz, greater ease of running, especially at points and curves, and less wear of the permanent way and rolling-stock. These two advantages are derived from the same point—the diminution of hammer action on the rails, which occurs in the following manner. As the leading truck enters a curve the rails




A B, centre line of car body; C C, swinging centres of maximum traction trucks.

change the direction of the leading wheels of that truck, and at the same time swing the truck centre over a small arc. It is evident that the direct hammering on the points and car body is chiefly set up by the impact of the leading wheels, because when the trailing wheels reach the points their direction is already slightly altered. If the pony wheels are leading there is less hammering, owing to their weight being less than that of the driving wheels + gearing, and also because the beginning of the change of direction of the car body is less violent, from the fact that the swinging centre of maximum traction trucks is kept as near the motor as possible, which causes the car body to swerve more gently when the pony wheels lead than when the driving axle is in front, because the arc described by the bogie pin, normal to the centre of the track, is considerably reduced.

The disadvantage of having the pony wheels leading is

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only shown on indifferently designed tracks by cars having wheels with small flanges. At anything approaching a fair speed, under those conditions the diminished weight on the pony wheels causes them to jump the track, especially at points or sharp curves. This fault is generally put down to the position of the wheels, whereas it should be credited to the owners of the tramway for not laying out sufficient capital to obtain proper running conditions, or to their technical advisers for not drawing their attention to these points. Accidents of this sort, however, do not happen where wheels are in use with sufficiently deep flanges (with track rails to correspond) and where the points are not too close an imitation of those in use on a horse tramway, where the leading wheels of a car are *pulled* and not pushed over the points.

To sum up, the advantages of leading pony wheels are—(1) increased total wheel base, with greater stability; (2) shorter cars can have bogie trucks fitted; (3) platforms can be built lower and stronger; (4) less destructive hammering at points, with resulting longer life to track and rolling-stock. The sole disadvantage is a liability to jump the track under the adverse conditions given above. The majority of bogie cars at present in use are run with the driving wheels leading, because the average tram track is too much like the old horse car lines it has superseded. In fact, in several instances no new rails have been laid. In properly-designed high-speed lines, however, the tendency is to adopt leading pony wheels.—B. P.

*Answer to No.* 657 (*awarded* 7*s.* 6*d.*).—Tramway engineers differ as to which way is the best to have the pony wheels on a maximum traction truck leading or trailing. By either wheels leading or trailing is meant the pair of wheels that are running first or second respectively on the foremost truck in whichever way the car is running. The advantages of running the large wheels leading are: (1) That the car is less liable to derailment when running through points, crossings, over uneven track or obstructions in the road, and also when rounding curves. (2) Pneumatic and mechanical slipper brakes may be more safely used (than when the pony wheels are leading) without fear of derailment. With the magnetic slipper brake, however, it makes no difference which leads, as in this case the truck, instead of being lifted, is pulled down on to the rail. (3) Slightly better adhesion when running up a gradient.

The advantages of running the pony wheels first are: (1) steadier and smoother running; (2) less hammering at rail joints, causing less wear and tear on the permanent way. The disadvantages are *vice versâ*.

A bogie car with maximum traction trucks is most awkward when derailed to get on the track again, and that may be taken as the main cause why in modern practice the pony wheels are run trailing. In fact, the writer of the article knows a case of a large tramway system which had at first the pony wheels leading on its maximum traction trucks, and have now either changed them round so as to have them trailing, or have substituted four-motor equipments with all eight wheels on the car of similar size, owing to continual derailments.—J. S.

*Answer to No.* 657 (*awarded* 5*s.*).—It seems to be a more or less controversial point as to whether the pony or idle wheels of a maximum traction truck shall be arranged leading or trailing. Tramway engineers seem very divided as to which really is the better position, some even asserting there is no real difference.

We will first consider them leading. It is supposed by some authorities that the running is smoother with them leading as they are so lightly loaded; in fact, only about 10 per cent. of the total weight is borne by each pair on a modern truck; they are able to round and enter points more easily than the heavily-loaded driving wheels, and thus minimise to a great extent sudden shocks to the car. Unfortunately, this very fact of them being so light running and having such a small adhesion to the rails, will often cause them to jump the rails on a curve or else miss the points. With this arrangement of the car trucks the total weight of the car body and electrical equipment is not so fairly distributed, it being more or less concentrated, as the driving wheels, which carry nearly all the load, are closer together, which in my opinion is rather a disadvantage.

Now, as to the pony wheels trailing. This, I think, is really the better method of the two, the advantages being: (1) The total weight of the car is spread over a larger wheel base—that is, taking the distance between centres of the driving axles as the overall wheel base, although, strictly speaking, this is not commonly called the wheel base, but as 80 per cent. of the total weight is borne by these wheels, it is worth considering, and although it may have no real effect on the cars running from a mechanical standpoint, it is better engineering. (2) Then again, the wheels with the most adhesive power on the rails will be leading, and therefore the car is not so likely to be derailed under conditions before mentioned, and although the running may not be quite so easy as by the former arrangement, it is by far the safer, especially for high-speed interurban traffic. This latter method is, in the writer's opinion, the better method, and I believe the general tendency at present is to adopt it.

The following tramway systems are a few that have their bogie cars with the pony wheels as last described: London County Council new electric cars, London United Electric Tramways, Nottingham, Darwen, Burnley, etc.—MAGNUS H. VOLK.

*Question No.* 658.—Describe what you consider the best type of packing for the piston rods of high-speed engines using superheated steam. How long should such packing last under ordinary conditions?

*Answer to No.* 658 (*awarded* 10*s.*).—Undoubtedly the best packing for piston rods, especially on engines using superheated steam, is a wholly metallic or a combination of metallic and soft packing. Some engineers insist on metallic packing throughout, whilst others use metallic or metallic

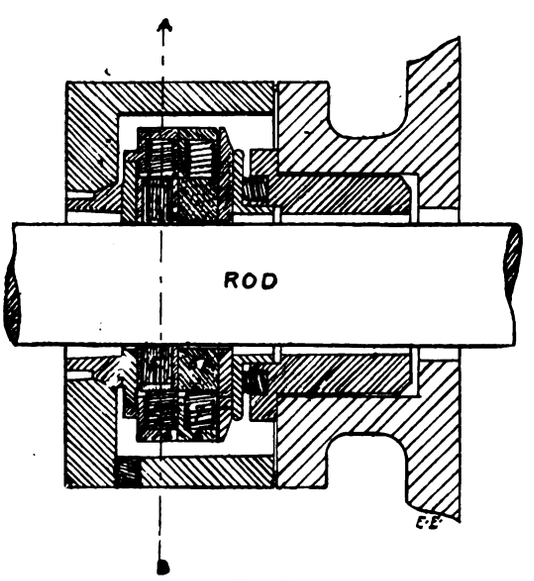


FIG. 1.

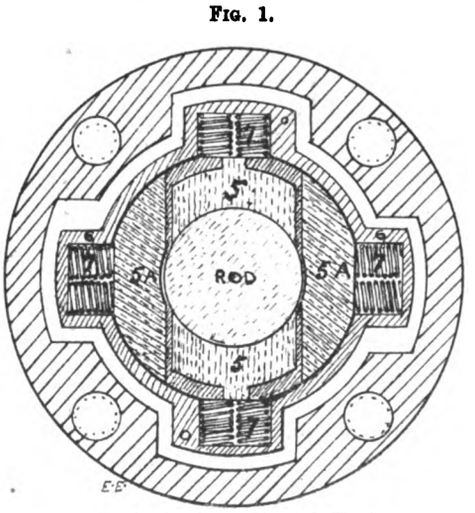


FIG. 2.—Section on Line A B, Fig. 1.

soft on the high-pressure and valve rods only, the low-pressure boxes being stuffed with soft packing. There are numerous makes of metallic packing in use, whilst the number of soft packings on the market is legion. Some

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are good, many are indifferent, and some distinctly bad, nearly all makers claiming some superiority over the others.

A metallic packing that is largely used on both land and marine engines is illustrated in Fig. 1. This packing consists of eight blocks (5-5A), which are held in strong rings (6), having pockets holding springs (7). These blocks are put together in two sections, four blocks to a section. Each section is composed of two packing blocks (5) and two guide blocks (5A). The joints between the blocks in one section are at right angles to those in the other section, thus breaking joints. The packing or working blocks (5) consist of a thin gunmetal case filled with Babbitt metal. The guide blocks (5A) are of solid gunmetal, and are not in contact with the rod. Their respective names indicate their duties.

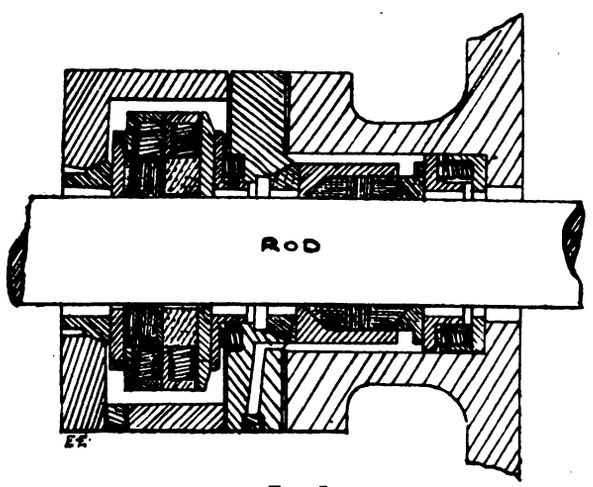


FIG. 3.

Another packing that is wholly metallic is shown in Fig. 3. This packing is a combination of the block packing shown in Fig. 1 and a cone packing (11) (Fig. 3). In this type the cone packing is not intended to be steam-tight, but to wire-draw the steam, thus relieving the outer block packing of part of its work. This packing, which is termed the "duplex packing," is specially suitable for high-speed engines using superheated steam, and is one of the best packings made.

In Fig. 4 is shown a semi-metallic packing that has met with much success amongst central-station engineers, one firm of high-speed engine-makers in this country using this packing exclusively for the high-pressure and valve rods of their engines that are intended to use superheated steam.

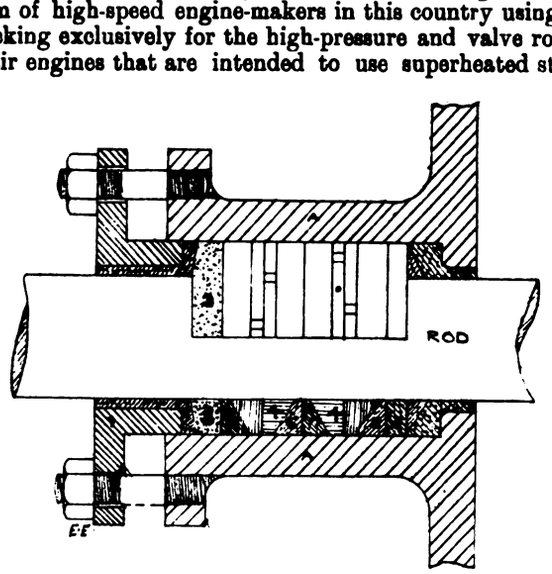


FIG. 4.

This packing is a combination of anti-friction metal rings (4) and asbestos or other soft packing. The stuffing box, A, is filled with alternate triangular rings of anti-friction metal (4) that are in contact with the piston rod, and brass rings (5) in contact with the walls of the stuffing box; a few turns of soft packing (3) and, last, the gland (1) are put in. The anti-friction rings are put in in sections, the ends being dovetailed together and the joints are crossed.

The writer has tried many of the leading makes of soft and soft metallic packing on engines using superheated steam up to 600deg. F., and has found that the high-pressure and valve rods require re-packing about every two working months. Sometimes it is possible to use up some of the old turns (gland end) of packing, but, as a rule, new packing is necessary throughout. With a combination (metallic) packing (Fig. 4), the writer has found the engines to run for over 12 months without re-packing. The success or otherwise of any packing depends in a great measure on the attention which is paid to it when working. This is more marked in the case of soft packing, and one often finds a skilled engine attendant—who knows how to use packing—not get through a quarter the amount of packing that another man who is careless and wasteful would do. A point which is not always given proper attention is the lubricating of the rods when running. Many times a shut down would have been avoided if the rods had been well "swabbed" before being allowed to start "chirping" and run hot.—S. L.

*Answer to No.* 658 (*awarded* 10*s.*).—Packings in use at the present time may be divided into three classes: (1) fibrous; (2) semi-metallic; (3) metallic. Undoubtedly the best of the three for use with superheated steam is the metallic class. As engineers, generally, give very little thought to the actual requirements of a piston-rod packing, it would be well to discuss the merits of the three classes from the standpoint of an ideal packing.

The essentials of a perfect packing are: 1. The pressure exerted by the packing on the rod to vary with the pressure of the steam in the cylinder. The pressure necessary to maintain a steam-tight point should evidently be less when the pressure in the cylinder is 20lb. absolute, than when it is 150lb. absolute. If the pressure of the packing on the rod remains constant, then it must be such as will make and maintain a steam-tight joint for the highest pressure in the cylinder. This constant pressure remaining on the rod while the pressure in the cylinder falls during expansion, it follows that the work done in overcoming the friction of the packing is greater in proportion as the pressure in the cylinder falls. If, on the other hand, the pressure of the packing on the rod is reduced in proportion to the fall of pressure in the cylinder, then the mechanical efficiency of the engine is increased at the lower pressures. The packing should, therefore, be so constructed as to permit of the pressure on the rod being controlled by the pressure in the cylinder.

2. The "tightness" of the joint to be maintained under the varying pressures. The packing should prevent the escape of high-pressure steam from inside the cylinder, and in the case of condensing engines should be able to maintain a vacuum. This condition is, perhaps, difficult to fulfil if condition 1 is to be maintained. The only practical method is to compromise by introducing a constant pressure. As will be shown later on, this constant pressure is in one form of metallic packing a very small one.

3. The packing must permit freedom for lateral motion of the piston rod. This is necessary owing to the wear of the guides, etc.

4. The packing must be capable of being worked at high temperatures as well as low. With superheated steam the highest temperature would probably be 600deg. or 700deg. F.

5. The packing to be capable of taking up wear independent of the man in charge. As wear takes place regularly, so adjustment should be made regularly to obtain the best results.

6. Wear of packing to be very small, so as to ensure a long life. A packing that wears quickly is also an expensive one, as to repack the rod the engine must be shut down during working hours, or the man in charge paid overtime if done after working hours.

*Class* 1.—The only packing of this class suitable for working with superheated steam is asbestos. A steam-tight joint is made by the aid of a gland and screws. With this arrangement it is impossible to relieve the pressure of the packing on the rod in proportion to the fall of pressure in the cylinder during expansion. It is, therefore, unsatisfactory as regards condition 1. As the packing is screwed to maintain a steam-tight joint for the higher pressure, it will maintain a steam-tight joint at the lower pressures, but at a cost disproportionate to the duty to be performed.

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When screwed up tightly, there is not sufficient elasticity remaining in this form of packing to permit of lateral motion of the piston rod; consequently, as the guides wear, the rod is subjected to a bending action. At high temperatures this class of packing scores the rod. No method has yet been devised whereby fibrous packings will automatically take up wear. The life of a packing depends chiefly upon the pressure to which it is subjected. This pressure is regulated, in the case of fibrous packing, by the highest duty to be performed by it. As this pressure remains constant while the duty required of the packing varies, it follows that the life of this class is shorter than it would be if the pressure varied in proportion to the duty performed. Asbestos packing might probably last six months. From the foregoing remarks it will be seen that fibrous packing is not an ideal one for engines using either superheated or saturated steam.

*Class* 2.—Being partly composed of fibrous packing, the greater number of objections applied to Class 1 will apply to this class also.

*Class* 3.—The majority of packings of this class use metal rings triangular in section, and placed in the stuffing box thus The rings are put in in sections and arranged to break joint. By the aid of a gland and screws the rings are pressed, one against the rod, the other against the walls of the stuffing box. This arrangement does not permit of the pressure on the rod varying with the pressure in the cylinder, and requires adjustment

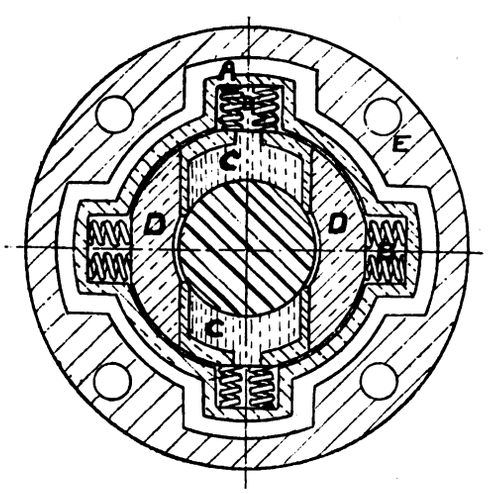



FIG. 1.

to be made periodically by hand. The one packing of this class constructed on scientific principles is that sold by the United States Metallic Packing Company, of Bradford. The type of packing recommended by this firm for use with superheated steam is constructed on the same principle as that recommended for use with saturated steam. For the sake of clearness the latter type has been chosen to illustrate the principle, and is shown in Figs. 1 and 2. It consists of two rings, A, having pockets in which are inserted springs, B. Each ring contains two packing blocks, C, and two guide blocks, D, and they are set so that the blocks in one ring are at right angles to the blocks in the other ring, thus breaking joint. The packing blocks, C, consist of a thin gunmetal case filled with Babbitt metal. The guide blocks, D, are of solid gunmetal, and are not in contact with the rod. E is the packing case, bolted to the cylinder cover; F is the follower spring bush, having recesses in which are placed springs, G, which press against a gland, H. F and H are bored larger than the diameter of the rod, and where they slide the one into the other there is a clearance of $\frac{1}{32}$in. J are plates for retaining the packing, A, and guide, B, blocks in position, and transmitting the pressure of the springs, G, to the ball and socket joint at K. Steam from the cylinder is admitted to the packing case, E, by way of the clearance between F and the rod, and the clearance between F and H. The passage of steam from the packing case on to the back of the packing blocks can be easily followed from Fig. 2. As the pressure in the packing case varies with the pressure in the cylinder, the pressure exerted on the rod varies with the duty to be performed by the packing. Tightness of joint under varying pressures is secured by the springs, B, exerting a force on the back of the blocks, C. The strength of springs, B, is such that in both condensing and non-condensing engines a force of 1½lb. is exerted. With condensing engines longitudinal pressure on the packing is met by springs, G,

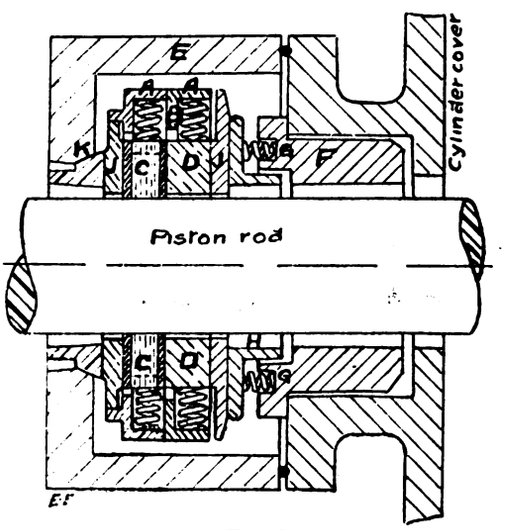
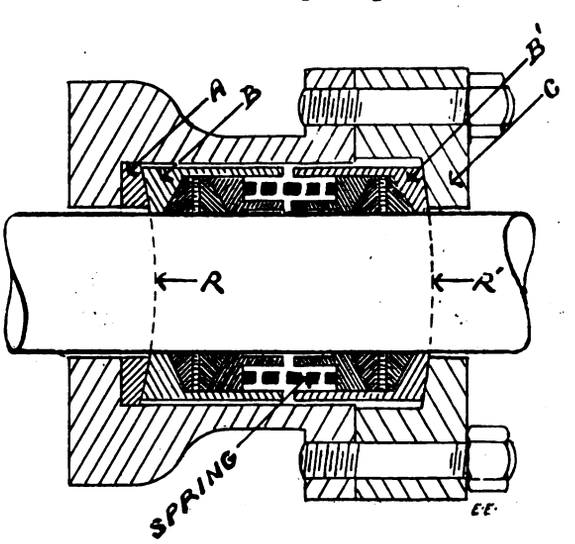



FIG. 2.

collectively, producing a pressure of 16lb. to the square inch on the ball joint at K. Freedom for lateral motion of the piston rod is secured by the aid of the ball and socket joint at K. One engine fitted with this packing is stated to have been kept running for a week with the piston rod bent $\frac{3}{16}$in. out of truth. Being wholly metallic, and the friction of the working parts small, the temperature it is capable of being worked at is practically determined by the melting point of the metals. The wear of the packing blocks, C, is automatically taken up by springs, B. Instances are recorded by the manufacturers where their packing has been at work continuously for 10 years without any outlay whatever for repairs. The cost of this packing is, of course, higher than that of a fibrous packing, but the advantages gained by its use fully justifies the extra expenditure.—E. G. T.

*Answer to No.* 658 (*awarded* 5*s.*).—Metallic packing will be the most suitable for the purpose. Ordinary forms of packing, made of hemp, asbestos, indiarubber, etc., have several disadvantages when there is a high steam pressure. In order to prevent leakage, the gland must be so screwed down that the friction between packing and rod absorbs a




considerable amount of power. To appreciate the friction that may be set up by packing, examine governing gear; where the valve is actuated by a spindle passing through a stuffing box, unless the gland is easy enough to blow slightly, satisfactory working is out of the question. Again, when a gland is so screwed down as to

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prevent leakage scoring is very likely to follow. Fibrous metallic packing is quite as easily manipulated as the ordinary kinds, and can be employed with any present existing form of stuffing box. When a new box is being constructed, such a form as that shown in the figure is an excellent arrangement. The bottom of the stuffing box is fitted with a gunmetal ring, A. The face of this ring and the inside of the cover, C, are turned to the form of surfaces of two concentric spheres. In the diagram these surfaces are marked R and $R^1$. The gunmetal cases, B and $B^1$, carry white-metal packing rings; between the two sets of rings is a helical spring which, the cover, C, being in position, forces the packing rings into close contact with the rod. Owing to the containing boxes being between the two spherical surfaces, a certain amount of movement in any direction is possible for the rod and packing. With regard to the second part of the question—viz., how long packing should last—scarcely more than a guess can be given. With a rod in good condition and the box carefully packed, just tight enough to slightly blow, an occasional adjustment will keep one packing satisfactory for a good many weeks. Given contrary circumstances, and the packing may have to be removed and replaced after the first run.—M. M.

## LONDON COUNTY COUNCIL ELECTION.

A joint committee of "The London Municipal Society" and "The Metropolitan Division of the National Union" is issuing a series of electioneering notes to enlighten or otherwise the minds of the electorate and to obtain votes. Among other notes is the following, entitled "The Truth about the Tramways." How far the note is in accord with its title, and how far the conclusions given are justified, is a matter of opinion. At any rate, a comparison between benefits and profits, etc., on leased and worked lines cannot be of much use as convincing proof for or against unless a good deal of further information is given. The Council would, perhaps, reply that it gave a longer run for its money, and if that is correct, the profit is in the pockets of the travellers, instead of in the bank of the Council.—ED. *E. E.*

### THE TRUTH ABOUT THE TRAMWAYS.

*From Official Sources only.*

*Where the Truth can be Found.*—What is the truth about the London tramways? Where shall we go to find it? Can anything be better than the official records of the Council itself? These are not one man's opinion, but recorded facts taken from the Council's documents. The truth once more is stranger than Radical fiction, for it completely exposes the untruths with which the Radicals are endeavouring to gull the ratepayers.

*The Story of the Trams.*—Every tramway constructed in a street by a company becomes purchasable at the end of 21 years by the public body in whose district it runs. About 4½ miles became purchasable by the London County Council in 1891. The arbitrators awarded the company £14,752 per mile for the lines. The Radical Council at once leased these lines to the company at a rental which returned the ratepayers 5 per cent. for their money. The next year—1892—another 19 miles of line in the North of London became purchasable, leaving 16½ miles of connecting lines purchasable at various dates up to 1910. On Nov. 7, 1893, a report of the Highways Committee (dated Oct. 26, 1893) recommended "That the Council do proceed with the acquisition of the undertakings relating to the 19 miles . . . and do offer to lease the same for a term of six years from July 31, 1892" (*L.C.C. Minutes*, 1893, p. 1,084). At this time there was a large Progressive majority who favoured this lease, and the proposal to lease was carried. For five years, owing to litigation with the tramway companies, the Council's municipalisation of the tramways was at a standstill. There was complete stagnation, no new lines were built, and the ratepayers had no return from the lines which became purchasable. The Council elected in 1895 determined to put an end to this stagnation. There was then no way possible whereby the Council could obtain control of the northern system until 1910.

*The Position in* 1896.—This was the position in 1896. It speaks for itself, and proves the assertion that under ordinary conditions the Council could not work the northern system until 1910. This fact was stated by the Highways Committee of that day.

*When Lines Became Purchasable.*—These dates are taken from the Council's own records: the Caledonian-road line was purchasable in 1898; Prince of Wales's-road in 1900; Pentonville-road in 1903; Fortess-road in 1905-6; Southampton-road, part of Fleet-road, and Kentish Town-road in 1906; Fleet-road line, Southend-green, Highgate-road, Gray's-inn-road, Chalk Farm-road, Ferdinand-street, and Junction-road in 1908; other parts of the above lines in 1909. These lines were the property of the London Street Tramways Company, and it will be at once seen that the greater part of them would not, under ordinary circumstances, have been in the possession of ratepayers even at the present moment. The lines of the North Metropolitan Tramways Company were in a similar position. Thus Canonbury-road, New North-road, Shoreditch, Cazenove-road, Whitechapel, Mile End-road, Bow-road, Dalston-road, Graham-road, Holloway-road, Seven Sisters, and Stamford-hill were not purchasable by the Council until 1898; Green-lanes line was purchasable in 1903; West India Dock-road, Great Eastern-street, and Commercial-road (parts of) were purchasable in 1906; Leman-street and Dock-street in 1909; Seven Sisters and Stamford-hill (parts of) in 1910.

*Why Working was Impossible.*—How much truth is there in the assertion that the Council's policy of working the northern system was checked by the Conservatives? Would Londoners care to see a system whereby passengers boarded a Council car for a short distance, then changed into a company car and again entered a Council car to get to their homes? Could such a system be worked? Would Mr. Benn dare to propose it to Londoners?

*The Next Best Thing.*—The next best thing was done by the Council of 1895-8; the only one in which there were as many Conservative councillors as Radical. A bargain was struck. That it was a good bargain for the ratepayers shall be shown. First of all, the whole of the lines, including those not purchaseable until 1910, were made one consideration. They were purchased at £10,000 per mile for double and £5,000 for single lines, conditional upon a lease being granted to one of the companies up to the year 1910, in which the last of the lines became purchasable.

*Benefits for Ratepayers and Passengers.*—This lease establishes these facts: By agreement the Conservative councillors saved the ratepayers £4,752 for every mile of double line purchased. The whole of the 43½ miles have belonged to the ratepayers for the past seven years. Under Progressive policy that could not have been possible even at this moment, nor for another six years. On the purchase price the return to the ratepayers is 9 per cent. The Progressive lease granted in 1892 returned but 5 per cent. The principle of no more double fares on Sundays or Bank Holidays was established. Workmen's cars at 2d. return were provided for the first time. Upon every new line the company pays 8 per cent. to the Council on the cost of construction. The Council borrows at 3 per cent., and so makes 5 per cent. profit for the ratepayers. The men's hours cannot be increased nor their wages reduced, and they must have one day's rest in seven. The lines must be worked by electricity whenever required by the Council. The Council can make experiments, at the cost of the company, of any system of traction they may choose. Fares have been reduced on the cars, and competing 'buses have had to lower theirs. The ratepayers have had profits for the past seven years from lines which would never have been theirs until six years hence but for this lease. By the leasing of the lines under these conditions the ratepayers have profited to the extent of over £170,000 beyond that which would have been possible under working such a chaotic system of lines.—*Report of Council's Officials.*

*Profits from Leasing and Working.*—The Council now owns 88¼ miles of the 115 miles of tramways in London. Forty-eight are leased and 40 are worked. The cost and results of purchase are interesting. The 48 miles of leased lines cost £849,530. The 40 miles of worked lines cost £1,159,088. Last year the leased lines brought a relief to the rates of £37,794. Last year the worked lines resulted in a loss of £2,250. The profits on the leased lines saved the ratepayers from being compelled to put their hands into their pockets to make good the loss on the worked lines. The leased lines, which have cost the ratepayers £849,530, have brought in a total profit of £237,794. The worked lines have yielded a total profit of £75,974, or only one-third of the amount produced by the leased lines, which cost 25 per cent. less.

*Which Do You Prefer?*—Which, after all, has been the better system for the ratepayers? Which has been better for the passengers? Ask those who travel on the conduit lines what they think of the speed. Ask them if they enjoy the breakdowns. How many times have they missed appointments through them? Do they accept Mr. Benn's excuse about the mud getting into the conduits? If they do, how will the Council abolish rain?

*Whose Fault?*—Londoners are told that it is not the Council's fault that the northern system is not electrified. Whose fault is it? By the terms of the lease the Council can reconstruct the lines for electrical traction at any time. Knowing that the conduit system is a costly failure, the Council is endeavouring to obtain the consent of the borough councils to the overhead system in certain districts. These councils, which are mainly

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Radical in complexion, refuse their consent. The company, on the other hand, believe that successful working is only possible with the cheaper and proved successful system of overhead traction, and, before changing their views, ask to see the results of the working of the Council's conduit system. In the electrification of the lines by any proved successful system, the company has offered the Council "every possible assistance." Whose fault is it? Who is to blame for the delay?

Ratepayers! Hundreds of thousands of pounds of your hard-earned money has been squandered on an electrical traction system that experience proves to be unsuitable for London. The profits which you were promised from the working of 40 miles of lines have dwindled into losses, and you are only saved from being compelled to meet those losses out of your own pockets, by the profits which come from the leasing of lines which the Council have power to electrify at any moment. The Conservative and Unionist policy is electrification of all lines owned by the Council; cheap fares consequent upon a cheaper and more reliable system of construction. How long are you going to allow reckless Radicals to squander your money in carrying out inefficient systems? Vote for the Conservative and Unionist candidates, who will give to London a service equal to that provided by the well-managed electric tramways on its borders, lighten your rates, provide cheaper locomotion, and relieve the overcrowding in the central districts.

## LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion held further sittings at the Westminster Palace Hotel on Thursday and Friday last week, the chairman (Sir David Barbour) presiding.

**Mr. A. Gray,** counsel to the Chairman of Committees of the House of Lords, said that as to existing parliamentary procedure he concurred with much of the criticism that had been passed upon it. One conspicuous disadvantage was the lack of a continuous policy in the committees. Each committee looked only at the Bill before it, and this would to some extent be remedied by creating some continuity in the committees. Another disadvantage was the great pressure of business which was concentrated into about three months of the year. He was against the proposal to deal with London traffic schemes by joint committees of the two Houses—altogether against it if the present procedure was maintained unaltered, less so if a board was or could be created which would operate as a committee of first hearing. It was highly inconvenient and anomalous that there should be not only two methods of proceeding under the Tramway Act—by provisional order and Bill—but also a third extra-parliamentary method by light railway order. He did not criticise the operations of the Light Railway Commission, which he believed had been of great general benefit to tramway enterprise, but as at present constituted it could hardly be viewed as a permanent body. The anomalies in regard to powers were remarkable. County councils were light railway authorities, but not tramway authorities, and this position had forced Parliament in one or two cases (notably in that of Middlesex) into recognising the county council as an authority competent to purchase and work tramways. The veto existed under the Tramway Act and the Standing Orders, but there was no veto under the Light Railway Act. Various suggestions had been made to the Commission as to the creation of an extra-parliamentary tribunal or board. Unless a scheme involved an obligatory presentment of all London Bills to the board, and a hearing in all respects equivalent to a hearing before a parliamentary committee, he thought it would hardly be advisable to substitute a joint committee for the double hearing in Parliament. Such a body as he suggested might consist of, say, five to seven members, of whom probably two should be distinguished engineers who were practising as consulting engineers only, and not in constructive work.

**Sir Theodore Martin,** examined by the Chairman, said he was a parliamentary agent, and had been in practice since 1845. He should think it expedient, before sanctioning fresh schemes to wait until the tube railways now under construction were completed and in full working. It would then be seen whether and how far they left wants still to be supplied, also whether in themselves they were in sufficient favour with the public to yield a fair return on the capital invested. At present they were in a great degree experimental. As to the general question whether or not it was desirable that there should be some general scheme for the laying-out of further underground railways in London, he considered that to be essential, and there could be no fitter authority for this than the present commission. He saw no reason why any fresh tribunal should be appointed to consider the lines that might be so proposed. No efficient tribunal could be constituted without creating additional expenses. To be effective the members of such a tribunal must be men of large experience, probably men in the receipt of large professional incomes. Any decision they might come to must, he thought, be open to revision by Parliament. The interference with property was so serious that no decision but a parliamentary one would give satisfaction. The amount of capital involved would also be so great that it seemed to him to be peculiarly the function of Parliament to deal with this question. That being his view, he considered that the present system of submitting all projected railways to the arbitrament of parliamentary committees could not be improved upon. Parliamentary committees had again and again dealt to the general satisfaction with schemes of greater magnitude than any new railway in London. In the course of his long and tolerably large experience the question of the fitness of these committees for dealing with measures affecting public as well as private interests had occupied much of his attention. He had tried to look at it with as impartial an eye as possible, but his conclusion had always been that the work was, upon the whole, well done, and as far as possible, where an adverse decision to one of the parties must be given, it had been given in such a way as to leave the conviction that justice had been done. Men of the world conversant with affairs formed the staple of committees, and no better tribunal, in his view, could be devised for judging what was best for the accommodation of London traffic, whether the money to pay for the measure was likely to be duly forthcoming, and what could or could not be done within reasonable limits of expense.

In the course of further examination, the witness incidentally mentioned that the Metropolitan District Railway, which cost £750,000 a mile to make, was the lamentable result of a report of a Royal commission.

**Mr. C. S. Meik,** civil engineer, of Victoria-street, was recalled in reference to proposals he had made before the Commission for the construction of new thoroughfares through London, and further information was given on those proposals by **Mr. W. Beer,** civil engineer, of Victoria street, and **Mr. W. R. Low,** of Basinghall-street, architect, surveyor, and valuer. From this it appeared that the following were the figures for the valuation of the cost of the land to be acquired in connection with the construction of the proposed main avenues, and the estimated recoupment to be derived from the sale of surplus lands: main avenue north to south—cost, £31,343,000; recoupment, £36,789,000; main avenue west to east—cost, £39,843,000; recoupment, £33,801,000 — totals: cost, £71,186,000; recoupment, £70,590,000.

The Commission adjourned.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 26

**Institution of Electrical Engineers.**—Manchester Section: Annual dinner.

**Institution of Civil Engineers.**—At 8 p.m., students' meeting. Paper: "Boiler-House Design," by Mr. L. G. Crawford.

**Royal Institution.**—At 9 p.m., discourse by Mr. A. Siemens on "New Developments in Electric Rays."

**North-East Coast Institution.**—Meeting at Newcastle-on-Tyne.

**Electro-Harmonic Society.**—At 8 p.m., ladies' night concert, King's Hall, Holborn Restaurant.

**Electrical Engineers Volunteers.**—At 9 p.m., Kensington Town Hall, annual regimental ball.

SATURDAY, FEB. 27.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture II.).

TUESDAY, MARCH 1.

**Institution of Electrical Engineers.**—Manchester Section: At 7.30 p.m., ordinary meeting. Paper: "The Mersey Railway—Multiple Control System," by Mr. H. L. Kirker.

**Institution of Civil Engineers.**—At 8 p.m., ordinary meeting. Further discussion of papers by Messrs. J. D. Twinberrow, A. L. Shackleford, and J. T. Jepson (*vide* last issue).

**National Electrical Manufacturers' Association.**—At 3 p.m., Hotel Cecil, second annual general meeting.

WEDNESDAY, MARCH 2.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to inspect the new stores and plant for handling grain at the Millwall Docks.

**Institution of Electrical Engineers.** — Students' Section: At 7.30 p.m., ordinary meeting. Paper: "The Determination of the Correct Proportion of Condensing Plant in a Central Station," by Mr. P. V. Hunter.

THURSDAY, MARCH 3.

**Rontgen Society.**—At 8.30 p.m., ordinary meeting. Presidential address: "Some Laboratory Notes of the Last Six Months."

**Royal Institution.**—At 5 p.m., Prof. H. L. Callendar on "Electrical Methods of Measuring Temperature" (Lecture II.).

FRIDAY, MARCH 4.

**Junior Institution of Engineers.**—At 8 p.m., ordinary meeting. Paper: "Some Practical Notes on Electric Storage Batteries," by Mr. G. C. Allingham.

**Royal Institution.**—At 9 p.m., discourse by Prof. Wm. Stirling on "Breathing in Living Things."

SATURDAY, MARCH 5.

**Institution of Electrical Engineers.** — Students' Section: At 9.30 a.m., visit to Messrs. J. I. Thornycroft and Co., Limited, Chiswick, W.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture III.).

**Glasgow Scientific Society.** — At 7.30 p.m., ordinary meeting. Paper: "British Competition and Manufacture," by Mr. M. Pickstone.

**Birmingham Association of Mechanical Engineers.**—Ordinary meeting. Paper: "Present Position of Trade in South Africa," by Mr. Ben. H. Morgan.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 23; Newcastle, May 6 and 7; Buxton, May 20 and 21.

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THE
# ELECTRICAL ENGINEER.

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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## THE G.E.C. ANNUAL.

"It is estimated that fifteen thousand mouths are dependent for food upon the successful operations of this company." Such was a sentence that fell from the lips of the chairman at the annual dinner of the company on Saturday last. The statement gives food for thought, and brings into clearer view the value of such an undertaking in the ranks of the industrial works of the country. Twenty-five years or so ago Mr. G. Byng commenced business. He had confidence in himself, he had an object, and steadily worked to attain that object, never giving himself rest till that object was in a fair way of being achieved. Then the long and arduous strain pronounced its effect, and he was for a long period physically prostrate. The man of initiative and energy was compelled to take things more quietly. It was, therefore, with the greatest satisfaction that all his friends saw him sufficiently recovered to preside at this great annual gathering, and trust that he will find himself fully restored to continue the great work which has been so successful. Commencing as a unit, increasing by an average of some six hundred units per year, depending upon the initiation of the one unit, is a fact which must surely be taken as a proof of ability and singleness of purpose. It is, however, not altogether with the prosperity of the G.E.C. that we wish to deal, but once more to call attention to the fiscal creed of the man who has, so to speak, created the company. He is from conviction a Protectionist, and it is just here that we must ask leave to differ with him, yet probably the differences are not so real as a direct negative would indicate. Much depends upon definitions. Our desire is to obtain equality of artificial conditions and take advantage of all natural conditions. Mr. Byng in his admirable little book demonstrates—what hardly needs demonstration (given natural conditions somewhat similar)—"that a manufacturer in a protected country can manufacture at a cheaper rate than a manufacturer in a Free Trade country." Of course, given certain conditions, this is a truism because of influence upon the factor quantity, a point strongly pressed by Mr. Byng. Opponents of fiscal change too often select for their arguments such expression as "Fancy putting a duty upon champagne, raw cotton, iron ore, etc.—cutting the nose to spite the face." No advocate of fiscal change suggests such things, nor do thorough-going Protectionists. Mr. Byng's text is mainly contained in such a sentence as "If our manufacturers cannot compete with protected goods in our own country, how can they hope to compete against them in our Colonial and neutral markets?" Mr. Byng, as the head of a manufacturing and distributing concern which has agencies in most parts of the civilised world, is in a position to speak from experience. In this case an ounce of experience is worth a pound of theory, yet we find men listening to and applauding the diatribes of a Winston Churchill, a Lord George Hamilton, a Lloyd-George—men of no experience—instead of welcoming and seriously considering the opinions of the expert. It is extremely difficult for fiscal reformers to meet the arguments of men who have no business experience, inasmuch as in most cases the factors that determine the problem are numerous and technical in character. We should have thought that a casual examination of financial considerations would have shown something to be wrong. A great feature in the speeches and writings of opponents to reform, is that our imports are partly paid for from the returns of investments abroad. The value of such investments is lauded, and the amount derived from them, given variously by various speakers, is generally an

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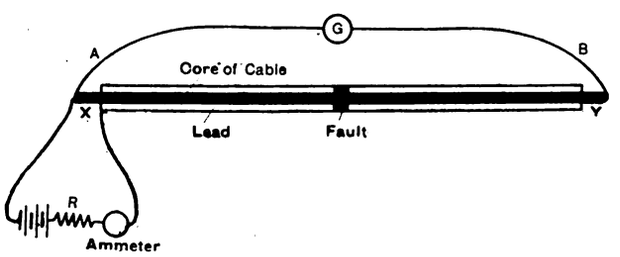
amount they require to make up some difference. Has it never struck these men that the argument cuts two ways If it is good for us to invest abroad, it is good for outsiders to invest here and bad for us. But is not this just what has been going on for the last few years? We cannot now get the money wanted at home, and have to rely on American and Continental investors. Then look at the money being invested by foreigners in our industrials. Of course, in a way, if we invest capital in Timbuctoo, it is good for Timbuctoo; so in a way, if Americans invest their millions here, it is good for us. But it is far from being good in the sense it is usually referred to. It means profits for outsiders, and every pound of that profit going outside the country is bad for the country. The receivers are the gentlemen of leisure, the producers are merely brain and muscle. The creed of Mr. Byng, if adopted, would, in his idea, probably lead to the G.E.C. being one of the largest concerns of its kind in the world. Other British concerns, he believes, would flourish proportionately, and there is every wish that such views should be seriously considered, and, if similar conclusions are accepted, should be adopted and carried into effect.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### CABLE FAULTS.

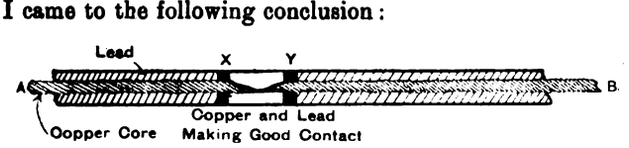
SIR,—Some time ago I read in your "Question and Answer" columns a test relating to faults on cables which I thought rather good, and decided to put it into practical use at the first opportunity. To the best of my recollection the following is a diagram of connections.




X Y = cable. The current is sent along the lead, through the fault, back along core end, A; a certain current, say 20 amperes, being regulated by resistance, R. The deflection on the galvanometer, G, is noted. The same amount of current is now sent from end B, the connections being similar (but at end B) and the galvanometer leads remaining the same in position.

Suppose A B is 100 yards in length and the drop of pressure from end A and B also is five volts, then the distance of fault from A and B would be equal—50 yards. The same argument applied, the ratios of the drop being different, the distance should be in proportion. When I took this test, however, the fault by your formula should have been a certain distance from A; but on opening the ground for a distance of five yards either way, no fault was found; eventually it was found a long way off, much nearer B, in fact.

On inspecting the bad place after it had been uncovered I came to the following conclusion:




The cable was practically burnt out for a space of 2in. between X and Y.

When the current was sent from end A there was only a very slight drop, owing to X making good contact with lead; whereas on the same amount of current being sent from end B there was a very large drop, the resistance at Y being much higher (the copper and lead being burnt so much that they were charred right up).

By applying the test, you see, the fault should come very near end A, whereas in the actual case it was much nearer B. From this example I think it is clear that this particular test cannot be relied on in such cases.

I trust this explanation will interest you and your readers of "Questions and Answers."—Yours, etc., O. L. L.

### GAS *v.* STEAM.

SIR,—I was particularly interested in the answers to Question No. 656, comparing the use of gas-driven plant with steam. I am surprised to notice that neither of the replies included a suction gas-producer. With coal at the price mentioned, and slack not being available at a low price, and with such a small set, it seems to me that a suction producer with its great simplicity would have enabled the first cost to be kept lower and also reduce the cost for wages.

The suction producer at Stowmarket is giving great satisfaction, and although the question of steam *versus* gas has not yet been settled at Felixstowe, I have not yet been able to obtain any figures for steam which would lead me to advise a change from gas driving.—Yours, etc.,

Stowmarket, Feb. 22, 1904. NAPIER PRENTICE.

SIR,—In the first answer to Question No. 656 in the current issue of your journal there is apparently an error in the figures given for cost of gas plant. From the total of £5,500 I gather that "J. H. S." estimates on a basis of £22 per kilowatt, which I consider an excessive figure.

I would like to know how "J. H S." distributes the odd £10 per kilowatt, as the total of £7 and £5 is only £12. No one who has gone carefully into the matter can have any doubt as to the suitability of gas-driven plant where profitable working is a consideration.—Yours, etc.,

Stowmarket, Feb. 23, 1904. E. A. LAMBERT.

## MUNICIPAL TELEPHONES.—II.

In our first article we have proved—till we are convinced to the contrary—that a difference in the definition of what constitutes a unit has led the critic astray. It is a fundamental axiom amongst logicians to, in the first place, find out the matters upon which there is agreement. In this controversy there is no point of agreement, and hence no starting point of controversy. The delightful argument that a consulting engineer errs, therefore a municipality is wrong, is put forward. It is neither logical nor in accord with common-sense, yet it serves a purpose with those who think the "loudest mouthed is the king of the trippers."

### Estimates.

Our eager critic says: "We shall not meet with any dispute if we say that the *cardinal principles* on which *municipal telephony* (the italics are ours) rests are that the average capital cost of a working subscriber's line in a modern telephone system is about £20, and that the average annual rate of about £5 is sufficient to pay for operating expenses, interest on capital, sinking fund to redeem capital, and all other charges incident to the conduct of a city telephone exchange system."

We dispute that assertion, and say the statement is absolutely untrue. A person is again being attacked, and not a principle.

Throughout the length and breadth of this country from first to last the cry of the municipalities has been (1) that private enterprise is sweating the public by charging what it pleases and how it pleases for things that are necessary to the general public and partake of the nature of a monopoly; (2) that the public ought to be better served at a less cost by municipal than by private action.

If the critics will disprove the contention of the municipalities on these points they will be serving a good purpose, but they do not attempt to deal with them. Instead of tackling the real question they discuss estimates

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as if a high or low estimate touched the question at all. They are doing what is abhorrent to all ideas of fair play — attacking a man while pretending to attack somebody else.

Let us state the cry of municipalisers once more. They give alternative reasons which may be termed the principles governing their action.

(1) Certain works of the nature of monopolies should be performed by the community for the community at cost price.
(2) The alternative is to make a profit and to assist the rates.

A quotation from a candidate's address for the London County Council election puts this clearly :

"That all monopolies, such as gas, water, tramways, markets, docks, river steamboats, and electric lighting, should be municipalised, and the profits, amounting to £4,000,000 annually, or three times the Council's revenue, devoted to public purposes."—Messrs. Steadman and Spender (candidates for Stepney) *vide Westminster Gazette*, Feb. 18, 1904.

It would require the language of an East State American paper to forcibly and adequately repudiate any allegiance to such a farrago as this.

We say these reasons or principles are fundamentally wrong, but the criticism against Glasgow and elsewhere does not touch these subjects.

What does it matter to the municipality whether an estimate is £20 or £200 per unit installation, or £5 or £50 per year expenses? The only question the muncipality troubles about is whether it can do the work more cheaply and efficiently than a private adventurer. To talk about estimates being *cardinal principles* is a misuse of terms. Estimates are, roughly, guides in financial matters, and no two engineers will do more than approximately estimate round a central figure for the same work. Estimates may be wrong, altogether irretrievably wrong, but that shows mistakes or incompetence in the engineers, and has nothing to do with the principles of the matter.

Our task is rendered far more difficult than it would be if the critics were not so discursive. Having shown, as we think, conclusively that the question of municipalisation is untouched by this particular critic, let us turn to the personal or engineer's question. In the first place, we must ask a question.

If an engineer estimates for certain work, and in the end the work is of a different character, is the original estimate to be held to hold for the altered work which was never under consideration?

Our answer would be that the old estimate is gone, but we should also say that in some cases—and we think telephony is one of them—the extension of the work should cost approximately a multiple of the unit estimate—that is, if the original estimate, say, per line, was £20 per line for not less than $x$ lines, it should be approximately £20 per line for $x+y$ lines. Of course, the increasing or decreasing of $x$ would entail alterations of details which might affect, and considerably affect, the original estimate, and we assume that the extended or decreased work is on the same system as that estimated for.

Before going further it will be well to see what the original estimate at Glasgow was for and the changes, if any. On p. 5 of the report is the following table :

| — | Original value. | Actually completed— 1901-2. | 1902-3. |
|---|---|---|---|
| Completed instruments to be provided | 5,250 | 5 479 | 9,122 |
| Partially completed lines | 1.200 | 8,787 | 7,387 |
| Switchboard accommodation (lines) | 6 050 | 7,060 | 10.826 |
| Number of pairs of cable lines | 6,450 | 14,572 | 18.171 |
| Mileage of pairs of wires in cables | 4,938 | 11 061 | 14,0$\frac{2}{9}$9¼ |
| Length of trenching (miles) | 22 | 94 | 127¾ |
| Number of pipes going out of exchanges | 32 | 126 | 135 |
| Capacity of pipes going out of exchanges (pairs of wires) | 6,900 | 27,000 | 31,000 |
| Length of pipes (miles) | 32 | 104¼ | 127¼ |
| Length of underground cable (miles) | 31 | 113¾ | 162 |
| Number of ground poles | 2,326 | 691 | 1,799 |
| Number of roof standards | 456 | 228 | 243 |

A very casual, without an exceedingly careful, examination of this table ought to be conclusive that at Glasgow the original estimate would in the end be somewhat modified.

On p. 12 of the report the statistics are given in fuller detail, but the above will suffice for our purpose for the present. A number of statements are made on this subject of initial cost by the critic in our esteemed contemporary to the effect: (1) "the Glasgow Corporation pinned their faith absolutely to those figures"; (2) "the parliamentary telephone enquiry of 1898 shows that the committee . . . was largely influenced by those figures"; (3) "the very Act of 1899 which made telephony legally possible may be said to be based on the theory"—*i.e*, £20 initial cost and £5 annual operative expenses; (4) "the soundness of these figures and estimates has been disputed time and time again." Here, again, comes the questions for what were £20 or £5 estimates: have they yet been proved to be wrong for the purposes estimated, who disputes them, and are they disputed for some other reason than their correctness for the work which was really estimated for? We are pretty sure that Mr. Hanbury's committee of 1898, the House of Commons in 1899, and the Glasgow Corporation were not misled by any estimates. If each and all accepted them to be approximately correct, it was simply because the weight of evidence was in their favour. The critic says the Glasgow accounts after two years' working proves his contention. We say they do nothing of the kind. Consider the estimate for 5,250 instruments involved 22 miles of trenching; the actuality for less than double the number of instruments has involved 127¾ miles of trenching, or more than five times as much trenching. To saddle the cost of this trenching on 9,122 instruments shows a desire to mislead, for, of course, the initial cost per instrument is increased, but as the trenching, so to speak, will carry more instruments, as these are added cost comes down. A similar argument holds good as regards length of pipe—in one case 32 miles, in another, for less than double the number of instruments, 127¼ miles. Need we labour this further to show how ingenuous the critic has been? How easy it is to criticise in this fashion may be seen from an extract from a criticism of this criticism which is before us :

"In dealing with the average cost per line or station "of the Glasgow undertaking, the *E.R.* writer has lost "himself in a complete muddle. He first deducts 1,606 "lines from the total shown in the report; the remainder "(7,441) are variously termed lines, actual lines, working "lines, direct exchange lines, subscribers' lines, and "actual subscribers' lines. The inference regarding the "odd 1,606 being they are non-existent, but in so far "that the critic estimates they have cost £11,194, they "appear to have a kind of existence in the shady recesses "of the writer's imagination. Conundrum: When is a "telephone line not a telephone line? may be an interesting amusement for an evening party, but it does not "come within the scope of serious discussion. In estimating the cost of these inferentially non-existing "lines, the critic has shown himself to be entirely "ignorant of local circumstances in Glasgow and "of telephone work generally. In building up "this flimsy fabric of fictitious figures to produce "the hypothetical result, he undervalues extension and "private lines. He ignores the fact that a great many "extensions and private lines pass through switchroom "testboards, and are consequently equal in cost to two "exchange lines, while in dealing with inside extensions "he also ignores the fact that many of them are connected to expensive apparatus. After a considerable "floundering in a quagmire of supposititious figures "the writer emerges with the statement that £34. 18s. "per line is the real average cost per line of the Glasgow "Corporation telephone system. If the *E.R.* writer "would make a similar calculation based on the "figures contained in last year's accounts, he would "find the real average capital cost last year was £40, "being £5 or £6 more than this year's average cost. "Again, if the critic should try a similar calculation next "year, he will most likely find a further reduction in the "average cost. *The fact is, the average cost of any telephone*

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"*line in any large network during the first few years of the "development of the system is a fleeting figure, and gradually "diminishes. . . .*" (The italics are ours.)

We have used this quotation because its sting is in its tail, and goes to the root of things. The cost per line, or per whatever unit is agreed upon, cannot be determined in the early stages of development. The hypothetical figures of the critic show this £40 (calculated for him) the first year, £34. 18s. the second year, and probably somewhat less the third year—how much we know not till it is finished.

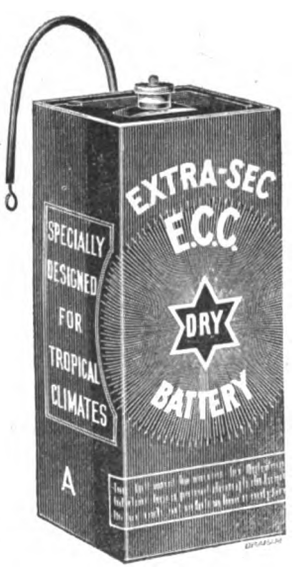
Now to what point have our remarks brought us?

1. We differ from the *Electrical Review* as to what constitutes cardinal principles, holding that the amount of an estimate of a particular engineer for a particular work has no more to do with the principles of municipalisation than has the sweetness or sourness of sugar.
2. That an estimate made for one thing is not to be accepted as holding good for another.
3. That the disputed general estimate was for one thing, and that in the carrying out the work at Glasgow changes have been made which tend to modify the estimate; and
4. That the work has not yet so far developed as to admit of an average cost per unit being determined.

## TRADE NOTICES AND NOVELTIES.

### The Extra Sec E.C.C. Cell.

We are indebted to the General Electric Company, Limited, Queen Victoria-street, E.C., for some further particulars relating to "the Extra Sec E.C.C. Cell," mentioned elsewhere in connection with the firm's progress leaflet for the current month. During the time they have been selling E C.C. dry cells the company have frequently been asked for a dry cell




which could be kept in stock for an indefinite period without deterioration. After a series of exhaustive experiments they are now placing on the market such a cell, which will be known by the above name. A battery composed of these cells, as sold, contains all the necessary ingredients for satisfactory working, with the exception of the exciting fluid, and it is only necessary to pour a saturated solution of sal ammoniac into the opening provided for the purpose to excite the battery and render the same ready for use. In one form the sal ammoniac solution is received by an absorbent material, which prevents its escape even though the cell be upset. In another type this absorbent material is absent, and consequently, if the battery is required to be put out of action for some considerable time, the sal ammoniac solution can be poured out, to be replaced when the battery is again required for use. The output obtained from the battery is large, each cell being capable of giving continuously a current of one-tenth of an ampere for 380 to 400 hours. The electrodes are so arranged as to be extremely close to each other; at the same time, the construction of the cell renders damage from short-circuits impossible, and the arrangement is such that the supply of the sal ammoniac solution between the electrodes is well maintained when once it is excited, these two facts reducing the internal resistance to a minimum. It will be seen from the description above given that the cell can be kept in stock for any length of time without deterioration, and this fact renders it specially suitable for use in hot climates and for export purposes generally.

### The "Crompton" Potentiometer, Electrical Pyrometer, and other Specialities

We have from Messrs. Crompton and Co., Limited, Arc Works, Chelmsford, a copy of the second edition of their potentiometer pamphlet, together with a price-list of the instrument and its accessory parts. For details of this potentiometer we must refer the reader back to our issue of Oct. 3, 1902. From the same firm we have a price-list of testing-room appliances, also a pamphlet describing their electrical pyrometer. This latter apparatus is designed for the continuous indication of the temperatures of flue gases or superheated steam, and of similar parts of steam plants, not exceeding 950deg. F. or 500deg. C. The essential parts of the device are an indicating instrument calibrated in degrees of temperature and a pair of metal rods connected to the terminals of the instrument, and brazed together at the other end. The brazed joint is placed at the point whose temperature has to be determined, which is then indicated on the instrument. For use in indicating the temperatures of flues, the instrument is mounted on a cast-iron plate screwed to the wall, and the metal rods are led through flexible metallic tubing and a length of iron pipes. The iron pipe is intended to be thrust through a hole in the brickwork to the point where the temperature is to be taken, and the flexible tube connects it to the instrument. The end of the iron pipe is closed with a screwed cap covering the brazed joint. The apparatus can be left permanently in its place, as the brazed joint and metal rods are not injured by the degree of heat mentioned. For use with superheated steam, the brazed joint of the metal rods may be bolted to the steam-pipe. The indicating instrument is contained in a strong cast-iron case, with dustproof joints, suitable for mounting in a furnace-room or over an economiser chamber. The scale, 200 deg. F. to 900 deg. F., is 5in. in length, and can be read to 5 deg. of temperature. The usual length of the iron tube is 6ft. and of the flexible tube 10ft., but these can be varied to suit requirements. Messrs. Crompton and Co. believe this pyrometer to be a much simpler and more practical instrument for the use of engineers than has hitherto been placed on the market.

### New G.E.C. Lists.

From the General Electric Company, Limited, Queen Victoria-street, London, E C., we have a copy of their progress sheet for the current month, in connection with which we note that the increased demand for a reliable main switch has induced the firm to again publish the prices of their well-known "Peel" switches. A new type of switch, named the "Quadrant," marks an advance in the design of switches of the "tumbler" pattern. The novel construction and action of this switch makes it possible to give a perfect electrical contact without losing the advantage of smooth working. The "Adelphi" D.P. motor switch, high-voltage cut-outs, patent square cord grip lamp-holders, the "Extra Sec" dry battery, specially designed for tropical climates, are also dealt with, besides which illustrations are given of some glassware of new design, particular attention being drawn to a "vein" shade which is supplied in two colours, pink and green, and is claimed to have a very striking effect when in use. Nor must mention be omitted of some electrical illumination devices in the shape of star sprays and coloured stars. A second list received with the above deals with "Geeko" fire-alarms. In this list the firm have endeavoured to put in a concise form full particulars for properly installing a complete fire-alarm system. The different apparatus shown includes some of the latest and best ideas put forward for this class of work. Special attention is drawn to an automatic fire-alarm shown on p. 4 of the list. This alarm is of the self-adjusting type, and is claimed to be the most sensitive and practical automatic device of its kind yet invented. It is noteworthy that the apparatus in question was awarded a gold medal at the recent International Fire Exhibition at Earl's Court.

### B.T.H. Transformers.

We have received from the British Thomson-Houston Company, Limited, Rugby, a copy of their pamphlet No. 164, which supersedes No. 94, dated May 2, 1901. This pamphlet fully describes and illustrates the several special features of the firm's type H transformers. It is excellently got up, and contains some useful data.

### Publications, Catalogues, etc.

REPORT OF THE SELECT COMMITTEE ON VENTILATION. Hickson, Ward, and Co., 15, Chiswell-street, E C. 1s.—This little volume contains the report of Sir Michael Foster's committee of last year, and is nicely printed and well supplied with side-heads for easy reference.

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## PERSONAL.

Mr. H. Richardson, A.M.I E E., last week delivered a lecture on "Electric Apparatus" at Wormit, under the auspices of the Literary Society, in Stewart's Hall. Mr. W. S. Kelt, vice-president, occupied the chair, and there was a good attendance.

The Stockport Town Council have confirmed the appointment of Mr. A. T. Eardley, the committee clerk of the Corporation, to the position of tramways manager.

Mr. A. D. Chalmers has been appointed resident engineer at the Gillingham electric light works at £250, increasing to £350 (one pupil allowed).

The Doncaster Town Council have appointed Mr. E. S. Rayner, of Swansea, electrical engineer and tramways manager, in succession to Mr. Wyld, who is removing to Birkenhead.

A smoking concert was held on Monday at Chelmsford, to take leave of Sergeant Law, a pupil at the Arc Works, who is going to represent Messrs. Crompton and Co. in the South of England. Sergeant Rook, D.C.M., presided.

We are informed that Mr. H. M. Harris, of Messrs. Harris, Lee, and Co., electrical engineers, of Johannesburg and Cape Town, who is expected to arrive in London at the end of this month to arrange additional agencies and place orders, can then be seen at 14, Upper Thames-street, London, E.C.

The annual dinner in connection with the Croydon electricity works took place on Friday last. Mr. Alderman Miller presided, supported by Mr. Councillor Rogers, Mr. J. Gray Scott (chief engineer), Mr. Alex. C. Cramb (chief assistant engineer), and many other gentlemen. A capital programme of music was carried out by the members of the staff and friends, and the opportunity was taken of presenting to Mr. J. Gray Scott (who is shortly leaving for Hong Kong) an illuminated address from the works staff as a token of the esteem and regard in which he is held.

The Exeter Electric Tramways Committee have recommended that Mr. J. E. Waller be appointed joint engineer for the tramways at a remuneration of 2½ per cent. upon the amount expended.

## APPOINTMENTS VACANT.

**Assistant Clerk**, Woolwich Electricity Department. Salary, £100 per annum. Applications by Feb. 29. Particulars from Mr. J. B. Mitchell, electrical engineer, White Hart-road, Plumstead.

**Secretary**, Institution of Electrical Engineers. Salary, £500 per annum. Applications by March 7. See advertisement in last issue.

**Fitter-Driver**, Keighley. Wages, 35s. per week. Applications to Borough Electrical Engineer by Feb. 26.

**Engineer**, Aberdeen, for Kingseat Asylum. Thorough knowledge of electrical machinery. Salary, £90 per annum, with free house, fire, light, and vegetables. Applications to Mr. C. B. Williams, 20, Union-terrace, Aberdeen, by 29th inst.

**Clerk of Works**, Bridlington, for electricity supply scheme. Salary, £4 per week. Applications by March 8. See advertisement.

**Junior Assistant**. Wages, 25s. per week. Applications by March 7 to Engineer, Electricity Works, Canterbury. See advertisement.

**Cable Jointers and Wiremen.** Apply, stating age, experience, and wages expected, to Harland and Wolff, Limited, Belfast. See advertisement.

**Man** to assist in testing dynamos and motors and in setting machines to work. Apply to Box H G, *Electrical Engineer* Office. See advertisement.

**Working Engineer**, Islington Infirmary, Upper Holloway. Salary, £2. 10s. per week. Applications by March 7. See advertisement.

# LEGAL INTELLIGENCE.

## LIABILITY OF TRAMWAY UNDERTAKERS.

In the King's Bench Division before Mr. Justice Channell, the case of Parker *v.* London County Council came before the Court on an order of a Master in Chambers for the determination of a point of law raised by the defendants. The defendant Council, by virtue of certain private and local Acts of Parliament, had acquired the tramways of, amongst other companies, the London Tramways Company, and at the time of the accident hereafter referred to, were carrying on the enterprise in relation to the tramways, with funds provided out of the rates. On June 16, 1902, the plaintiff, whilst a passenger on one of the defendants' tramcars, sustained injuries in an accident which occurred to the car on which he was being carried, through the alleged negligence of the defendants' servant, the driver of the car. On Jan. 12, 1903, the plaintiff issued a writ claiming damages for the injuries which he had sustained through the negligence of the defendants' servant. The defendants contended that they, in carrying on the working of the tramcars, were protected by the provisions of the Public Authorities Protection Act, 1893, and that inasmuch as the plaintiff had not commenced proceedings within six months of the negligent act complained of, the action was barred by the limitation provided by Section 1 (*a*) of that statute. The question for the Court was whether or not the defendants' contention was in law a good defence to the action.

**Mr. Justice Channell**, in giving judgment, said he had come to the conclusion that the matter was concluded by authority, and that he must give judgment for the defendants. The question which arose was whether or not the accident was one to which the Public Authorities Protection Act applied. The case before Mr. Justice Kekewich, the Attorney-General *v.* Margate Pier and Harbour Company, showed that the tramway company from whom the defendants had purchased the undertaking would not have been protected by the statute under similar circumstances, since they were a commercial company, and although they would have been acting under statutory powers they were not, in carrying passengers, executing a statutory duty. The present case was different, inasmuch as the company carrying on the enterprise was a municipal body. It was a general principle, when anything had to be paid for out of the rates, that the ratepayers must bear their own burdens, and must not leave such things unpaid so that they would have to be paid for at some future time by other ratepayers. That might have been the reason why the protection was given to public authorities by the Legislature. However that might have been, he did not rest his decision on that. He had to decide what was the effect of the words which the Legislature had used. The complaint against the defendants was that of negligence in working the trams. If the matter had been open to him, he would have been inclined to say that on the true construction of the section the defendants would have been protected from the consequences of negligence in the course of the construction of the tramways, but that they would not be protected from the consequences of their servants' negligence in carrying on the work in relation to the working of the trams after the construction was completed. He thought there might be a good deal in such an argument, if the point was open for him to decide apart from authorities. The case, however, was covered by the authorities, and in particular by the case of "The Ydun." In that case a municipal corporation had become a harbour authority with powers to take tolls from ships entering the harbour. The harbourmaster was negligent. In an action to recover damages from the corporation for the consequences of that negligence it was held that the corporation in carrying on their duties in respect of the harbour were protected by the provisions of the Public Authorities Protection Act. It seemed to him that that case was an express decision on the question before him. He did not think that there was anything in the other case to which he had been referred to justify him not following that decision. He therefore gave judgment for the defendants on the point of law.

Judgment was entered for the defendants with the costs of the argument.

## DAMAGE TO GAS-MAINS.

Major Phillip Cardew, R.E., the arbitrator on the claim of the Chepstow Gas Company against the Chepstow Electric Light Company for compensation for damage to mains, has made his award for £36. 6s. 6d. and £44. 7s. 6d. costs in favour of the gas company, holding that the electric company did not give the required notice to sink trenches nor conform to the requirements for protection of gas-mains, etc., and that the electric lines and works were laid in too close promixity to the mains of the gas company, rendering access to the latter difficult and inconvenient in certain streets. He did not find that the trenches were, as alleged, filled in by the electric company in an unworkmanlike manner.

## NATIONAL ELECTRIC TRACTION COMPANY.

In the High Court, on the petition of W. G. Skipworth, a judgment creditor, for the winding-up of the above company, it was stated by counsel that the amount in question was £198. 11s. 6d. and costs were to be taxed. Application had been made to the company to pay, but there was no response.

His Lordship made a compulsory order.

# COMPANIES' MEETINGS AND REPORTS.

## CAMBRIDGE ELECTRICITY SUPPLY.

The report of the directors for the year ended Dec. 31 last states that the additional parliamentary powers referred to in last year's report have been obtained, and these enable the Company to supply electrical energy in the district immediately surrounding the borough. Mains have now been laid in several portions of this area, and a supply of electrical energy commenced. The directors having further considered the question of moving the generating station, have come to the conclusion that, having regard to all the difficulties and expense that this course would entail, it is impracticable. They are therefore taking steps to utilise the whole of the site of the existing works for electric generating purposes, and have also purchased some additional freehold property in Thompson's-lane, to which they intend to move the stores and workshops. These alterations and the additional machinery and mains that are now required to meet the increase in the Company's business necessitate further capital expenditure. The directors, therefore, propose to make a further call of £1 per share payable on March 31 next, and to create £30,000 of 4½ per cent. debentures, a portion of which will be offered to the shareholders during the present year. During the year 1903 there had been added to the Company's mains the equivalent of 5 482 8-c.p. lamps, making the total 44,038. The number of units supplied has been 471,510, an increase of over 40,000 units. The Company after paying all charges, and placing £1,500 to depreciation fund account, has a balance of £6,267. 12s. 3d., which added to £688. 1s. 6d. brought forward from last year, makes £6,955. 13s. 9d. An interim dividend of 2½ per cent. (absorbing £1,782. 10s. 4d. and interest on loan (£323. 3s. 10d.) have already been paid, leaving a net balance of £4,849. 19s. 7d. Out of this the directors recommend the

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payment of a dividend of 4½ per cent., making 7 per cent. for the year. This will absorb £3,507. 11s. 8d., leaving a balance to carry forward subject to a fractional adjustment of income tax of £1,342. 7s. 11d.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 2,856 | 13 | 5 |
| Distribution of electricity | 185 | 18 | 3 |
| Rents, rates, and taxes | 597 | 15 | 8 |
| Management expenses | 860 | 19 | 5 |
| Law charges | 2 | 2 | 0 |
| Depreciation in works, plant, etc. | 1,500 | 0 | 0 |
| Special charges—insurances, etc. | 67 | 17 | 9 |
| Total expenditure | 6,071 | 6 | 6 |
| Balance carried to net revenue account | 6,137 | 17 | 2 |
| | £12,209 | 3 | 8 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of energy | 11,620 | 11 | 4 |
| Public lighting | 23 | 0 | 4 |
| Rental of meters | 428 | 2 | 8 |
| Transfer fees | 2 | 12 | 6 |
| Cash discounts and sundry receipts | 134 | 16 | 10 |
| | £12,209 | 3 | 8 |

Abstract of General Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 75,384 | 0 | 0 |
| Sundry creditors | 467 | 18 | 0 |
| Net revenue account, less interim dividend | 4,849 | 19 | 7 |
| Depreciation fund account | 3,769 | 10 | 6 |
| Workmen's deferred pay | 554 | 0 | 10 |
| Amount owing to bankers | 12,793 | 5 | 4 |
| Unpresented cheques | 6 | 6 | 2 |
| | £97,825 | 0 | 5 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended on works | 86 281 | 16 | 8 |
| Stores on hand | 1.001 | 1 | 0 |
| Stores on capital account | 4 505 | 11 | 2 |
| Sundry debtors | 5,807 | 18 | 11 |
| Cash in hand | 2 | 12 | 11 |
| Installation work in progress | 113 | 2 | 0 |
| Cost of changing consumers' installations to 200 volts | 106 | 17 | 9 |
| | £97,825 | 0 | 5 |

## NORTHWICH ELECTRIC SUPPLY.

The report of the directors for year ending Dec. 31 last states that the result of the year's working has been satisfactory, the Company being now on a firmer basis than heretofore. A statistical table shows that whereas there were only 10 consumers in 1897, and 88 in 1898 (with 3 885 8-c.p. lamps), last year there were 351 consumers, with the equivalent of 16,678 8-c.p. lamps. These are the highest figures yet reached, the number of consumers at the end of 1902 being 325, with 13,896 lamps. The table includes the use of motors, which now aggregate 203·5 h.p., equivalent to 5.825 8-c.p. The gross revenue from current supplied shows an increase of £116. 18s. 3d., and from other sources a decrease of £6. 10s., this decrease being due to meter and cable rents having been reduced leaving a total increase of £110. 8s. 3d. over the previous year. On the other hand, the expenses, including legal expenses, debenture, and interest charges, show an increase of £107 0s. 11d. Steady progress has been made both in lighting and power supply, there being an increase of 4,857 units sold for lighting and 10,087 units for power purposes. With regard to capital expenditure, the directors consider it will be necessary to raise a further £5,000 in order to consolidate the accounts. After writing £30 from preliminary expenses and £43 off free wiring account, and adding £400 to the depreciation fund, the net profit for the year is £560. 9s. 7d.; adding to this sum £31. 12s. 5d., the amount carried forward last year, there is a total available for distribution of £592. 2s. The directors recommend the payment of a dividend of 3 per cent., payable on March 9, which would absorb £514. 2s. 11d., and the carrying forward of £77. 19s. 1d.

## CARLISLE ELECTRIC TRAMWAYS.

The annual report of the directors shows a surplus of £3,112 on the revenue account, the total receipts having been £10,278 and the expenses £7,166. The balance of profit and loss account, after providing for debenture stock interest and debenture stock trustees' remuneration, was £2,041. Of this, the directors propose to carry forward £500 to the fund to meet depreciation, raising that fund to £2 533; and to carry forward £341, leaving £1,200 to be paid in dividend at 2 per cent. per annum. The car miles run during the year had been 334.393, an increase of 14,264. The number of passengers carried was 2.805,277, an increase of 588 694. The increase in the receipt was £879, but the working expenses were £805 more than last year. The ½d. stages introduced last year had proved financially satisfactory, and had been extended to the whole system.

## METROPOLITAN ELECTRIC TRAMWAYS.

The ordinary general meeting of the shareholders in this Company was held on Wednesday at Salisbury House, Mr. E. Garcke presiding.

**The Chairman**, in moving the adoption of the report, referred to the lines which had been purchased from the North Metropolitan Tramways Company—8½ miles in all—for which they had paid £50,000 in cash, and they had taken over the £150 000 of debentures of the North Metropolitan Company. A balance of £10,000 was still due to that company. The debentures carried 3½ per cent, and were redeemable in 1909. All these tramways were under reconstruction for electric traction at the cost of this Company, and about six miles had already been reconstructed. On proceeding to reconstruct and to equip electrically the mile of line within the area of the London County Council, they were opposed by that body, and the matter was now before the Courts. The County Council could not obtain possession of this line until 1910. The Company held about 78,000 of the 110 000 shares in the North Metropolitan Company, and the Board felt quite comfortable about this investment. The Company now held practically two-thirds of the capital in the Harrow-road and Paddington Company, which owned 2¾ miles of tramways operated by horse traction, but which were to be electrified. With reference to the light railways which were to be leased by the Company from the County Councils of Middlesex and Hertfordshire, about 50 miles of these railways had been applied for by those bodies, and 37½ miles had already been sanctioned, the remainder being in outlying districts, and not pressing for immediate construction. Of the 37½ miles 11½ were being constructed by the Middlesex Council, which had to provide the capital for building the lines, this Company finding the capital for the electrical equipment. Of the 11½ miles nine were practically already completed, situated in the Edgware-road, the Great North-road, and in Lordship-lane, between Wood Green and Tottenham It was, therefore, hoped that the Company would be operating in the course of the ensuing summer about 20 miles of tramways and light railways by the overhead system of electric traction. They had to share the surplus profits on the light railways with the two County Councils. In the case of the lines in Middlesex the Company and the Council would each receive 4½ per cent. on their capital, and the surplus profits, after paying all expenses, were to be divided as to 45 per cent. to the Council and 55 per cent. to the Company. In the case of the light railways in Hertfordshire, the Council and the Company would receive 4 per cent. and 6 per cent. respectively on their capital, and, after paying all expenses, the surplus would be divided as to 41 per cent. to the Council and 60 per cent. to the Company. The tenure of the light railways was until 1930 in Middlesex, and in Hertfordshire the period was for 42 years from the date of the confirmation of the orders. With regard to their important investment in the North Metropolitan Electric Power Supply Company, they had made an agreement with the Middlesex Council by which the latter approved of the Company's obtaining from the Power Company the current required for working the light railways. The price fixed was one which was calculated to leave a fair return on the capital invested in the plant and undertaking of the Power Company, all the shares in which were held by this Company. Two Acts of Parliament had been obtained by the Power Company giving them the right in perpetuity to supply electricity in bulk within an area of about 325 square miles in Middlesex, Hertfordshire, and Essex. The directors were at present in negotiation with the Hertfordshire County Council respecting an agreement enabling the Company to take power for the light railways in Hertfordshire from the Power Company. During the past year the latter had been engaged in erecting a very extensive power-house at Brimsdown, near Enfield; it would have an immediate capacity of about 3,000 kw., and it would be capable of further extension to about 6 000 kw. or 7,000 kw. The Power Company had made an important agreement with the Willesden Council, whose power-house they had purchased. But for this purchase the Power Company would have had to put up another power-house in that district. They had to supply the Willesden authority with electricity in bulk to enable the latter to provide the electric light in their locality, and the Company could also utilise the power-house for the purpose of their tramways and light railways in that district, and for supplying electricity in bulk to other local authorities or companies who might desire to purchase it instead of generating it themselves. The price to be paid to the Willesden Council for this purchase was £72,034, payable by half yearly instalments of £2,000 extending over about 24 years, but the Council had the right to require payment in one sum on giving six months' notice. In that case, however, no interest, of course, would be paid beyond what had accrued. The Power Company were carrying on important negotiations for the further supply of electricity in bulk to certain local authorities.

**Sir E. Spencer, M.P.**, seconded the motion, which was carried.

## NATIONAL TELEPHONE.

The half-yearly meeting of the shareholders in this Company was held last week at Hamilton House. Sir Henry Fowler, M.P., presiding.

In moving the adoption of the report (which appeared in our last issue), the **Chairman** said he thought that the results of the past six months' working would be considered satisfactory. The chairmen of most of the railway companies and large manufacturing undertakings had recently called attention to the rapid growth in the rates. He quite agreed with railway chairmen and others in thinking that this was a case where taxation and representation should go together. He believed that the railway companies last year contributed to the local rates more than £3,000,000, and yet they had no representation on the local boards. The rates which this Company were called upon to pay were increasing year after year, and he contended that they had the right to at all events the same representation as a £10 householder got in his locality. Complaints were sometimes heard of the delay which took place in executing orders for telephonic connection. There were two reasons why the orders could not be carried out with the same dispatch as when one asked for a pound of sugar or some other article. In the first place, every new order meant the expenditure of extra capital; and, secondly, there was the constant difficulty with regard to wayleaves. At this time 12 months ago the total number of

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unexecuted orders was 8,315, against 10,553 at the present moment. These figures showed that their business was not a dwindling one. On the contrary, the growth of the Post Office telephone service had been accompanied by an increase in the Company's business instead of a decrease. He then referred to the provision of capital for meeting the growing demand on the Company's resources. It was clear that if London was to be supplied with anything like an adequate telephone service, both the Post Office—with whom they were working in harmony—and themselves must face the question of further capital expenditure, and this remark applied also to the Company's business in all the other large towns of the country. The Board, in connection with their consideration of the subject of the development of the Company's business, sent the general manager (Mr. Gaine) and the engineer-in-chief (Mr. Gill) to the United States during the Christmas holidays to examine into the condition of the telephone system there and acquaint themselves with the latest improvements and inventions. In the memorandum on his visit to that country prepared by Mr. Gaine, a comparison was made between the telephone service in a number of the principal cities in the United States and similar cities at home. Comparing London and New York, Mr. Gaine wrote: "The telephone area of London covers 640 square miles and has a population of about 6 500,000. Greater New York (which includes New York City, Brooklyn, Jersey City, Newark, Long Island, and suburban districts) covers an area of about 400 square miles with a population of 4,000,000. In London the Company has about 65,000 lines, while the Postmaster-General recently stated that the Post Office had 15,000, making together 80,000; in Greater New York the number is upwards of 200,000. In Manhattan Island alone, which constituted the centre of New York, and which had an area of about 21 square miles and was about equivalent to the area covered by the City, Westminster, and Kensington, there are upwards of 110 000 lines at work. The New York service is not a cheap service. The charges are at least three times more than those which are now in operation in London, but notwithstanding the high prices charged, the New York service is popular, and it fulfils the public requirements." Mr. Gaine also gave particulars of the larger number of lines working in proportion to the population in Philadelphia, Washington, and Boston as compared with those in Liverpool, Edinburgh, and Manchester. The unlimited service rate in Boston was £32 per annum, and in Philadelphia the scale commenced with £14 for 800 calls and rose to £30 for 3,000 calls, whereas in Liverpool and Manchester this Company gave unlimited service for £10 per annum. Mr. Gaine added that he felt satisfied that if the Company were in a position to canvass freely and develop their business properly, the number of users in this country could be more than doubled in a comparatively short time. He was of opinion that provision would have to be made for the expenditure on the telephone system of this country of upwards of £10,000,000 of new capital within the next few years

**Mr. George Franklin** seconded the motion.

A short discussion followed, in the course of which **Mr. Lea-Smith** commented on the poor results shown by the Post Office telephone service in its first year's working. There was a loss, after making allowance for the payment of interest and deducting other charges, of £54 700.

The **Chairman** remarked that the report dealing with the Post Office telephone system was well worth studying. It showed what a wide divergence there often was between actual facts and the sanguine statements which were made as to the cost of providing a great public service.

The motion was adopted.

## BRITISH ELECTRIC TRANSFORMER.

The first ordinary general meeting of the shareholders was held at Salisbury House, Mr. E. Phillips presiding.

At the outset, the **Rev. C. Black** moved an adjournment until after the extraordinary general meeting, of which notice had been given, had been held, and till the two proposed new directors, if elected, had had an opportunity of considering and approving the accounts in company with the existing members of the Board.

The **Chairman** replied that the motion was not acceptable to himself and colleagues, and he proposed to proceed with the ordinary business.

**Mr. Petersen** protested against an outside solicitor being called in, and said that the proper solicitors to be present were those whose names appeared on the prospectus, Messrs. Faithfull and Owen.

A discussion ensued, in the course of which it was moved and seconded that Messrs. Faithfull and Owen should be sent for. On a show of hands being taken this was carried, but the Chairman refused to act on it.

The **Chairman** then dealt with the accounts, which were given in our last issue. He next explained the differences which had arisen between the directors, and said that the majority felt it necessary to take steps for removing Mr. Bain from the office of chairman. Since Oct. 19 last Mr. Bain and Mr. Petersen had impeded the efforts of the other directors in every way. The crux of the position was whether the shareholders would support Mr. Bain or Mr. Berry. The latter was the Company's technical adviser, and it was by his ability that they had been able to keep abreast of the times. No good purpose could be served by having two new directors to examine the accounts. The accounts had been properly audited and a clean certificate was attached to them. He maintained that the object of Mr. Bain and his friends was to obtain control of the Company, whereas the sole object of the majority of the Board was to conduct the business for the benefit of the shareholders. He concluded by moving the adoption of the report, which was seconded by Mr. Berry.

**Mr. Petersen** said that there was no truth in the statement that Mr. Bain and himself were trying to obtain control of the Company. All they asked for was the election of two independent directors, who would be able to look into the position and give their support to which ever side they found to be in the right. **Mr. Bain** spoke in justification of his action as chairman of the Board, and eventually, on a show of hands, the report was adopted. A poll was demanded by Mr. Petersen, which resulted in the motion being confirmed.

An extraordinary general meeting was subsequently held, at which a resolution for the election of Mr. Kolle and Mr. Beevor, as additional directors, was submitted, and carried on a show of hands by a small majority. On a poll being taken, however, the resolution was defeated.

## NORTHAMPTON ELECTRIC LIGHT.

The annual meeting of the shareholders was held at Northampton on Thursday last week, Mr. F. H. Thornton presiding.

The report stated that the Company had shared to some extent in the depression prevailing throughout the town, and the income was temporarily affected by the reduction in the price of current, in regard to which the public were the first to benefit The mains had been largely extended with the especial object of opening up the important manufacturing and residential districts of St. James's End and Dallington. Steps had been taken to obtain a provisional order for extending the area of supply, which would include not only the added portions of the borough, but a number of surrounding parishes. The directors a few months since received an intimation from the Finance Committee of the Town Council that they were instructed to endeavour to reopen negotiations for the purchase of the Company's undertaking. The facilities for inspection and information required had been given, and in the event of matters proceeding further the directors would, in due course, communicate again with the shareholders. It was proposed to pay dividends on the 6 per cent. preference shares £120, and on the 5 per cent. preference shares £300 for the half-year (the first half-year having been already paid), also one year's dividend on the ordinary shares at 4½ per cent., amounting to £1,529. 11s., and to carry forward £209. 12s. 6d.

The **Chairman**, who moved the adoption of the report, said the directors were pleased to be able to lay before the shareholders such a satisfactory statement of accounts and report. Important alterations had been effected during the year, expensive and much more efficient boilers replacing the old ones. Another great feature of the work had been the laying of mains, more of which had been put down than ever before in one year. Something like four miles of mains had been laid in the Dallington direction alone. They hurried on with the work of laying the mains because there was a call for electric light in the district referred to, and because they wanted to get the mains over the new west bridge whilst it was being enlarged. He noticed that they had got 251 h.p. at work in motors, as against 150 in the previous year and the number of consumers increased from 580 to 704.

**Mr. W. Tomes** seconded the motion, which was carried.

An extraordinary meeting was held afterwards, when it was unanimously resolved that the capital of the Company should be increased to £100 000 by the creation of new "B" shares of £1 each.

The **Chairman** explained that during the ensuing year the chief expenditure would be the laying down of a new engine, at a cost of about £4,500.

## WESTMINSTER ELECTRIC SUPPLY.

The ordinary general meeting of the shareholders in this Corporation was held at the offices, Eccleston-place, Belgravia, on Wednesday, Lord Suffield presiding.

In moving the adoption of the report, the **Chairman** said that he was again able to congratulate the shareholders on the satisfactory progress of the Company's business, and on the fact that the directors were in the position to recommend the payment of an increased dividend. The equivalent of 59,153 lamps of 8 c.p. had been added to the circuits during the period under review, and applications continued to be received at a gratifying rate A feature of the past year's working had been the growing demand for current for trade purposes, such as motors, passenger lifts, builders' hoists, and the charging of batteries for motorcars, and this was a most promising field for the extension of the business, in addition to the ordinary demand for lighting, which also continued to increase. The rate of charge per unit fixed for the current to be taken from the Central Company this year showed a substantial saving as compared with the past 12 months, and, as the load increased at the station in St. John's Wood, the Board were advised that the cost would eventually be considerably reduced. In order to meet the growing demand for electric energy, they had acquired from the Duke of Westminster a long lease of an excellent site for an underground station in Mayfair, and in close proximity to the Company's generating station in Davies-street, for the purpose of transforming the current received from the Central Company's station. The work was proceeding satisfactorily, and the station would be ready for use in time for the heavy load of next winter. With regard to the public lighting in the city of Westminster, he stated that the Company were now supplying and maintaining 952 arc and 202 incandescent lamps.

**Mr. Boulnois, M.P.**, seconded the motion.

**Prof. Kennedy** stated that the amount of current sold for energy had largely increased during the past two years, and especially during the last 12 months. They had been charging a lower rate, which made its use worth the while of those who required power for lifts, builders, and other purposes throughout the Company's district. At the same time, it must not be forgotten that the city of Westminster was not an industrial part of London, and unless the nature of the buildings should be very much altered they could not expect to have so large a demand for power as those companies which served districts in which there were a great many factories.

The motion was adopted unanimously, and the proposed dividend at the rate of 14 per cent. per annum approved.

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## BROCKIE-PELL ARC LAMP.

The adjourned ordinary general meeting of the shareholders in this Company was held at 60, Worship-street, E.C., Sir Frederick Dixon-Hartland, M.P., presiding.

The **Chairman** said he was sorry that the report was not so good a one as on the last occasion, but the Company was not alone in that respect, as many of its competitors were in the same position. The cause of the failure to make any dividend was that it had not had so much work to do as in previous times. The directors had done their best to keep the work up to standard, and there was no denying the fact that falling off was not the fault of the Company. Three years ago there were only three or four tenderers for any contract, but now there were never less than 18 or 20, and in a great number of instances prices were actually less than the cost of manufacture. The reason why foreigners could compete was because of the tariff and protection they got in their own country. He thought there should be means of retaliation. Competition was the sole cause of the Company being unable to make a profit. He thought it would be advisable for the Company to have a managing director appointed to the Board who would give the whole of his time to the Company, and be responsible for the whole of the work being carried on in the most efficient way. The directors had before them the names of men and hoped to be able to appoint one shortly. He never pretended to be well up in the electrical portion of the business, but only attended to the monetary portion. He held 1,000 shares and had never parted with any of them. The directors had the interest of the Company at heart, and they would look carefully into any suggestions of a practical nature that were proposed.

After a lengthy discussion the amendment, that the meeting be adjourned and a committee appointed there and then, was lost, and the report and accounts were adopted.

A resolution was then proposed by the Chairman and carried to the effect that a committee of three shareholders, with power to add to their number, be appointed to confer with the directors as to the position of the Company. The directors undertook to call a meeting of shareholders for the purpose of deciding the individuals to constitute the committee.

## DUBLIN AND LUCAN ELECTRIC RAILWAY.

The half-yearly meeting of the proprietors of this railway was held at Dublin, Mr. Wm. Hill, J.P., presiding.

The **Chairman**, in moving the adoption of the report, said it would be seen that they had an increase in their receipts of £212. 12s. 5d., the passengers showing an increase of £184. 4s. 9d. and the goods an increase of £28. 4s. 3d. The increase in expenditure was £113. 3s. 9d., and £72 of this had been expended on repairing buildings and other damage caused by the gale in February last year, and which, they hoped, was exceptional. They had a saving in motive power of £80. A return was recently published as to the expenditure compared with receipts on Irish tramways. He would take the three principal cities—Dublin, Belfast, and Cork. In Dublin it was 57·5, in Cork 59·1, and Belfast, where the trams were still worked by horse haulage, it was 75·6. The percentage on the Dublin and Lucan line, which ran into the country, and not through populous towns, was 56·4, which ought to convince the shareholders that the management of the Company was satisfactory. The directors hoped they would after this six months reduce it still further to 50 per cent. There was a net available balance after providing for debenture interest of £1,426. Out of that they proposed to pay a dividend at the rate of 5 per cent. on the preference shares, absorbing £475, and to place £700 to the Dick and Co. account toward the payment of the electrical equipment debt.

**Mr. William F. Clarke** having seconded the motion, the report was adopted.

## DERBYSHIRE AND NOTTS ELECTRIC POWER.

A special general meeting of the promoters of the Derbyshire and Nottinghamshire Electric Power Company was held at Westminster for the purpose of considering a proposed parliamentary Bill to confer further powers upon the Company and for other purposes. The Bill, it was explained to the shareholders, had for its principal object certain alterations in the borrowing powers of the Company, and, further, it sought to enable the Company to carry out agreements with the local authorities in regard to working.

The necessary resolutions to give effect to these objects were passed.

## KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The ordinary general meeting of the shareholders in this Company was held last week at the offices, Brompton-road. Lieutenant-Colonel R. E. Crompton presided.

The report of the directors on the position of the undertaking at the end of the year 1903 showed that during the year the number of houses and shops connected with the system has increased from 2,889 on Dec. 31, 1902, to 3,210 on Dec. 31, 1903, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 249,870 to 280,133. The renewal account now stands at £50,430. 1s. 8d., being an increase of £6,285. 5s. 7d. over the amount of the account at the end of the previous year. After providing for the amount placed to renewal account, writing £3,000 off cost of purchase of Kensington Court Company, Limited, in the capital account, and after paying the dividends on the 6 per cent. first preference shares to June 30, 1903, on the 5 per cent. second preference shares to Sept. 30, 1903, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit af the net revenue account for the year 1903 is £17,773. 5s. 11d. Of the above sum £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £15,648. 5s 11d. a further dividend on the ordinary shares at the rate of 10 per cent. per annum, for the past half-year, and a bonus of 2 per cent. for the year, making with the interim dividend paid on Aug. 1, 12 per cent for the year. This will leave a balance of £8,298. 5s. 11d. to be carried forward.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 20 392 | 19 | 8 |
| Distribution of electricity | 4,752 | 5 | 8 |
| Rents, rates, and taxes | 5,515 | 17 | 4 |
| Management expenses | 4,688 | 3 | 1 |
| Law and parliamentary charges | 164 | 8 | 3 |
| Depreciation | 9,285 | 5 | 7 |
| Special charges, insurances, etc. | 409 | 8 | 11 |
| Total expenditure | 45 208 | 8 | 6 |
| Balance carried to net revenue account | 28,804 | 16 | 9 |
| | £74,013 | 5 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter, less rebates and bad debts | 70,178 | 1 | 4 |
| Sale of current for public lighting | 786 | 11 | 5 |
| Rental of meters and other apparatus | 2,138 | 15 | 0 |
| Rents receivable on freehold property and transfer fees | 909 | 17 | 6 |
| | £74,013 | 5 | 3 |

ABSTRACT OF GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 295,000 | 0 | 0 |
| Debenture interest accrued | 1,431 | 5 | 0 |
| Due to sundry tradesmen and others | 5,223 | 11 | 6 |
| Net revenue, less dividends paid | 17,773 | 5 | 11 |
| Renewal fund account | 50,430 | 1 | 8 |
| Depreciation fund account—leasehold property | 620 | 6 | 9 |
| | £370,478 | 10 | 10 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 341,611 | 17 | 3 |
| Stores on hand | 1,595 | 14 | 9 |
| Amount owing by consumers | 21,866 | 18 | 11 |
| Other debtors | 96 | 4 | 5 |
| Rates and insurances paid in advance | 1,476 | 14 | 11 |
| Cash at bankers and in hand | 3,831 | 0 | 7 |
| | £370,478 | 10 | 10 |

The **Chairman** referred with deep regret to the loss the Board had sustained through the death of Sir Frederick Bramwell. He then said there had been a satisfactory increase in the past year in the number of lamps supplied by the Company. The renewal fund was now upwards of 15 per cent. of the actual capital expenditure of the Company. The Board were able to declare a dividend of 10 per cent., and they advised the payment, in addition, of a bonus of 2 per cent., making 12 per cent. for the year. This method of distributing the profits had been adopted by the directors after careful consideration. From time to time as the Company had reduced the cost of production they had given back part of it to the consumers in the shape of reduced prices, but it was not possible or convenient to give such reductions yearly. In electric lighting and supply companies the profits and dividends depended upon two things—the increase of the gross income by adopting a system of price best adapted to meet the competition of gas and other illuminants, and the reduction of working expenses by paying continuous attention to each item and by keeping the plant in the best possible condition. The price charged by the Company compared favourably with that of any West-end company, and many of their consumers would get a still further reduction in the current year. The total working cost during the period under review had reached the lowest figure ever reached in London. Although they had spent on maintenance much larger sums than any of the other companies, their economies had been so great as to "beat" them in the total cost. He felt strongly about the iniquitous manner in which the Company were assessed for rating purposes. The assessment, as at present carried out, was in the nature of an income tax—based on the profits. The more the Company reduced their working expenses, the greater was the sum on which they were assessed and on which the rates were levied. As a consequence they now paid in the form of rates to the two metropolitan parishes in which the works were situated a sum equal to 60 per cent. of their coal bill, whereas two other companies in adjoining districts only paid two thirds of this amount. The question was entirely beyond the Board's control, but it was right that the shareholders should know what a large proportion of their receipts already went to the public authorities. He concluded by moving the adoption of the report.

**Mr. R. W. Wallace, K.C.**, seconded the motion, which was adopted.

## IMPERIAL TRAMWAYS.

The ordinary meeting of the shareholders in this Company was held on Saturday at Bristol, Mr. George White presiding.

The report of the directors for the year ended Dec. 31 stated that on the Middlesbrough, Stockton, and Thornaby Electric Tramways the gross receipts amounted to £49,963. 7s. 7d., and the number of passengers carried was 9,576,125, compared with totals of £49.254. 16s. 4d. and 9 367,027 in the preceding year. The net profit for the year is £16,353. 14s. 6d. A Bill is being promoted in the present session to authorise extensions of the system from Middlesbrough to Ormesby, South Bank, and Eston, and for doubling the existing

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lines in the neighbourhood of Stockton racecourse, which will afford additional facilities for the conduct of heavy traffics. The Bill will be submitted for the shareholders' approval at an extraordinary meeting following the ordinary meeting. The operations of the Corris Railway Company resulted in a dividend at the rate of 6 per cent. on the share capital, the whole of which is held by the Company. No variation has been made during the past year in the Company's investment in the London United Tramways (1901), Limited, which is represented by 41,500 5 per cent. cumulative preference shares of £10 each fully paid, and the net income derived for the year amounted to £19,712. 10s. This company continues to show satisfactory progress, and has just announced the usual dividend of 8 per cent. upon its ordinary capital It will be seen that the net revenue account for the year shows an available balance of £41,899. 6s. 1d., and after payment of interest on debenture stock for the whole year, and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £26,066. 13s. 4d., it is proposed to appropriate the balance as follows: dividend at 6 per cent. per annum on the preference capital (paid on Jan. 1 last), £5 725; final dividend at 10 per cent. per annum (making 9 per cent. for the year) on the ordinary capital (less income tax), £9,541. 13s. 4d.; and to carry forward to the next account £565. 19s. 5d. The reserve funds remain at the sum of £120 471. 14s. 7d.

The **Chairman**, in moving the adoption of the report, said they had another satisfactory year to report. They had been rather resting on their laurels, and benefiting from the position built up in previous years. He referred to the figures and to the dividend of 9 per cent. for the year. He hoped the shareholders would consider that dividend satisfactory, and he thought he might venture to promise that the current year's result would not be any worse. With their ample capital powers and resources, they were ready to look at any promising undertaking. With their position so thoroughly established, he thought they need not take undue risks; at the same time, the directors were sufficiently enterprising to be ready to engage in any business which their practical experience led them to feel sure would form profitable investments for their capital. With regard to the subsidiary companies, the Corris Railway showed the same dividend of 6 per cent, though the traffic receipts were less by a few hundred pounds, owing to the temporary closing of one of the slate quarries. The Middlesbrough line showed progress, and they were promoting a Bill for extension to Ormesby, South Bank, and Eston, and for doubling the existing lines in the neighbourhood of Stockton racecourse. The proposed doublings of lines and additional facilities in Middlesbrough had been dropped, owing to the attitude of the Corporation. The Imperial Company held £415 000 in preference shares in the London United Tramways, and he thought the shareholders were to be congratulated on the results of the year's working.

The motion was adopted.

## YORKSHIRE ELECTRIC POWER.

The ordinary meeting of the shareholders in this Company was held at Leeds, Mr. A. G. Lupton presiding.

The **Chairman**, in moving the adoption of the report, said that the directors had bought and paid for the site for their Thornhill station, while the parliamentary cost of obtaining their Act and of the issue of capital, amounting to £47,746, had also been paid. One or two items had still to be paid, and they estimated that the amount would altogether come to about £48 000. That was a very considerable sum, but it was much less than the maximum figure which appeared in their prospectus—viz., £55,000. The balance of cash in hand in December last, £17,585, had enabled the directors to delay making the next call on the shareholders, but the buildings at Thornhill were now really proceeding. In the next few months they would have to make a considerable payment for buildings and machinery, and further calls would have to be made to meet this. The wet weather had caused some difficulty to the contractors, and there had been some delay, but the work was proceeding, on the whole, to the satisfaction of their engineer. The whole of the foundations were laid, and the main framework of the engine-house was completed. The chimneys were above the level of the ground, and the framework of the boiler-house was being rapidly proceeded with. They had entered into negotiations with several of the local authorities in the neighbourhood, and he was glad to say that they had been met in a very friendly spirit. The local authorities appreciated that the scale of charges which the Company was able to put before them was a very advantageous one, and they understood that they and the consumers of power in their districts would be put in as advantageous a position as was enjoyed by consumers of electricity in large cities. He had every confidence from the negotiations they had already entered into that they would find the local authorities and the Company working in friendly alliance for the benefit of both sides. Some half dozen Bills had been lodged in the present session of Parliament, wherein local authorities were asking for powers to supply electricity outside their own areas. In such a supply they would be in direct competition with the Company, and the directors had felt that it was absolutely necessary to oppose them. Some of these authorities were asking for exceedingly extended powers, not only in their own district, but practically over the West Riding, if not the United Kingdom. He believed many of those clauses had been drafted and put into the Bills by parliamentary agents, probably without the knowledge and certainly without the thorough appreciation of the authorities concerned. Mr. Lupton emphasised the fact that the opposition of the Company was entirely confined to this point of supply outside their own areas. They had no objection whatever, and, indeed, they would wish to do all in their power to assist local authorities who desired to distribute within their own areas. It was only when they went outside their own districts that the directors felt they were trenching upon the powers of the Company, and ought to be opposed.

**Mr. E. A. Carelan** seconded the resolution, which was unanimously adopted without discussion.

## LONDON UNITED TRAMWAYS (1901).

The general meeting of the shareholders in this Company was held on Monday at the offices, High-road, Chiswick, Mr. Samuel White presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), said for some years the Company had been building up and developing the undertaking, and strenuous efforts were made to get the lines through the Thames Valley, Hampton, and Hampton Court constructed and in working order by Easter of last year, so that they might be in a position to take advantage of the ensuing summer's traffic On previous occasions the chairman and the directors had intimated that the traffic which they expected to obtain from this important part of the system would be, under suitable conditions, limited only by the capacity of the Company to handle it. Last season, however, the weather conditions were about as unpropitious as they could be for a business like theirs. All Mr. Robinson's arrangements were made for dealing with a very large traffic, and without expending a pound more in carrying on the business their gross and net traffic would certainly have been anything from £20 000 to £30,000 more than it was if the weather had only been normal. If they had obtained this additional revenue, the directors would have been able to establish a reserve fund as well as to pay the dividend of 8 per cent. per annum. In the circumstances the Board considered themselves well advised in not interfering with what they regarded as their normal dividend, holding that they could well afford to wait for another year to begin the reserve fund. The Act of Parliament which the Company obtained last year, although not of great importance in itself, would enable them to effect the conversion to double track of a number of inconvenient short lengths of single line. The new line from Uxbridge along Askew-road, Goldhawk-road, and Paddenswick-road to Hammersmith-broadway was approaching completion. It was only one mile in extent, but it would have very far-reaching effects on their undertaking, especially in association with the District Railway Company. When that company had electrified their system, and had reduced their fares to a level which would compete with the uniform fare on the Central London Railway, their Company would be able to serve the public in a far greater degree than they were at present doing by means of this small connecting line, and passengers from the western suburbs would have the alternative given to them of travelling to the City by the Company's northern lines and the Central London Railway, or by their southern lines and the District Railway.

**Mr. Charles A. Spofford** seconded the motion, which was carried unanimously.

An extraordinary general meeting was held subsequently to consider a resolution approving the Company's Bills—(1) for conferring further powers on them for constructing tramways and widening and altering roads and acquiring lands in Middlesex, Bucks, Surrey, and London; and (2) for empowering the Company to construct railways between certain of their existing and authorised tramways and the Hammersmith Station of the District Railway Company.

The **Chairman** stated, with reference to the first measure, that the scheme originally included tramways extending their northern Hounslow line through Colnbrook and Slough to Maidenhead, and the lower line from Hounslow on to the town of Staines. They had a line authorised connecting Brentford and Hanwell, and the proposed line was one to connect Brentford and Ealing. They also proposed a line across the new Kew Bridge, connecting up their Middlesex with their Surrey tramways. Their experience with the various local authorities, however, had been of such a nature that all these proposals had been withdrawn, with the exception of the line extending their Hounslow line from Baber Bridge to Staines. Exorbitant demands were made on them by most of the local authorities, especially those of Brentford, Ealing, Slough, and Buckingham. With regard to Brentford, the Company proposed to construct only a few yards in the district to connect with the lines across Kew Bridge, and on that the local authorities founded demands running into hundreds of thousands of pounds. Among other things, they wanted the Company to give them a widened thoroughfare through the centre of the town of Brentford at a cost, he believed, of about £400,000 or £500,000. In fact, the directors began to think themselves unfortunate in being connected with an undertaking in the neighbourhood of Hounslow Heath. Unfortunately, under the Standing Orders the consents of the local and the road authorities were essential before any such scheme could be proceeded with, and the authorities took advantage of this position. The directors would be greatly disappointed if as one result of the London Traffic Commission this Standing Order was not eliminated. Municipalities were not in the same position, although they sometimes found themselves, as in the case of the London County Council, "hoist with their own petard" when they proposed to construct lines in districts of their own subsidiary authorities. The directors wanted nothing more than that any scheme they promoted for the convenience of the public should be submitted to an impartial tribunal of either House of Parliament. That was the only place for the Brentford or any other district council to state their case, and Parliament could then decide as between them and the Company. The second Bill referred to in the resolution was for authorising two connections by means of what were practically tube railways. They proposed to form a connecting line from the Grove, adjoining Hammersmith-broadway, so that the tramway cars might be passed without changing passengers on the surface down to the lower level alongside the platform of the District Railway station at Hammersmith-broadway. Passengers would thus be able to change from the train to the tramcar by only a few paces of distance, and under cover the whole way. The other tube railway was on the south side of the Thames, and its effect would be that the Company would have a connection with the District Railway

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from their authorised Richmond and Barnes lines, from its terminus on the south side of Hammersmith Bridge, by a pair of large tunnels capable of carrying tramway cars with their passengers under the Thames into the District station at Hammersmith-broadway. The state of that Bill at present was that they had not been successful before the examiner in their contention on the Standing Orders question, but in due course the examiner would report to the Standing Orders Committee, and then the tussle between the Company and the London County Council had to be decided by that tribunal. Meantime, it was necessary that the shareholders should approve the Bills.

**Mr. J. Clifton Robinson** seconded the motion, which was carried unanimously.

Since the above meeting the Standing Orders Committee have refused to dispense with the compliance with the Standing Orders in the case of the Railways Bill, and it will not be allowed to proceed. In the case of the other Bill the committee have agreed to dispense with the Standing Orders provided that certain lines for which the necessary consents have not been obtained are struck out of the Bill. In a letter to the public Press Mr. Robinson states that, in consequence of the "extortionate nature of the demands" of the local authorities, the Company have felt compelled to abandon the whole of the proposals except as regards the continuation of the existing lines from Baber Bridge, Hounslow, to Staines. This means the abandonment of (1) the extension from Hounslow to Maidenhead; (2) the cross town line connecting Ealing with Brentford and Richmond; and (3) the line over Kew Bridge. He goes on: "In the proposals which they laid before Parliament the Company had well recognised their obligations towards the local and county authorities and the public in respect to street, road, and bridge widenings, as I think you will admit when I state that our proposed expenditure on public works of this character in respect to only 21½ route miles of extensions amounted to no less a sum than £217,932. . . . But our own offers were not regarded as sufficiently generous, for the demands made by the local authorities would require us to spend an additional sum of £642,630, making a total sum of £860,562 required to be expended on public works before we should be able to proceed to construct the additional 21½ miles of extensions to the Company's existing system." In regard to the Railways Bill, Mr. Robinson, referring to the opposition of the London County Council, says: "The allegations set forth came with ill grace from the London County Council, considering that body is itself promoting similar schemes with the object of connecting its own tramways at various points on both sides of the river by direct transit below the level of the street, connecting one system of surface tramways with another. The London County Council alleged that we should have promoted our tubes as ordinary street tramways; but it was evidently a case of Scylla and Charybdis, for it is notorious that, had the latter course been adopted, we should utterly have failed to obtained their assent. The position is, therefore, that the London County Council, alike as the existing tramway authority of London and as a competing promoter to the London United, can prevent any combination of the tramways with our allied tubes or underground railways, although intended to follow lines practically analogous to the London County Council's own proposals for the relief of the congested condition of the streets and the increased comfort of the travelling public. The outcome of the situation is, first, that we have a set-back of at least two years in the carrying out of a scheme, admirably conceived by Mr. Yerkes, to afford the greatest possible measure of convenience to millions of travellers passing between tram and train; and, secondly, that our heavy outlay on surveys, the preparation of parliamentary plans, etc., has been worse than wasted, by the action of a competing tramway authority whose policy has ever been inimical and obstructive to independent effort. This may, perhaps, be regarded as a culminating example of the burdens under which the London United, in common with other tramway companies, have groaned for many years past, and the question now arises whether so demoralising a condition of affairs should be allowed to continue, and whether the Royal Commission on London Traffic should not take occasion in both hands and determine upon the abrogation of the iniquitous Standing Order under which the London County Council is free to exercise its deadly power of veto."

## MORLEY ELECTRICAL ENGINEERING.

The annual meeting of shareholders in this Company was held at Bradford on Wednesday, Mr. Harry Fox presiding. Resolutions were passed declaring a 10 per cent. dividend, free of income tax. Mr. William M. Gray was reappointed auditor of the Company. The directors were congratulated on a very successful year's trading.

## NEW COMPANIES REGISTERED.

**Electroid, Limited.**—Capital, £60,000. Objects: to adopt an agreement between R. Abrey and E. E. Moody, for the acquisition of a secret process for the manufacture of a composition designated electroid, to manufacture and deal in the said composition, and to carry on any business incidental or auxiliary thereto. Registered office: 109, Victoria-street, S.W.

**"Relyante" Motor Works, Limited.**—Capital, £100. Object: to carry on the business of motor engineers, contractors, mechanical, electrical, engineers, contractors. Registered office: Blackhorse-lane Works, Walthamstow.

**W. J. Peckham, Limited.**—Capital, £10,000. Objects: to acquire and carry on the business by W. J. Peckham at 84, Osborn-road, Southsea, at 278-280, Commercial-road, Portsmouth, and at 5, Stoke-road, Gosport, of manufacturers and factors of and dealers in cycles, motorcars, electricians, etc.

**Bickle Engineering Company, Limited.**—Capital, £3,000. Objects: to acquire and carry on at the Great Western Docks, Plymouth, the Bickle Engineering Company, and to carry on the business of mechanical, marine, electrical and general engineers, etc. Registered office: 36, Bloomsbury-square, W.C.

**Applegarth and Ostlere, Limited (86,655).**—Capital, £4,000. Objects: to acquire and carry on the business of R. Applegarth and the Simplex Appliance Syndicate, London, as submarine, mechanical, and electrical engineers, etc. Registered office: 11, Queen Victoria-street, E.C.

**Dulverton Electric Lighting Company, Limited (86,671).**—Capital, £3,000. Objects: to adopt agreements with G. B. Fisher and with Messrs. Edwards and Armstrong, and to carry on at Dulverton or elsewhere in Somerset the business of an electric lighting company. Registered office: High-street, Dulverton, Somerset.

**Adams-Randall Telephone Patents Company, Limited, London, E.C.**—Lien has been registered Feb. 12 for £50 6 per cent debenture, part of £10,000; amount previously issued, £9,950. Trustee, F. Davies, 95, Finsbury-pavement, E.C. Charged on the property, patents, and leasehold premises.

**Concentric Condensers, Limited.**—Capital, £5,000. Objects: to adopt an agreement with F. W. Brackett, P. Pryce-Brown, and W. W. Crawford, and to carry on the business of dealers in condensing, cooling, and heating apparatus and fittings and machinery connected therewith, engineers, iron and brass founders, etc. Registered office: Hythe Bridge Ironworks, Colchester.

**Derbyshire and Nottinghamshire Electric Power Syndicate, Limited, London, E.C.**—A debenture has been registered for £15,000 and 5 per cent. interest, given in substitution for a security dated March 19, 1903, in favour of the Nottingham and Nottinghamshire Banking Company, Limited, to secure £9,000 and interest. Charged on the undertaking, property, and assets, including the uncalled capital.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Retz (Lower Austria).**—The Municipality require tenders for the installation, etc., of an electric light works. Tenders by March 20.

**Plasencia (Spain).**—The Municipality require tenders for installing and working an electric lighting undertaking concession. Tenders by March 28.

**Aberdeen.**—The Council have authorised the engineer to obtain tenders for the additional plant for the Ferryhill station. The estimate is about £20,000.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Wrexham.**—The Town Council invite tenders for stores, including various electrical fittings. Particulars from the Borough Electrical Engineer. Tenders by March 12.

**St. Annes-on-Sea.**—The Urban District Council invite tenders for a steam dynamo. Specifications from Mr. J. H. Clothier, Electricity Works. Tenders by noon on 27th inst. See advertisement in last issue.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for the year ending March 31, 1905. Tenders by 4 p.m. on March 2 to the Town Clerk. See advertisement in former issue.

**Salford.**—Tenders are invited for various electrical materials for 12 months. Specifications, etc., from the Electrical Engineer's Office, Frederick-road, Pendleton. Tenders by 29th inst. See advertisement in last issue.

**Manchester.**—The Tramways Committee invite tenders for general stores. Particulars of Mr. J. M. McElroy, general manager, 55, Piccadilly, Manchester. Tenders by 10 a.m. on March 7. See advertisement.

**Hackney.**—The Guardians invite tenders for providing and fixing electric light fittings. Specifications, etc., from Mr Frank R Coles, Clerk's Office, Sidney-road, Homerton, N.E. Tenders by March 9. See advertisement.

**Kilmarnock.**—The Corporation invite tenders for the various plant in connection with electric lighting and tramways. Specifications, etc., can be obtained from the Town Clerk. Tenders by 29th inst. See advertisement in last issue.

**Manchester.**—The Rivers Committee invite tenders for the supply of various articles for 12 months from April 1, including electrical goods. Specification from Secretary, Rivers Department, Town Hall. Tenders by 10 a.m. on 29th inst.

**Bermondsey.**—The Borough Council invite tenders for wiring building and supply and erection of fittings for installation of electric light at the generating station. Specifications can be obtained at the Town Hall. Tenders by March 1.

**Kirkcaldy.**—The Corporation invite tenders for the platelaying and permanent way inside the extension car-sheds. Specification, etc., from Mr. O. F Francis, Electricity Works, Victoria-road, Kirkcaldy. Tenders by noon on 27th inst.

**Gainsborough.**—The Urban District Council invite tenders for telephone instruments, fire alarms, and connecting overhead wires. Specification from Mr. R W. Fraser, electrical engineer to the Council. Tenders by March 16. See advertisement in last issue

**Aston Manor.**—The Corporation invite tenders for two water-tube boilers, superheater, and mechanical stoker. Specifications from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on March 14. See advertisement.

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**London, E.C.**—The Metropolitan Asylums Board invite tenders for installations of fire alarms and telephones at their asylum, Caterham, Surrey. Specifications etc, can be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on March 8.

**Blackburn.**—The Electricity Committee invite tenders for supply of various stores for the year ending March 25 1905. Specifications, etc from Mr. A S. Giles, Electricity Works, Jubilee-street, Blackburn. Tenders by Feb. 29. See advertisement in former issue.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Cape Town.**—Tenders are invited for arc lamps and accessories for the general lighting of the forthcoming exhibition. Specifications, etc., may be obtained from the Torque Electrical Engineering Company, 20 to 28, Dalling-road, Hammersmith. See advertisement in last issue.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Hornsey.**—The Town Council invite tenders for stores for electricity works, and cables and cable stores, etc, in connection with their electricity supply. Specifications, etc., on application to Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 4 p.m. on 29th inst.

**Swindon.**—The Corporation invite tenders for the supply and delivery of various stores during 12 months ending March 31, 1905 including ironmongery and electrical fittings and iron castings and lamps. Particulars can be obtained from Mr. H. J. Hamp, Town Hall, Swindon. Tenders by 12 noon on 27th inst.

**Coventry.**—The New General Traction Company, Limited, invite tenders for the construction of about three miles of new tramways and the reconstruction of 5¼ miles of tramways. Specifications, etc., may be obtained from Mr. I. E. Winslow, engineer, 30, Bishopsgate-street Within, E.C. Tenders to the Engineer by March 5, at 1 p.m.

**Ilford.**—The Urban District Council invite tenders for the supply of various stores required during year ending March 31, 1905, including electricity meters and demand indicators, arc lamp carbons, etc. Specifications, etc., from the Chief Electrical Engineer, Electricity Works, Ilford. Tenders by 4 p.m. on March 8. See advertisement.

**Greenock and Edinburgh.**—The May Oatway Fire Appliances, Limited, invite tenders for wiring the premises of Messrs. Fleming Reid and Co., Greenock, and the Lyceum and Theatre Royal, Edinburgh, for direct communication with the fire brigade. Particulars of Managing Director, 49, Queen-street, Glasgow. Tenders by March 2. See advertisement.

**Manchester Ship Canal.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection of 25 electric hoists and 10 electric fixed cranes for transit sheds. Specification, etc., can be obtained from Mr. W. H. Hunter, M.I.C.E., chief engineer, 41, Spring-gardens, Manchester. Tenders by March 1.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**Cambuslang (Scotland).**—The Lanark County Council invite tenders for providing and erecting engines, dynamos, switchboards, lamps, main and distributing cables, and other works necessary to provide a complete system of electrical supply within the lighting district. Specifications, etc., from Messrs. Hunter and Jack, 101, St. Vincent-street, Glasgow. Tenders by 10 a.m. on 29th inst.

**Stepney.**—The Electrical Committee invite tenders for the supply and erection of one 1,000-kw. steam-turbine-driven double-current generator; and four water-tube Babcock and Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump, and accessories. Specifications may be obtained at 27, Osborn-street, Whitechapel. Tenders by March 14. See advertisement.

**Shoreditch.**—The Council invite tenders for various articles and works during year from April 1 to March 31, 1905, including electric cables and sundries, gas pipe and fittings, and engineers' stores. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender may be obtained from Mr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, Old-street, E.C. Tenders by March 8.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Gerona (Spain).**—The Civil Government Office of the Province of Gerona or the Directorate-General of Posts and Telegraphs, Carretas No. 10 Madrid, will receive tenders for a concession to establish and work for a maximum of 20 years a system of telephones in the city of Figueras. The plan presented by Don Anastasio Magin Alcaniz y Giralt is to serve as a basis, and on equal terms the individual named has certain preferential rights.

**Wimbledon.**—The Urban District Council invite tenders for the supply of engine-room stores, cables, joint boxes and jointing material, transformers, meters, lubricating oils, and incandescent lamps and carbons to the electricity department during the year ending March 31 1905. Specifications may be obtained from the Chief Electrical Engineer, Electric Light Works, Durnford-road, Wimbledon. Tenders by March 18. See advertisement in last issue.

**Hydro-Electric Plant.**—The Marques de Sant Ilano has received sanction to construct the works necessary for the appropriation of three cubic metres per second of water from the River Manzanares for the use of the upper zone of Madrid and for industrial purposes, and of two cubic metres per second from the River Guadarrama for industrial purposes exclusively. Don Juan Bon y Alvares has obtained sanction to appropriate for industrial uses 25 cubic metres of water from the River Tajo, derived at the point called "Hoya de Botarque," in the district of Almonacid de Zorita, Guadalajara.

**Ilford.**—The Urban District Council invite tenders for the supply and erection of the following plant: one 1,000-kw. steam dynamo, comprising vertical engine coupled direct to multipolar dynamo; extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, motor-driven pumps, water-cooling tower, and pipework; water-purifying plant; pipework; feeder and pilot cables, feeder pillar, and joint-boxes. Specifications, etc., may be obtained from Mr. John W. Fenton, Town Hall, Ilford, Essex. Tenders by March 22. See advertisement.

## RESULTS OF TENDERS.

**Battersea.**—The Borough Council have accepted the tender of C. A. Parsons and Co., at £4,890, for a 1,750-kw. steam turbine dynamo.

**Durban.**—Messrs. Stothert and Pitt, Limited, Bath, have received an order from the Harbour Authorities for combined water cranes and tanks, and also a 20-ton electric travelling crane.

**Canvey Island Tramways.**—Messrs. Bruce Peebles and Co., Limited, 39, Victoria-street, S.W., have received the following contract: power-house equipment, five cars, motors and trucks, and overhead equipment, at £14,250.

**Northampton.**—The British Westinghouse Electric and Manufacturing Company, Limited, have placed an order with the Paterson Engineering Company, Limited, for a combined feed-water softener and grease eliminator for the tramway power station.

**Swindon.**—The Corporation have accepted the tender of Messrs. J. G. White and Co., 22A, College-hill, Cannon-street, London, at £4,164. 8s. 7d., for the supply, delivery, and erection of steel poles, overhead line section boxes, arc lamps, and accessories.

**London, S.E.**—The Highways Committee of the London County Council have recommended for acceptance the tender of Messrs. Ransomes and Rapier, Limited, London, at £805, for the supply, delivery, and erection of the seven railway turntables required for use in connection with the Greenwich electricity generating station.

**Wiring.**—The May-Oatway Fire Appliances, Limited, have accepted tenders for wiring installations for direct connection with the fire brigades at Glasgow, as follows: Messrs. Carrick and Topping, for Messrs. J. and B. Stevenson's bakeries: Messrs. Raeburn and Duncan, for Messrs. Gilmour, Thompson, and Co.'s warehouses.

**Chester.**—The following tenders have been accepted: J. Wright and Co., 124, Victoria-street, Westminster, Berryman feed-water heater, £61. 5s.; Babcock and Wilcox, 30, Farringdon-street, E.C., two superheaters to two boilers, £180; Electrical Power Storage Company, testing battery, £9. 18s. The Council have decided to obtain two additional transformer magnet coils from Thomas Parker and Co., Limited, for £29.

**London.**—The London County Council have received the following tenders for the necessary wiring and fittings in connection with the new fire stations at Deptford and Old Kent-road:

Deptford station.

| | | | |
|---|---|---|---|
| F. Hodgson and Co., 24, Queen Victoria-street* | £185 | 17 | 0 |
| Alliance Electrical Company, Limited, 137, Regent-street | 198 | 7 | 0 |
| A. H. Marshall and Co., 270, High-road, Leytonstone | 210 | 0 | 0 |
| Duncan, Watson, and Co., 100, Charing Cross-road | 226 | 0 | 0 |
| L. Sunderland and Co., 39, Victoria-street | 238 | 0 | 0 |
| F. J. Coleby and Co., 7, Thayer-street, Manchester-square | 238 | 10 | 0 |
| Oliver, Clarke, and Co., St. Mark's-road, North Kensington | 240 | 0 | 0 |
| Tyler and Duncan, 20, New Bridge-street | 240 | 0 | 0 |
| W. H. Johnson, 200, Upper Kennington-lane | 251 | 19 | 0 |
| Drake and Gorham, Limited, 66, Victoria-street | 254 | 10 | 0 |
| Laing, Wharton, and Cunnington, 93, St. Martin's-lane | 261 | 9 | 0 |
| Barlow and Young, 8, London-street | 280 | 0 | 0 |
| National Electric Construction Company, Limited, 34, Victoria-street | 293 | 19 | 6 |

Old Kent-road station.

| | | | |
|---|---|---|---|
| F. Hodgson and Co., 24 Queen Victoria-street* | 157 | 0 | 0 |
| Alliance Electrical Company, Limited, 137, Regent-street | 180 | 15 | 0 |
| Duncan, Watson, and Co., 100, Charing Cross-road | 202 | 0 | 0 |
| A. H. Marshall and Co., 270, High-road, Leytonstone | 206 | 0 | 0 |
| W. H. Johnson, 200, Upper Kennington-lane | 210 | 17 | 0 |
| L. Sunderland and Co., 39, Victoria-street | 223 | 0 | 0 |
| Tyler and Duncan, 20, New Bridge-street | 225 | 0 | 0 |
| F. J. Coleby and Co., 7, Thayer-street, Manchester-square | 227 | 0 | 0 |
| Oliver, Clarke, and Co., St. Mark's-road, North Kensington | 239 | 0 | 0 |
| Laing, Wharton, and Cunnington, 93, St. Martin's-lane | 240 | 9 | 0 |
| Drake and Gorham, Limited, 66, Victoria-street | 241 | 10 | 0 |
| Barlow and Young, 8, London-street | 260 | 0 | 0 |
| National Electric Construction Company, Limited, 34, Victoria-street | 278 | 2 | 6 |

* Recommended for acceptance.

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**Erith.**—The Urban District Council have accepted the following tenders: boilers, etc, Yates and Thom, Blackburn, £2,285; pipework, Sir Hiram Maxim Electrical Engineering Company, Limited, Westminster, S.W., £805; condenser plant, Blake and Knowles Steam Pump Works, 179, Queen Victoria-street, E.C, £472; steam alternator (Westinghouse-Belliss combination), British Westinghouse Electric and Manufacturing Company, Limited, Trafford Park, Manchester, £3,240; switchboard extension, General Electric Company, Limited, Witton, Birmingham, £440.

**London, S.E.**—The London County Council have received the following tenders for the supply of five additional fuel economisers required for the Greenwich electricity generating station:

| | | | |
|---|---|---|---|
| J. Carter and Sons, Stalybridge (not to specification) | £2,518 | 8 | 6 |
| A. Lowcock, Limited, Shrewsbury | 3,060 | 8 | 0 |
| E. Green and Son, Limited, Wakefield* | 3,071 | 6 | 0 |
| Clay Cross Company, Chesterfield | 3,150 | 15 | 6 |
| Goodbrand and Co., Stalybridge | 3,164 | 13 | 11 |

* Recommended for acceptance.

**London, S.W.**—The Westminster City Council have received the following tenders for the electric light extension at the Marshall-street Baths and Wash-houses:

| | | | |
|---|---|---|---|
| Tamplin and Co. | £405 | 0 | 0 |
| Rider and Co. | 359 | 7 | 0 |
| District Electric Company | 269 | 0 | 0 |
| Jackson Bros. | 265 | 0 | 0 |
| Taylor and Co. | 263 | 0 | 0 |
| Bakewell and Co. | 258 | 11 | 0 |
| Bromley and Co. | 236 | 3 | 0 |
| Potter and Sons (accepted) | 178 | 0 | 0 |

**London, S.E.**—The London County Council have received the following tenders for the supply of the boiler feed pumps required for the Greenwich electricity generating station:

| | | | |
|---|---|---|---|
| J. C. Lyell and Co., London (incomplete) | £3,030 | 0 | 0 |
| Lowmoor Iron Company, Limited, Bradford | 3,410 | 4 | 0 |
| C. A. Musker, Limited, Liverpool | 3,545 | 0 | 0 |
| J. G. Moore, Hartlepool | 3,550 | 0 | 0 |
| J. Cochrane and Co., Glasgow* | 3,618 | 0 | 0 |
| Bever, Dorling, and Co., Limited, Bradford | 3,658 | 15 | 6 |
| Phœnix Dynamo Manufacturing Company, Limited, Bradford (three tenders) £3,710. 19s. 6d. to | 3,876 | 1 | 6 |
| Bruce Peebles and Co., Limited, Edinburgh | 3,751 | 0 | 0 |
| Campbell Gas-Engine Company, Limited, Halifax (two tenders) £3,751. 9s. 5d. and | 4,405 | 10 | 6 |
| Blake and Knowles Steam Pump Works, London (three tenders) £3,936 to | 5,171 | 10 | 0 |
| F. Pearn and Co., Limited, Manchester | 3,957 | 10 | 0 |
| Johnson and Phillips, London (four tenders) £3,977. 18s. to | 4,125 | 0 | 0 |
| Lancashire Dynamo and Motor Company, Limited, Manchester (four tenders) £4,157. 11s. to | 4,978 | 1 | 0 |
| Hunter and English, London | 4,174 | 15 | 0 |
| British Westinghouse Electric and Manufacturing Company, Limited, Manchester (seven tenders) £4,255. 18s. to | 5,792 | 6 | 0 |
| A. Bartclay, Sons, and Co., Limited, Kilmarnock (two tenders) £4,357 and | 4,488 | 8 | 0 |
| Pratchitt Bros., Carlisle | 4,380 | 19 | 0 |
| British Thomson-Houston Company, Rugby (two tenders) £4,453 and | 4,456 | 4 | 0 |
| Goodfellow Engineering Company, Limited, Manchester | 4,459 | 9 | 6 |
| Coalbrookdale Iron Company, Limited, Shropshire | 4,580 | 15 | 0 |
| Mirlees, Watson, and Co., Limited, Glasgow (two tenders) £4,634. 14s. and | 4,744 | 14 | 0 |
| à. Koppel, London | 5,018 | 7 | 0 |
| W. H. Bailey and Co., Limited, Salford (two tenders) £4,731. 10s. and | 4,887 | 0 | 0 |
| E. Scott, Mountain, and Co., Newcastle-on-Tyne (two tenders) £4,788. 14s. and | 5,088 | 14 | 0 |
| H. Berry and Co., Limited, Leeds | 5,022 | 0 | 0 |
| Worth, McKenzie, and Co, Limited, Stockton-on-Tees | 5,156 | 0 | 0 |
| Worthington Pump Company, Limited, London | 5,161 | 14 | 0 |
| R. W. Blackwell and Co., Limited, London (three tenders) £5,312. 2s. to | 5,470 | 0 | 0 |
| Rhodes Electrical Manufacturing Company, London | 6,580 | 2 | 0 |
| Crow, Harvey, and Co., Glasgow (two tenders) £6,680. 10s. and | 6,980 | 10 | 0 |
| Electrical Mining Company, Limited, Derby | 6,691 | 10 | 0 |
| Baker's Patent Appliances Company, Limited, Scarborough | 6,734 | 16 | 6 |
| Mather and Platt, Limited, Manchester | 8,483 | 10 | 0 |

* Recommended for acceptance.

**Additional Traffic Returns.**—Anglo-Argentine, £1,887 increase; Auckland Electric (12 months to Dec 31, 1903), receipts, £80,089; Barcelona Ensanche y Gracia, £73 increase; Barcelona, £173 increase; Brisbane, £82 decrease (month of January, £10,425, decrease £224)—total for 1903, £125,659, increase £1,302; British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £13 increase (month of January, £14,055, increase £962); Calcutta, £349 decrease; Cape Town (month of January), receipts £18,213, expenditure £8 305; Isle of Thanet Electric, £18 decrease; Lisbon Electric (month of November), receipts 91,526 milreis, expenses 62,069 milreis; Mexico Electric (month of January), receipts £45.400, expenses £29,000; Perth Electric, £125 increase (for the year 1903: receipts £62,097, expenses £34,871); Port Elizabeth (month of January), receipts £4,503, expenditure £3,032.

# BUSINESS NOTES.

## TRACTION.

**Southend.**—Five new bogie cars are to be ordered for the summer traffic.

**Bath.**—The Electric Tramway Committee propose to lay a line in Manvers-street and Pierpoint-street.

**Scarborough.**—A partial service of electric cars is expected to be put on the new tramways next month.

**Derby.**—A practical start has been made with the construction of the electric tramway system in the town.

**Lincoln.**—An enquiry was held yesterday into the application of the Town Council to borrow £11,500 for the purchase of the tramways undertaking.

**Twickenham.**—The District Council have sealed an agreement with the tramways company with reference to the proposed tramways in their district.

**Friern Barnet.**—The Urban District Council have consented to the extension of the time for the construction of the proposed light railways for two years.

**Wolverhampton.**—An order has been received from the Board of Trade sanctioning the borrowing of £16,514 by the Town Council for purposes of their tramways.

**Gloucester.**—Next month will see the inauguration of the electric service on one section of the tramways in the city, which are under reconstruction for electrical traction.

**Ashton.**—The agreement with the Manchester Corporation for the running of through cars to and from Ashton took practical effect on Monday, when the new service was commenced.

**Stoke Newington.**—The Borough Council are favourably inclined towards the proposal of the County Council to adopt the conduit system, but have not yet given their formal sanction.

**Broughty Ferry (Dundee).**—The Caledonian and North British Railway Companies have lodged a petition against the application for an order for the construction of the Broughty Ferry tramway.

**Blackpool.**—The Tramways Committee of the Blackpool Town Council have decided to adopt 1d. fares, commencing April 1. This applies only to the promenade section, where there will be three 1d. stages.

**Heaton Norris.**—The Board of Trade have sanctioned the borrowing by the District Council of £5,713, the purchase money for their portion of the tramway undertaking of the Manchester Carriage and Tramways Company.

**Perth.**—Messrs. Kincaid, Waller, Manville, and Dawson have presented their report to the Town Council, estimating the total cost of reconstructing the tramways at £46,000. An extension to Dunkeld-road is proposed at a cost of £4,500.

**Railways (Electrical Power) Act, 1903.**—The Board of Trade have now made rules pursuant to the Railways (Electrical Power) Act, 1903, with respect to applications for orders under that Act. The rules will be placed on sale as a Government publication.

**Sheffield.**—In acceding to the request of the tram conductors for meal hours, the Town Council have made a substantial and popular concession. Meal times are now to be allowed without any reduction of pay, and the men are to work 67 hours per week, less relief for meals.

**Heywood.**—On Wednesday the Town Council sealed the agreement between the Bury, Rochdale, and Oldham Tramways Company and the various local authorities for the transfer of the undertaking of the company and the carrying of it on until the completion of the purchase as arranged.

**Newport (Mon.).**—At a meeting of the Electricity and Tramways Committee on Tuesday specifications were considered for the new cars on the Stow-hill route, which will shortly be taken in hand. The cars will have many improvements, amongst which will be special brakes for negotiating the hill.

**Hull.**—Owing to increased working expenses the profit on the tramways during the past year has been £19,269, compared with £25,173 the previous 12 months. Thus the amount to be applied to the relief of the rates is only £11,500, against £14,500 the previous year. The actual figures will shortly be published.

**Bristol Tramway Employes.**—The whole of the employés of the Bristol Tramways and Carriage Company, Limited, numbering 1,531 men and boys, were last week entertained to supper at the Drill Hall, Queen's-road, by the directors of the company, to celebrate the inauguration of the pension fund scheme.

**North-Eastern Railway.**—Although the company abandoned the official electrical trials which were to have taken place on the Tynemouth lines on Sunday, a time table has been issued for a series of experimental trial runs which are to be made between Walker Gate and Tynemouth on the main branch between Newcastle and Tynemouth.

**Newcastle.**—A further extension of the tramways has been opened from the junction of Union-road and Shields road to a point about half a mile along Union-road, where the cars will terminate their journey meantime until the further extensions are ready. When completed they will give a direct connection between the city and Walker, *via* Union-road and Welbeck-road.

**Stoke-Newcastle.**—The new tramway from Stoke to Newcastle was examined and passed by an inspector of the Board of Trade on Tuesday. The line was accordingly opened for passenger traffic, and in future a regular service of electric cars will run between the two towns. The new line has long been anxiously looked forward to, and will without doubt prove a great convenience.

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**Auckland.**—The directors of the Auckland Electric Tramways Company report the traffic receipts for the 12 months ending Dec. 31 last to be £80,089. It is pointed out that during the first six months of this period only a portion of the company's lines was operated, and Sunday running has only been allowed with the city of Auckland since Oct. 4 last. The cabled traffic receipts for the 29 days ending Jan. 29, 1904, were £8,900.

**Kirkcaldy.**—The Town Council have for some time past been considerably divided over the question of the fares on the tramways, and at the last meeting a number of proposals were submitted, the dissatisfaction being increased owing to the halfpenny stages on the new route being shorter than on the old route. It was ultimately decided that a special meeting of Council in committee should be held to consider the whole matter.

**Thornaby.**—A special meeting of the Town Council has sealed an agreement with the Imperial Tramway Company, by which it is provided that the date of purchase of the undertaking shall be 21 years from Aug. 6, 1897; that the company shall pay the Corporation £200 per annum for each mile of route in the borough; and that the company shall bear the expense of widening the road between Thornaby and Erimus Bridge to a width of 50ft.

**Keighley.**—A special meeting of the Town Council is summoned for to-day to consider an important development of the Corporation tramway system. It is proposed by the Joint Tramways and Electricity Committees that the existing lines from Ingrow to Utley shall be changed to the overhead trolley system, and that the same shall apply to the new line from Cavendish-street to Stockbridge. Application is to be made to the Board of Trade for powers to borrow £42,790.

**Hove.**—The arbitrator appointed to determine the present value of the portions of the Brighton and Shoreham tramways in Hove and Portslade, which the local authorities have the right to purchase from the British Electric Traction Company under the company's recent Act, has fixed the same at the sum of £3,538 in the case of Hove and £1,134 in the case of Portslade, or a total of £4,762, and has awarded the company its costs in each case. The offers the local authorities made were £1,122 for the Hove portion and £462 for the Portslade portion, a total of £1,785.

**Chesterfield.** The engineer to the Corporation has prepared the estimates required by the Standing Orders of Parliament, showing in detail the cost of the proposed tramways and other improvements for which sanction is sought under their Bill of the present session. The total cost of the whole of these works is estimated at £127,642, of which the proposed tramways will require the expenditure of £95,021, and the proposed street improvements £23,641, while £8,980 is to be spent upon machinery, etc., for their electric lighting undertaking. Of the sum intended to be spent on the tramways is an item of £10,223 for 18 double-deck cars.

**Competition.**—Electric tram competition is being felt severely by the Great Western Railway in those suburbs served by the London United Tramways. One of the means by which the authorities at Paddington hope to counteract the scheme of cheap travel inaugurated by their formidable rival, is that of issuing books of 25 return tickets for the three classes at reduced rates. Presiding at the half yearly meeting of the London and North-Western Railway Company, the chairman, Lord Stalbridge, was able to assure the shareholders that the traffic was returning from the tramways to the railways, owing to the greater certainty of the latter.

**Stockport.**—At a meeting of the Tramways Committee, the borough treasurer submitted a statement showing the financial result of the year's working of the electric tramways. On the first year there was a deficiency of £800. Last year that deficiency was reduced to £563. On the present year's working the deficiency had entirely been cleared off, and in the borough treasurer's opinion there would be a small surplus after the capital charges due had been met. Nothing had so far been provided for depreciation. The members of the committee considered the statement satisfactory, inasmuch as it showed that the position of the tramways was improving.

**Edinburgh and Leith.**—A conference of representatives of the Edinburgh and Leith Town Councils has been held with the view of arriving at some amicable arrangement as to the form of traction to be adopted for the tramway route from St. Andrew-square to the foot of Leith-walk, thus abolishing the Pilrig difficulty and providing a through route. The conference lasted about an hour and a half, when it was intimated that, after an exchange of views on the subject, it had been decided to adjourn to a future date, and that in the interval the feeling in the matter of the lessees—the Edinburgh and District Tramways Company—should be ascertained.

**North London.**—At a meeting of the Holborn Borough Council on Wednesday, it was stated that the London County Council having applied for consent to the adoption of the conduit system of electrical traction, the Works and General Purposes Committee reported that on the ground of economy, efficiency in working, and the saving of enormous interruption of traffic and the business of the ratepayers in the borough, they were of opinion that the overhead or trolley system for the electrification of the tramways within the borough was far preferable to the conduit system. The matter was adjourned to the next meeting in order that the opinions of the inhabitants might be obtained.

**Chester.**—The Tramways Committee have instructed the city surveyor and electrical engineer in connection with the proposed tramways extension in Boughton to prepare a full report, with plans and estimates, and submit the same to the meeting of the committee to be held in April next, when the result of a year's working of the present system will have been ascertained, the plans providing for (1) a double line of rails from the junction with the existing tramways to the Fountain, Boughton, and (2) the completion of the main thoroughfare in Boughton; (3) side poles on one side of the road only, with long brackets for carrying the overhead wires; (4) avoiding centre poles wherever possible.

**Aldershot.**—An enquiry has been held at Aldershot by Colonel G. F. Boughey and Mr. H. Allan Steward, two of the Light Railway Commissioners, in reference to the proposed light railway between Aldershot Station and Farnborough. An order for the making of this line was granted in January, 1902, but no proposal had been made by the original promoters. Messrs. Greenwood and Batley have now acquired the order, and seek to run with it an electrical supply order. They asked for an extension of 12 months to purchase the necessary land and another year for making the line. The Commissioners said that they would issue a fresh order for approval, and would accept the precedent of the Colne and Trawden line as to the financing of the railway.

**Glasgow.**—An agreement has been concluded between the Corporation of Glasgow and the County Council of Renfrew and the Upper District Committee of the county with reference to the extension of the Glasgow tramway car system to Giffnock and Thornliebank. By this agreement the Glasgow Corporation, jointly with the burgh of Pollokshaws, is to pay half of the cost of rebuilding the bridges over the River Cart at Kilmarnock-road, and over the Auldhouse Burn at Thornliebank-road, the remaining half to be borne by the county authorities. Both structures are to be widened to 30ft. It is a condition of the agreement that the extension of the car system shall not be used as an argument for the annexation of the county area to the city.

**Leicester.**—The Tramways Committee have submitted to the Town Council an audited statement of accounts of the tramways undertaking for the year 1903, from which it appears that the gross profit on the revenue account is £9,149. 0s. 8d. The interest and sinking fund charges in respect of the old tramway undertaking, and additional capital for the electric tramway works (together with stamp duty on mortgages) amounts to £10,479. 5s. 7d., and there is consequently an adverse balance of £1,330. 4s. 1d., which the committee have determined to debit to the reserve fund, so that there need be no recourse to the rates to make up this deficiency. The committee are of opinion that, having regard to the considerable interruptions to tramway traffic necessitated by the new works, the result of the year's business as shown by the accounts is highly satisfactory.

**Belfast.**—Speaking at the half-yearly meeting of the Belfast Street Tramways Company, the Chairman said the Corporation had lodged their Bill for the purchase of their undertaking. That Bill provided for the Corporation taking compulsory possession of the company's undertaking on Jan. 1 next, instead of waiting for the expiration of the term of their agreement, under which they could not give notice to purchase until after Aug. 10, 1907. It was proposed by the Bill that an arbitration should determine the amount to be paid on Tramway Act terms, plus all allowance for the unexpired term. The company were opposing the Bill. They had retained counsel, and had that day affixed the seal of the company to the petition against the Bill. In these circumstances he did not think it desirable or in the interests of the company that they should discuss the matter that day.

**Halifax.**—Members of the Town Council have inspected the Skircoat tram depôt, which has been constructed at a total cost, including the site, of about £30,000. A suite of workshops, well equipped for their respective requirements, has been introduced, and accommodation has been provided for 120 cars, or 30 more than the Corporation at present possess. It was mentioned during the tour that, whilst everyone of the axles for the cars obtained from America had broken, not one of English manufacture in use had given way. After leaving the tram depôt the electricity station was visited, where a new engine and dynamo, which have involved an expenditure of £8,000, were started. Major Druitt, an inspector of the Board of Trade, visited Halifax on Wednesday, and made an inspection of the Corporation's new tramline from Hove Edge to Brighouse, as well as of short additional lines which have recently been constructed in the borough of Halifax. The inspection proved satisfactory, and the opening of the Brighouse extension for traffic will take place to-day.

**Swansea.**—At the last meeting of the Borough Council Mr. Sinclair, in moving the adoption of the minutes of the Tramways, etc., Committee, alluded to the recent decision in the Chancery Court (reported in last week's issue) with regard to the construction of the Act of Parliament respecting Swansea tramways. The construction placed on that Act of Parliament by the Corporation was that they would be able to acquire the tramways within a short space of time, but there was a doubt, and to remove that before 1906 the Corporation thought it wise to ask the decision of the Court upon the matter. As they were now aware, the decision of Mr. Justice Bucknill was distinctly against the construction placed on the Act by the Corporation, and it now appeared, according to the wording of the decision, that their power in regard to purchasing the tramways was placed in the remote future. He suggested going to Parliament and asking them to amend an Act which had been construed differently to what they intended. Mr. Justice Bucknill had described the Act of Parliament as one "which I agree is not very clear." The matter was allowed to drop.

**Foreign Rails.**—Sir Thomas Dewar had asked the President of the Board of Trade if he would state the number and value of contracts for rails and railway material placed by the London County Council with foreign makers during the last five years, and what percentage of these contracts were secured by German firms. In his reply Mr. Gerald Balfour says that particulars of this nature do not in the ordinary course come to the knowledge of the Board of Trade. He has, however, been supplied with a statement on behalf of the London County Council as follows: "The total value of all contracts let by the London County Council for tramway works is about £2,000,000, of which amount £150,000, or 7½ per cent. represents foreign work. The Council began by restricting the tenders for this work to British firms,

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but owing to the limited number of tenders and the high prices, it adopted open competition, and, as the result, all materials are now being obtained in this country and at much lower prices. Altogether the Council estimates that it has saved in rails alone about £40,000 by its policy of open competition. No contracts have been sent to Germany."

**Halesowen.** — A special meeting of the District Council has concluded agreements with the Empire Electric Lighting Company for the disposal of the electric lighting and light railway orders which have been presented to the Council. The terms are to the effect that the company undertake within six months of the signing of the agreement to construct an electric generating station within the district. They also undertake to light the public lamps in the district at the same price charged by the gas companies, and to provide all the necessary posts, lanterns, and fittings; further, to supply electricity for the lighting of the municipal buildings at the rate of 5d. per unit, and to private consumers at 7d. per unit. The company also agree to complete the tramways from Halesowen to Lye and to the Old Hill boundary within two years from the date of the signing of the agreement, and to complete the other lines contained in the order within six years, and to promote during the session of 1904 in Parliament a Bill for an extension order to Old Hill. The company further consent to return £1,385, being the amount expended by the Council upon the orders. Provision is made for the Council to purchase the electric lighting and tramway undertakings at the end of 21 years as going concerns.

**Bradford.**—The abstract of accounts of the Corporation, prepared by the city treasurer, for the year ended March 31, 1903, contain much matter of interest concerning the tramways undertaking. The total amount so far spent in the shape of capital upon the tramways has been £709,762. There has been written off for depreciation up to March 31 last the sum of £30,143. The income for the year ending on that date was £173 534. The working expenses were £117,496, leaving a profit of £56,038. Out of this there was paid on sinking fund and interest £36,189, leaving a net surplus of £19,849, which has been applied as follows: liquidation of adverse balance brought forward, £3,103; proportion of amount paid to tramway companies in respect of profits for unexpired period of leases, £9,000; and depreciation of plant, £7,746. The profit of this concern as a commercial undertaking on the capital borrowed, apart from sinking fund and interest, is about 7 per cent., although fares have been reduced and lines which do not pay have been opened for the benefit of the public. It must also be remembered that part of the money due to the old companies was paid by the Tramways Committee out of revenue, the amount so paid up to March 31 last having been £12,877: and that the equipment and plant of the department were fully maintained during the year, no less a sum than £31,000 having been spent upon renewals and maintenance out of revenue.

**London County Council.**—In consequence of the introduction of the electric service on the Council's line to Greenwich, the 2½d. stage from Bermondsey New-road to Greenwich (Devonshire-road) is to be extended to Greenwich Station, and two additional ½d. stages are to be established on this route. At a cost of £6,600 the Highways Committee propose to double the tramway in Goswell-road, and to use the conduit system in the reconstruction of the line. On the reception of the report of the committee at the meeting of the Council on Tuesday, Mr. Benn (chairman), in answer to questions, said that the receipts per car mile on the Council's electric tramways were 12·21d. More than that would be wanted to make up for the terribly bad year they had experienced from the loss of the omnibus service and other contingencies. The estimate was 1s. per car mile. The figures given by the President of the Board of Trade in the House of Commons on the previous evening in reference to the foreign contracts of the Council were based upon calculations made by the Council's engineers. The statement that £40,000 had been saved in the cost of tramrails alone by accepting foreign contracts was quite correct. The figure was arrived at by a calculation of the difference in the prime cost of rails when the first purchase was made by the Council and the last. The new tramway proposals which Parliament will be asked to sanction this session involve an expenditure of £1,729,845, including £657,300 for street widenings.

**Sunderland.**—An estimate of the tramways undertaking for the year ending March 31 next has been issued to the members of the Tramways Committee. It shows that the estimated income is £63,061, made up as follows: traffic receipts, £62,500; bank interest and rents, £304; interest on investment of reserve fund, £166. 19s. 6d.; and advertising on tickets, £90. 2s. 4d. For the previous year the total income was £59,930, of which £59,142 was for traffic receipts. The expenditure is as follows: electric power supply, £11 839; salaries of clerical staff and collectors, £727; motormen, £6,030; conductors, £5,100; inspectors, £930; point boys, £218; tickets and punches, £500; uniforms, £600; compensation for injuries, £200; cleaning cars, wages and material, £1,888. Rolling-stock: shed foremen, £305; handy men, painters, carpenters, £1,595; materials per stock and tradesmen, £500; oil, sand, and lighting, £270. Repairs: buildings, £40; overhead equipment, £394; instruments, £50; track, £458; cleaning way, £300. General charges: manager, £422. 18s. 4d.; engineer, £200; printing, stationery, and establishment charges, £575; rent of offices, etc., £350; rates and taxes, £1,600; license of cars, £48; insurance £100 15s. 1d.—total, £35,240. 13s. 5d. This gives a gross profit of £27,820. 8s. 5d., which is disposed of as follows: compensation reserve funds, £500; Channel Squadron and regatta funds, £111. 5s.; Electrical Association and St. John Ambulance Association, £83. 5s., interest, £8,670; depreciation and renewal fund, including sinking fund, £13,690—leaving a net profit of £4,765. 18s. 5d., against £5 000 in the previous year. Since the Corporation took over the tramways system the total of net profit, including the amount shown in this estimate, is £16,765. 8s. 5d.

## LIGHTING AND GENERAL.

**Honley.**—The Urban District Council are purchasing an oil economiser.

**Bangor.**—The City Council have decided to oppose the North Wales Electric Power and Traction Bill, 1904.

**Dunfermline.**—The Council have agreed to the site selected by the Fife Electric Power Company for a generating station.

**Frome.**—The Urban District Council have received sanction to borrow a further sum of £8,500 for the electric works.

**St. Austell.**—Messrs. Fribbert and Co., electricians, Westminster, have decided on a site for a station in which to erect electric lighting plant.

**Penrith.**—The Penrith Ratepayers' Association intend to oppose the electric lighting scheme for the town as proposed by the Urban Council.

**Lampeter.**—The Town Council are asking Prof. Ferrier, of the University, Bristol, to advise the Council as to installing electric light in the town.

**Fulham.**—The Borough Council have decided to take up a loan of £25,000 to meet the cost in connection with the electricity and dust destructor undertaking.

**Rotherham.**—An enquiry was held yesterday into an application of the Corporation for sanction to borrow over £14,000 for the purpose of extending the electric lighting department.

**Barton Regis.**—The Southern District Corporation have offered to supply electric light and to take all liability and risk, but the Council have decided to hold their hand at present.

**Wrexham.**—A uniform charge is to be made to private consumers for lighting current of 5d. per unit from Sept. 30 next. Current will be supplied to the infirmary at 3½d. per unit.

**Beckenham.**—The Urban District Council propose to borrow £10,000 for electric lighting purposes. An agreement with the National Telephone Company has been sealed.

**Aluminium.**—The British Aluminium Company have again found it necessary to increase the capacity of the Foyers works, by the erection of two more series of aluminium furnaces.

**Basingstoke.**—The Lighting Committee have resolved to proceed with the negotiations and completion of the draft contract with the National Electric Construction Company, Limited.

**Yacht-Lighting.**—The A.B.P. Accumulator Company, Limited, Stockton-on-Tees, inform us that they have just completed a second order for cells for Sir Thomas Lipton's yacht, "Erin."

**Falmouth.**—We understand that a final agreement has now been entered into between the Town Council and Messrs. Crompton and Co., including electric light and the refuse destructor.

**Dover.**—The units of electric light supplied for the Folkestone road lighting have increased from 3,743 in the corresponding quarter of last year to 4,757 in this. Extra lamps have been put on.

**Western Telegraph Co.**—The directors declare an interim dividend, payable on March 25, of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended Dec. 31 last.

**Stock Exchange.**—The Stock Exchange Committee have been asked to allow Edmundson's Electricity Corporation's further issue of £68,533 4½ per cent. first mortgage debenture stock (redeemable) to be quoted in the official list.

**Salisbury.**—The better lighting of the workhouse having become an urgent necessity, both the gas and electric lighting companies are being approached by the Guardians, who desire to ascertain the best and most economical method.

**Northwich Electric Supply Co.**—The directors recommend a dividend of 3 per cent., against nothing last year. There has been an increase of over 14,000 units of current sold for lighting and power. A further £5,000 capital is to be raised.

**Bolckow, Vaughan, and Co.**—The directors have decided to pay on March 8 next to ordinary shareholders registered on the books of the company on Feb. 23 an interim dividend for the half-year ended Dec. 31 last at the rate of 5 per cent. per annum.

**Newcastle.**—The Watch Committee of the Corporation have agreed to support the recommendation of the Education Council that the whole of the Council schools of the city, and other places relating to the same, be lighted with electricity from the power station.

**Dumfries.**—The Council have decided to submit the offers of Messrs. Crompton and Co. and of the India Rubber Company for their provisional order to Messrs. Buchan and Hogarth, electrical engineers Edinburgh, with a view to advising the Council in the selection.

**Brompton and Kensington Electric Lighting Co.**—This company have reduced the price of energy for lighting, which now varies from 5½d per unit under 500 units to 4d. under 5,000 units. The charge for power will remain at 3d., and discounts are to be abolished.

**Swansea Telephones.**—The Corporation Telephones Committee have asked the manager to prepare a detailed statement of capital and revenue account, and also estimates for extensions. This statement is to be verified by the borough accountant, and the amount of the projected loan be fixed upon the basis thus arrived at.

**Stirling.**—The last report by Mr. Hanson, electrical engineer, shows that for the four weeks ended Jan. 23 28,061 units of electricity had been generated at the power station, as compared with 25 393 for the same period of 1903. The total number of 8-c.p. lamps connected for all purposes was 12,861, as against 10,364 at the same period last year.

**Bath.**—The Town Council have adopted the reports submitted by the Electric Light Committee giving in detail the recommendations made by Mr. E. Manville as to incurring further heavy capital expendi-

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ture, and the reasons which guided the committee in declining to recommend such expenditure. A summary of the report appeared in our last issue.

**Tottenham.**—The Tottenham ratepayers have asked the Council, amongst other things, not to carry out their electrical scheme, because the Council were pledged to large commitments, and because of the doubtful financial success of the undertaking. They further suggested that no member of the Council should be connected with the transactions of such scheme.

**Edinburgh.**—Between Jan. 22 to Feb. 11 new applications have been received for electric current equivalent to 13,786 8 c.p. lamps, as compared with 3,850 in the corresponding period of 1903. Since the beginning of the department's year the applications have been equal to 88,246 of 8 c.p., an increase of almost 30,000 over the record for the same period a year ago.

**Pelton Engines.**—Mr. Percy Pitman, Borbury, Ledbury, Herefordshire, is taking advantage of the liberal allowance made by the Postmaster-General in the size of post cards, and has issued a card of gigantic proportions illustrating his special Pelton waterwheels and turbines, and the Kerfer water motor, for all the wearing parts of which phosphor-bronze and gunmetal are used.

**Ipswich.**—According to the last report, the present number of connections is 60, with an equivalent of 4,800 8-c.p. lamps wired. The total units generated for lighting up to Dec. 31 last was 10,861; the total units generated for traction was 65,005; the ratio of units sold to those generated has been 93·5 per cent. The total revenue upon this account to Dec 31 last was £690. 11s. 1d.

**New Cable Line.**—The Great Northern Telegraph Company, Limited, notify that the Kiakhta line is now opened for traffic, replacing the Vladivostok line, which is momentarily closed. The line *via* Kiakhta is the shortest (quickest) route to the Far East. The rates are the same as *via* Vladivostok—4s. 5d. to China, 4s. 10d. to Japan, etc. Telegrams should be marked *via* Kiakhta.

**City of London Electric Lighting Co.**—The directors have resolved to transfer £45 500 to reserve, and recommend a dividend on the ordinary shares of 5s. per share, making, with the interim dividend of 5s. per share paid in July, a total distribution of 10s. per share for the year ended Dec. 31, being at the rate of 5 per cent. per annum. A balance of about £22,000 is carried forward.

**House of Commons.**—Messrs. Matthews and Yates, Limited, of Swinton, Manchester, London, Leeds, Glasgow, etc., have been entrusted with the order for ventilation plant at the Houses of Parliament. We are informed that during the past two years or so Messrs. Matthews and Yates have supplied some 60 or 70 fans for the ventilation of committee rooms, division lobbies, lavatories, etc.

**Ham.**—The Edmundson Electricity Corporation have informed the District Council that the company cannot agree to the Council's request to reduce the maximum prices to private consumers to 6d. and 3d., with a flat rate of 5½. They would therefore have to ask the Board of Trade to deal with their applications as far as this district is concerned as an opposed application, and would ask the Board to dispense with the consent of the Council.

**Northampton Institute.**—To-night Lord Kelvin will distribute the prizes and certificates at the City Polytechnic, St. John's-street-road, Clerkenwell, E.C. The ceremony will be preceded by an organ recital by Dr. Davan Wetton. There will be displays at the gymnasium and the swimming-bath. The building will be thrown open to members and their friends on Saturday, when there will be a number of entertainments between 8 and 10 p.m.

**Gillingham.**—Additional mains are to be laid at a cost of £40 and £30 respectively. The resident engineer's last monthly statement for the electricity works shows that during the four weeks ending Jan. 30, 1904, 18,100 Board of Trade units had been generated, as compared with 11,445 units generated in the corresponding month last year. Some streets in Brompton are to be lighted, and the gas standards will be used as electric light standards.

**Durham.**—At the last meeting of the Weardale District Council a letter was read from the County Council asking for information with a view to adopting a county scheme of electrical supply. In the discussion which ensued it was pointed out that Weardale possessed a good water supply for generating purposes. The Wolsingham Steelworks are introducing electric power, and they might include in their scheme public lighting or private installations

**Devizes.**—The Corporation have discussed whether it was possible to lease their electric lighting powers instead of using them. The Council own the gasworks, and no addition has been made to them for 15 years, although the output has increased from 25 to 30 per cent. It is recognised that either the gasworks must be enlarged or £19,000 spent on an electric lighting installation. Notice has been given to rescind the motion that the Council use the powers themselves.

**Manchester.**—The British Westinghouse Electric and Manufacturing Company, Limited, of Trafford Park, have agreed to the insertion of the fair wages clause in their municipal contracts, to join the Employers' Federation, and to abide by the working terms mutually agreed upon by the federation and the representatives of the trade unions, in order to strangle criticism and avoid friction. It is stated that the fair contracts clause of the Manchester Corporation has been the main factor in bringing about this decision.

**Brighton.**—The resident engineer has reported on the scheme for changing over to the higher voltage the whole of the Brighton lighting area, that about one-half only of the area scheduled had been changed over. Owing to the rearrangement of the feeders which would be necessary in connection with the new switchboards for working in conjunction with the Southwick power scheme, it was essential that the remainder of the area should be changed over this spring. The estimated cost of effecting this will be approximately £4,000, which is to be borrowed.

**Dundee.**—A consulting engineer has just visited the West Station in connection with the proposed installation of the electric light. It is understood that a commencement with the work is not to be made until the success of the innovation at the Tay Bridge Station has been more thoroughly proved. A special committee of the Town Council has been appointed to consider the price of electricity supplied to large consumers and to bring up a recommendation as to what arrangements should be come to for the future in reference to the charges to consumers generally.

**Kingston-on-Thames.**—The Town Council have agreed to the building by the Electromobile Company of a motor garage at the electric works. The company guarantee £50 a year for current. The Lighting Committee have agreed to the Highway Committee's proposals in regard to the lighting of private roads in the borough, subject to the owners providing the lamps, and to the assessment being not less than £200 per lamp, each road to be dealt with on its merits as applications arose, the committee reserving liberty to reject any application. Arrangements have been completed for a supply of current to Kelly's Mill.

**Maidstone.**—The total amount of proposed lighting of the tramway is 14 arc lamps (one at terminus), one one-ampere Nernst lamp, 12 half-ampere Nernst lamps; total candle-power, 9,240; total cost per annum, £224; cost per candle-power per annum, 5·8d. The present lighting consists of 11 half-ampere Nernst lamps, 15 gas lamps, one large gas lamp; total candle-power, 1,380; total cost per annum, £100. 7s. 6d.; cost per candle-power per annum, 17d. The Town Council have resolved to wire small houses for electric light at a cost of from £2. 15s. to £3. 15s. each, and to charge the occupiers an extra ½d. per unit.

**Hampstead.**—The Borough Council have adopted a report of the Lighting Committee recommending that a main for the supply of electric current be laid in a portion of Glenmore-street, at a cost of £72; that a new sub-station be constructed in West-end-lane, by Sherriff-road; that six new transformers be purchased and additional cables be laid to provide for the probable additional demand for electric current during next winter, at a total estimated cost of £2 347; and that conduits be laid in the roads about to be paved with wood in order to save breaking up the roads in future, at an estimated cost of £113. 17s. 4d.

**Windsor.**—The following report has been adopted by the Town Council: "1. The question referred back to your committee as to obtaining more equal distribution of public lights in side streets has been fully discussed, and after having inspected lights erected by the gas company and electric light company, they recommend that the tender of the Windsor Electrical Installation Company be accepted for five years, determinable by the Corporation at the end of the first two years on six months' notice in writing so to do. The tender recommended for acceptance is for 10 2,000-c.p. lamps, 21 500-c.p. lamps, and 260 twin 16-c.p. lamps, giving 32 c.p. combined, at an annual cost of £1,375."

**Portsmouth Dockyard.**—Now that the end of the financial year is approaching, the machine and tool makers who have contracts with the Admiralty for supplying new machines and tools are very busy. Large consignments of machines and tools have been arriving weekly. Among the former are some of the most modern and up-to-date machines driven by electricity, and others automatic and belt-driven. There is one machine that has been constructed at Birmingham for destroyers' water-tube boilers. It will do work equivalent to six men on ordinary lathes, and if the authorities can only keep the machine supplied with constant work, there will be a saving of hundreds of pounds in the course of a year.—*Portsmouth Evening News.*

**Halesowen.**—The District Council have sealed agreements with the Empire Electric Lighting Company for the disposal of the electric lighting and light railway orders belonging to the Council. The company undertakes, within six months of the signing of the agreement, to construct an electric generating station within the district. They also will light the public lamps in the district at the same price charged by the gas companies, and to provide all the necessary posts, lanterns, and fittings; further, to supply electricity for the lighting of the municipal buildings at the rate of 5d. per unit, and to private consumers at 7d. per unit. The company further agrees to complete the tramways from Halesowen to Lye and to the Old Hill boundary within two years from the date of the signing of the agreement, and to complete the other lines contained in the order within six years and to promote during the session of 1904 in Parliament a Bill for an extension order to Old Hill.

**Electric Share Market.**—Trading has been on a small scale in the market for electric shares during the last week just closed, and movements disclose an irregular tendency. In the supply division Citys have put on ¾ at 11¼ on the dividend announcement. The rate (5 per cent., making 5 per cent. for the year) is the same as that for 1902, and is quite up to market expectations; but, in addition to increasing the amount carried to reserve by over £10,000, the directors are able to carry forward a sum equal to that brought into the 1903 accounts. Charing Cross issues have shown weakness on the new issue of 10,000 ordinary and the same number of preference shares. The ordinary are ¼ lower at 8, the preference have lost ⅛ at 5⅞, and the debentures are 1 down at 103. A rise of a point to 105 is recorded by Edmundsons debentures, and the other issues have maintained a firm tone. Metropolitans close ½ lower at 18. Tractions have continued dull. British Electrics fell at one time to 10, but a little investment buying quickly brought about a partial recovery, the closing price showing a loss on the week of only ¼ at 10¼. The preference have recovered ¼ to 11. Buenos Ayres and Belgranos close ⅛ off at 3, and Imperial preferences have given way ⅛ to 14¼. British Westinghouse preference are ¼ better at 4, and Willans and Robinson have improved ¼ to 4¾. Telegraph Constructions finish a point better at 34½. Crompton debentures are quoted at 1½ lower at 97½.—*Financial Times.*

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**Bradford.**—The total income of the electricity department for the year was £75,739. The working expenditure was £35 672, leaving a profit of £40,067. Out of this there was paid in repayment of loans and interest on loans £31,144, and there was set aside for the depreciation of plant £8 436, leaving a net surplus of £587. Apart from the payment of sinking fund and interest, the operations of this department would have shown as a trading concern a return on the capital invested, after allowing for depreciation, a profit of 6½ per cent. The Corporation has placed an order with the British Westinghouse Electric and Manufacturing Company for a 1,000-kw. direct-current E T. generator, together with field rheostat and other auxiliary apparatus. The generator will be vertically divided, and will run normally at 550 volts, 85 revolutions per minute. This is a repeat order, and the machine will be exactly similar to the generators already supplied to the Corporation by the same company.

**Sudbury.**—The Town Council have sealed an agreement with the Empire Electric Lighting and Power Company, Limited. Under it the company will take over the Corporation's provisional order, and will undertake to commence the necessary work within three months or six months with the consent of the Board of Trade, and to complete the entire works necessary for the lighting of the town by electricity within nine months after commencement. The company agree to pay the Corporation the sum of £750. The company are to supply electricity for the public lighting, and instal it in all present public buildings. The prices to be charged for lighting purposes are not to exceed 7d. per Board of Trade unit, and for power not to exceed 4d. per unit. The Corporation are to have power after 21 years, and at the expiration of every subsequent five years, to give 12 months' notice of their intention to put an end to the agreement and purchase the undertaking as a going concern, the price to be fixed by arbitration.

**Coventry.**—Upon the minutes of the Electric Light Committee coming up for confirmation at the last City Council meeting, the following paragraph, which authorised the payment of commission, was struck out, notwithstanding that the Chairman of the Electric Lighting Committee explained that the appointment was only to replace a meter reader who had left: "Resolved, that the manager be authorised to appoint a meter reader at wages of 30s. a week, and to pay him a commission of 6d. per 8-c.p. lamp or equivalent for all new custom which he can obtain." Exception was taken to the committee giving commission, as it would be an incentive to the person appointed to induce the consumers of gas to transfer their accounts from the gas department to the electric light. It was stated that it was very undesirable that these two departments should be fighting against each other, and if the Council adopted this clause it might bring retaliation on the part of the Gas Committee.

**South Wales Electrical Power Co.**—In connection with the issue of £50,000 new debenture stock—the second similar amount out of the £250,000 authorised—by the South Wales Power Distribution Company to existing shareholders, some interesting particulars are given as to the present position of this important undertaking. Owing to the establishment of similar enterprises in other manufacturing districts, its progress is watched with more than usual interest. The directors state that they are well satisfied with the prospects of the company. Applications for current are continually being received, and consumers taking substantial amounts are being arranged with. The small station at Bridgend has been at work for some months, and shows satisfactory results. Customers have been connected at Pontypridd and Cwmbrau. The buildings of the Neath station are completed, the machinery is being delivered, and this station should be at work in about three months. It is stated that numerous enquiries for large quantities of power all over the area are being received.

**London Gazette.**—The first meeting in the estate of Charles Wallis, electrical engineer, 121, Cleethorpe-road, Great Grimsby, will be held at 11 a.m. on Feb. 27 at 15, Osborne-street, Grimsby. A general meeting of members of the Electric Resistance and Heating Company, Limited, will be held at 130, Dashwood House, New Broad-street, London, on March 25, at 2.30 p.m., to have an account laid before them showing the manner in which the winding-up has been conducted. Frederick Stone has been released from trusteeship in the estate of David Roberts, electrical and motor engineer, residing at 30, Macklin-street, lately residing and trading at 3 and 5, Whiston-street, Derby. March 3 is the last day for receiving proofs in the estate of John William Talbot (trading as Hooley, Talbot, and Co.), electrical engineer and contractor, Regent-street, Rugby, Warwick (E. T. Pierson, official receiver, 17, Hertford-street, Coventry). A receiving order has been made out in the estate of Samuel Henry and James Edgar Thompson (trading as Thompson Bros. and Co.), electricians, 6, East-street, Plymouth, Devon.

**Hastings.**—The Council are consolidating the existing agreements with the National Telephone Company, Limited, for the hire of exchange telephones, etc. The company are prepared to enter into an agreement with the Corporation for a term of three years, under which the Corporation shall pay a reduced rental of £220 per annum in respect of the whole of the existing lines and instruments now hired by them—for which rents, amounting in the aggregate to £278. 10s. per annum, are now payable—and shall also pay in respect of each additional exchange telephone which the Corporation may require during the term of three years without regard to the distance from the exchange, a fixed rent of £5 per annum—but the company shall not be called upon to provide at that rent during the term of three years a number of additional telephones exceeding six—and a rent of 5s. each per annum for any number of additional extension bells which may be required during the term, the company to shift any then existing line and instrument as may from time to time be required during the currency of the agreement on payment by the Corporation of the out-of-pocket expenses incurred by the company in connection with the removal, the rental to be payable on April 1 in each year.

**Hackney.**—The revised estimates of the Electric Lighting Committee for distributing mains, etc., in London-lane, Mentmore-terrace, and Martello-terrace, new feeder to Hackney Wick, Gainsborough-road distributor, and Sidney-road distributor, amount to £3 996 (the estimates as originally submitted to and adopted by the Council on Nov. 26, 1903, amounted to the sum of £5 330). The periodical overhaul of the refuse elevators necessitates the erection of scaffolding to give proper access to some portions of the machinery. It has been pointed out by the borough electrical engineer that a permanent structure would be more convenient, and would, moreover, reduce the cost of maintaining the destructor. A design has been prepared for a permanent platform around the elevator head, and the estimate of Messrs. Nightingale of £106 has been accepted. The Dalston Theatre was originally connected to the distributing mains on the south side of Dalston-lane, but the demand has so greatly increased that the necessity has arisen for an increase in the pressure between the theatre and Dalston Junction feeding point. Additional work is to be carried out at a cost of £90 so as to improve the supply.

**Perth.**—The report of the electrical engineer with regard to the proposed extension of the electricity department, noted in our last issue, states that to ensure this plant being delivered in time tenders would require to be invited at once for one 420-kw. steam dynamo, with foundations, etc., £4 500; one fan for induced draught, £500; tramway switchboard, etc., £1,400; additions to present switchboard, £250. As the feeder cables at present supplying the town are now fully loaded, it would be advisable to lay an additional feeder from the works to the top of Kinnoull-street at an estimated expenditure of £1,650. This cable could be laid at the same time as the tramway feeders, thus saving a breaking up of the roadway a second time. The estimated expenditure immediately required is therefore £8 300. In order to meet any extension of lighting as well as tramways, which will be likely to take place within the next five years, the following additional plant will be required: additional generating plant, £5 300; water-tube boiler and feed pumps, £1,250; surface condensing plant, £1,100; distributing cables, £1,550; meters, cut-outs, etc., £1,200; contingencies, £1,300; estimated immediate expenditure, £8,300.

**Southend.**—Application is to be made for sanction to a loan of £660 for the provision of an economiser in connection with the boilers. The following statistics were presented at the last Town Council meeting: electric lighting fund, estimate one year to March 31, 1904, £8,725; expenditure, nine months to Dec. 31, 1903, £7,136; estimated income, one year to March 31, 1904, £8,400; income, nine months to Dec. 31, 1903, £6,947; light railways fund, estimate one year to March 31, 1904, £14,841; expenditure, nine months to Dec. 31, 1903, £12,701. The electrical engineer (Mr. Heenan) reported that during the months of November, December, and January electric light mains had been laid in eight roads. The lighting load this winter equalled 320 kw., as compared with 123 kw. the previous year, and the units generated for lighting purposes on Christmas Eve, 1903, were 2,739, as compared with 930 for Christmas Eve, 1902. In the last three months 51 consumers were connected, with the equivalent of 2,450 lamps, bringing the total lamps connected to 31,519. Owing to the steady demand for electric light it would be necessary to instal an additional boiler before the summer. Their average daily load was now 308 kw.; the Kursaal and other places of entertainment would add at least another 100 kw., and for new consumers he estimated about 80 kw., making a total of 488 kw. They should, he considered, be prepared to meet a lighting load of, say, 532 kw. The traction load of about 200 kw. would bring this up to 732 kw.

**Junior Institution of Engineers.**—On Saturday afternoon a visit took place to the Colonial Consignment and Distributing Company's Frozen Australasian Meat Stores, Nelson Wharf, Commercial-road, Lambeth, under the guidance of Mr. C. S. T. Molecey, A.M.I.C.E., chief engineer. These premises were constructed in 1891 for the purpose of forming a central depôt, whence the frozen meat supplies from the Colonies might be received and distributed throughout the United Kingdom, inclusive of London itself. They were erected for Nelson Bros (now the above-named company) by Messrs. John Mowlem and Co., contractors, to the designs of Messrs. Bramwell and Harris, of Westminster. Electricity for lighting the cold rooms, offices, and premises generally, is generated by two of Messrs. J. and H. Gwynne and Co.'s vertical compound engines, each coupled direct to a Paterson and Cooper low-speed dynamo. Hydraulic-power water is supplied for the lifting apparatus at a pressure of 750lb. on the square inch by a Smith and Vale compound duplex steam-pump having 6in. water-rams, working on a 15ft. stroke 12in. diameter accumulator. The London Hydraulic Power Company's service water at the same pressure is laid on through meters to the ring main water service pipes as a stand-by when the pump is shut down for repairs. The three Lancashire steel boilers, 7ft. 6in. diameter by 30ft. long, of which two are in use at one time, made by Messrs. Galloway, and fitted with Vicar's mechanical stokers, supply steam at 140lb. pressure. Service pumps for condenser water and boiler feed water, a filter, heater, and general steam condenser and air-pump, complete an installation running day and night throughout the year.

**Southwark.**—Mr. J. W. Thompson has held an enquiry with reference to the application of the Borough Council to the London Government Act Commissioners for a scheme providing that the expenses of the new electric lighting undertaking should be chargeable on the whole borough. Mr. Vesey Knox appeared for the Borough Council, and explained that under the adjustment scheme any deficit on the electric light undertaking was borne by Newington, whereas the surplus, when the scheme realised a profit, would have to be spread over the whole borough. It was to remove this anomaly and in the interests of unity in administration that the application was made. As Newington's liabilities and assets with regard to the undertaking had been treated in the adjustment scheme as liabilities and assets of the whole borough,

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and Newington had been debited with the excess of the liabilities over the assets, the natural result, he contended, should follow that the repayment of the loans and interest should fall upon the whole borough. The application was opposed by Mr. Horace Avory, K.C., on behalf of ratepayers in the parish of St. Saviour's; by Mr. W. Shakespeare, barrister, as representing the ratepayers in St. George's; and by Alderman Bowers, on behalf of Christchurch. Mr. Jones also offered opposition on behalf of the owners of the Humphrey estate in St. Saviour's, and a number of ratepayers appeared in their individual capacity against the scheme, on the ground that it would be unfair to saddle the losses on a purely Newington undertaking upon the other parishes. The mayor (Alderman Haynes, J.P.), the borough treasurer (Mr. Patterson) the electrical engineer (Mr. Blaikie), and the town clerk (Mr. J. A. Johnson), gave evidence in favour of the scheme. The enquiry will be continued to-day. An enquiry is being held by the Electric Lighting Committee into the general working of electric light station.

## COLONIAL NOTES.

**Victoria Falls.**—It is estimated that the initial outlay in connection with the electric power scheme at Victoria Falls, on the Zambesi, will be £500,000, while subsequent outlays will probably run into millions.

**Cape Power Station.**—Two additional 500-kw. dynamos have been ordered for the Docks power station. These dynamos will be employed in supplying the electricity to work the 23 additional cranes which have been indented for, and which will be added to the equipment of the south arm.

**Johannesburg.**—It is stated that the Allgemeine Elektricitäts-Gesellschaft are opening offices in Johannesburg, under the title of the A.E.G. Electrical Company of South Africa, and Mr. W. M. Arnot and Baron Mannheim have been appointed joint general managers. Mr. Charles Flesch de Nordwall, a director of the Allgemeine Elektricitäts, is about to take up a permanent residence in London to manage the home affairs of the company, whose registered offices are at 125, Charing Cross-road. A company has been formed for the purpose of erecting a central electric power station at Johannesburg. The station will furnish electric power to the mines, and a proposal has been made to the Town Council for it to supply the town demands for lighting purposes trams, etc., also, and so obviate the otherwise inevitable expenditure on a municipal power station.—*S. A. Reports.*

## PROVISIONAL PATENTS, 1904.

FEB. 15.

**3704. An improved current collector for conduit electric tramways or railways and the like.** Charles Palmer Grew, 6, Blessington-road, Lee, London.

**3722. The Ajax, to be applied to electric trams and motorcars.** Francis Henry Bostock, 209, Mansfield-road, Nottingham.

**3768. Improvements in electrical heating and resisting apparatus.** Andrew Wybrant Penrose and Max Hankin, 28, New Bridge-street, London.

**3774. Improvements in vapour electric lamps.** Howard Irving Wood, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Feb. 14, 1903, being date of application in United States.) (Complete specification.)

**3787. Improvements in electric railway systems.** Abraham Adam Shobe and William Embley, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 10, 1903, being date of application in United States.) (Complete specification.)

**3790. Improvements in and relating to electric furnaces.** Charles Albert Keller, 18, Buckingham-street, Strand, London. (Complete specification.)

**3798. Improved means and apparatus for supplying electrical energy for the lighting of trains and other purposes.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Johann Heinrich Ludwig Onken, Germany.)

**3809. Safety electrical cut-out.** Arthur John Fuller and Marshall Handyside Bennett, 13, Chipstead-street, Fulham, London.

FEB. 16.

**3826. Improvements in and in the manufacture of insulating or non-conducting materials for electrical purposes.** Pontite, Limited, and Silvius de Pont, 18, St. Ann-street, Manchester.

**3840. Improvements in controlling apparatus for electric motors.** John Klinkenberg, 121, West George-street, Glasgow.

**3847. Dynamo-electric machines.** Charles Arthur Allison, 52, Chancery-lane, London. (The Hooven Owens, Rentschler Company, United States.) (Complete specification.)

**3882. Improvements in dynamos.** Isidor Deutsch, 46, Lincoln's-inn-fields, London. (Complete specification.)

**3884. Improvements in alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3886. Improvements in electric motor control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3885. Improvements in electrical switching systems.** Gilbert Wright and Francis Victor Nicholls, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Feb. 16, 1903, being date of application in United States.) (Complete specification.)

**3891. Improvements in and relating to electrical energy meters.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Riccardo Arno, Italy.)

**3896. Improvements in the method of and means for protecting apparatus on alternating-current systems.** Charles Hesterman Merz and Bernard Price, 46, Lincoln's-inn-fields, London.

**3897. Improved method of and means for protecting apparatus on alternating-current systems of distribution.** Charles Hesterman Merz and Bernard Price, 46, Lincoln's-inn-fields, London.

**3912. Apparatus for regulating electric current.** La Société L'Industrie Verrière et ses Dérivés, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, Feb. 17, 1903, being date of application in Belgium.) (Complete specification.)

**3913. A process of and apparatus for the generation of electric energy.** Herman Jacob Keyser, 1, Queen Victoria-street, London. (Complete specification.)

FEB. 17.

**3935. Improvements connected with electric cable troughs or conduits.** The Seacombe Pressed Brick and Tile Works, Limited, Walter Hebden Wilson, and Frederic Phelp Jones, 15, Water-street, Liverpool.

**3950. A new method for tilting electric lampshades by means of a counterweight.** Noel Pemberton Billing, known as Noel Pemberton, 13, Glendower-place, South Kensington, London.

**3955. Improvement in making and breaking contact with automatic electrical circuit breaker.** William Harrison, 10, Suffolk-place, Ardsall-lane, Salford.

**3960. An electrical automatic fog signal.** Thomas Johnson Watkinson, 64, Petre-street, Sheffield.

**3979. Clock for regulating electric, gas, and other light.** Charles Rutherford, 37, Stockbrook-street, Derby.

**3994. Improvements in electrodes for arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**3995. Improvements in and relating to electric couplers.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**3996. Improvements in electrical conductors and methods of making the same.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**3997. Improvements in electrodes for arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**3998. Improvements in methods of producing metals from a compound containing silicon.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**3999. Improvements in arc light electrodes and methods of making the same.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4000. Improvements in arc lamp electrodes.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4001. Improvements in electrodes for arc lights.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4002. Improvements in arc light electrodes.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4003. Improvements in arc light electrodes.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4004. Improvements in electrodes for arc lamps and method of making the same.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4005. Improvements in electric arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4016. A new or improved galvanic battery with regenerative apparatus.** Ferdinand Protz, 18, Buckingham-street, Strand, London.

**4020. Improvements in electric switches.** Alphonse Constant Reyrolle, 46, Lincoln's-inn-fields, London.

FEB. 18.

**4034. An improved electric terminal coupling for electric batteries or wires.** Arthur Sydney Bright, 73, Church-street, Camberwell, London.

**4057. Improvements in appliances for charging and cutting out electric accumulators.** Armand Louis (known as Guy) de Sainville, 51, Deansgate-arcade, Manchester.

**4062. A new type of electric arc lamp.** Giovanni Scialpi, Taranto R, Arsenale, Italy.

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**4059. Improvements in and applicable to electric furnaces.** William Simm, Henry Simm, Robert Storey, and John Shuttleworth Sellers, 9, Tempest-hey, Liverpool.

**4075. Improvements in supports for conductor rails of electric railways.** Henry Lewis Doulton and Charles Edward Morris, Lambeth Pottery, Lambeth, London. (Complete specification.)

**4110. Improvements in electrical connectors.** William Crammond Martin and James Lowson, 46, Lincoln's-inn-fields, London.

**4116. Improvements in and connected with electrically-controlled lifts and hoists.** Engine Chandoir, 173, Fleet-street, London.

**4133. Improvements in arc lamps and electrodes therefor.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4134. Improvements in arc lamp electrodes.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**4138. Improvements relating to telphers.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. The United Telpherage Company, United States. (Complete specification.)

FEB. 19.

**4145. Improvements in methods of fixing switchboard panels.** John Somerville Highfield, 16, Stratford-place, London.

**4146. Improvements in centering devices and arc lamps for optical lantern illuminants.** Robert William Paul, 68, High Holborn, London.

**4147. Device for obtaining an even operation of electrical current generators with interrupted driving power.** Torius L. Kolkin, 2, Norfolk-street, Strand, London.

**4167. Device for cooling electric sparking arrangements in internal-combustion engines.** Robert Sanderson and John Sanderson, 42, Railway-arches, Pilgrim-street, Newcastle-on-Tyne.

**4168. Improvements in or relating to the driving machanism of certain classes of machinery, such as electrically-driven cranes, hoists, and the like.** William Whitwell and Co., Limited, and Charles Demain, 6, Finkle-street, Stockton-on-Tees.

**4176. Improvements in and relating to multiplex telegraphy.** Stephen Dudley Field, 51, Deansgate-arcade, Manchester. (Complete specification.)

**4188. Improvements in or relating to electric accumulators or storage batteries.** Alfred Blackman, St. Brelade, Glamorgan-road, Hampton Wick, Middlesex.

**4191. Improvements in electric traction systems.** Ernest Francis Moy and Percy Henry Bastie, 3, Greenland-place, Camden Town, London.

**4219. An improved pneumatic sound disc or diaphragm for telephones and other apparatus.** Albert Joseph Ridley, 37, Chancery-lane, London.

**4233. Improvements in electrical switchboard appliances.** George Keith Buller Elphinstone, 24, Southampton-buildings, Chancery lane, London.

**4234. Improvements in electrical measuring and indicating instruments.** George Keith Buller Elphinstone, 24, Southampton-buildings, Chancery-lane, London.

FEB. 20.

**4252. Improvements in or relating to the overhead wires or equipment of electric railways.** Norman Stewart Bertram, 55, Market-street, Manchester.

**4291. Automatic and electric fire-alarm acting under the principle of the dilatation and contraction of the air or other gases.** Louis Adolphe Carré, 24, Mark-lane, London.

**4309. Improvements in electric switches.** The General Contracts Company, Limited, Edward Samuel Cook, and William Howard Chipperfield, 149, Strand, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 10, 1904.*

1903.

**3425. Means for controlling electric circuits.** Leitner and Lucas.

**3863. Electric cut-outs.** Sluce and Chase.

**4645. Electric arc lamps.** Carolan. (General Electric Company.)

**5796. Electromagnetic stopping device for shuttle, embroidery, and similar machines.** Beyreiss.

**6140. Electric ignition apparatus for motorcars and other services.** Webb.

**6405. Carbon-holders for electric arc lamps.** Hamilton-Adams.

**6486. Induction electric motor armatures.** Carolan. (General Electric Company.)

**6501. Forms for winding electric coils.** Carolan. (General Electric Company.)

**7452. High-tension electric circuit breakers.** Carolan. (General Electric Company.)

**7456. Supports and casings for electric contactors.** Carolan. (General Electric Company.)

**8468. Electric lamps for use in connection with bakers' ovens and the like.** Mingay.

**8474. Electric ignition devices for internal-combustion engines.** Lovelace.

**9649. Means for transmitting electric current to tramcars and the like.** Hirst and Son, Limited, and Hirst.

**9712. Electric railway and tramway systems.** Cooper.

**15420. Process for the electrolytic production of zinc.** Kaiser.

**16232. Manufacture of electrical resistances.** Weaver.

**17034. Induction transformer for wireless telegraphy stations.** Ducretet.

**27576. Magneto-electric igniting apparatus for internal-combustion engines.** Roos.

**27733. Electrically-driven suspended railways.** Hearson. Adolf Bleichert and Co.)

**27825. Electric lamp, particularly for miners' use.** Soc. des Accumulateurs Chelin. (Date applied for under International Convention, Aug. 3, 1903.

1904.

**758. Process for insulating electrical conductors.** Heys. (Ammon.)

**1187. Electric accumulator plate.** Elieson.

**1279. Manufacture and production of pipes, or conduits, or other articles for use underground or in other situations where they are subject to electrical or corrosive action.** Johnson. (Brown and Tredway.)

**1307. Electric condensers.** Moscicki.

**1308. High-tension electric condensers.** Moscicki.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅛-⅜ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6½ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 103-105 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3⅞-4¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅝ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10½-11½ |
| —— 6 per cent. Pref. | 5 | .. | 5½-5⅝ |
| Crompton and Co. | 3 | .. | 1⅝-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-98,861 | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1¼ |
| —— 6 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1⅛-1⅜ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9⅛-9⅝ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 12-13 |
| —— 4½ per cent. Preference | 5 | .. | 6-5½ |
| —— 4½ per cent. Debentures | 100 | .. | 103-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 18 19 |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 14½-15⅝ |
| Telegraph Construction and Maintenance | 12 | .. | 33-35 |
| —— 5 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | .. | ¼-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 114-117 |
| Bournemouth and Poole, Ordinary | 10 | .. | 12½-13½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 9⅝-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10½-11⅝ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10-10¼ |
| —— 7 per cent. Preference | 5 | .. | 9⅛-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 6-7 |
| —— Nos. 20,001-30,000 | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 14½ |
| —— ,, ,, ,, £10 Ord. | 6 | .. | 10⅝ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7⅛-8⅛ |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅛-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 102-101 |
| Chelsea Electricity Supply | 5 | .. | 5¼-6⅛ |
| —— 4½ per cent. Debentures | 100 | .. | 106 109 |
| City of London, Ordinary | 10 | .. | 10⅜ 11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 8 9 |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11¼-12⅛ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5⅜ 6¼ |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3-4 |
| —— 5 per cent. Debenture Stock, Red | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7½-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. | 100 | .. | 103-106 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | — | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | — | 9¾-10¼ |
| London Electric, Ordinary | 5 | .. | 1¾-2¼ |
| —— 6 per cent. Pref. | 5 | .. | 5¼-6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 95-58 |
| Metropolitan Ordinary | 10 | .. | 17½-18½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 97 100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 93 101 |
| —— Preference | 4 | .. | 100 103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,510 | 5 | .. | 5¼ 6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 97-100 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | — | 96-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | — | 5¼-5¾ |
| —— 4 per cent. Debenture Stock | 100 | — | 85-90 |
| South London, Ordinary | | — | 3¾-4¼ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | — | 14-15 |
| —— 7 per cent. Pref. | 5 | — | 8-9 |
| —— 3½ per cent. Deb. | 100 | — | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | — | 4¼-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4¾-5¼ |
| Westminster, Ordinary | 5 | — | 12½ 13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | — | 5-5⅛ |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | — | 91-94 |
| —— 4 per cent. Pref. | 100 | — | 96 99 |
| —— ,, ,, deferred | 100 | — | 86 89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | — | 110-115 |
| City and South London, Consolidated Ordinary | 100 | — | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | — | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | — | 123-126 |
| —— ,, ,, ,, '96 | 100 | — | 119-122 |
| —— ,, ,, ,, '01 | 100 | — | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | — | — | 13-13¼ |
| —— Ordinary, 1-50,000 | — | — | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | — | 102-104 |
| Waterloo and City, Ordinary | 100 | — | 91-94 |

## Electric Tramways.—

| | | | |
|---|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | — | 4⅜-4¾ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 | .. | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | .. | 13¼-14¼ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | .. | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 82-85 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | .. | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | — | 9¼-10¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | — | 10¼-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | — | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | — | 2¾-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | — | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | — | 4¾-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | — | 104-107 |
| —— Prov. Cert., all paid | 100 | — | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | — | 1⅛-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | — | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | — | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | — | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | — | 11-12 |
| —— Debentures | 100 | — | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | — | 12¼-13¼ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | — | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | — | 94-97 |
| Imperial Tramways Ordinary | all | — | 22-22¾ |
| —— 6 per cent. Cum. Pref. | all | — | 144-154 |
| —— 4½ per cent. Deb Stock | 100 | — | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | — | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | — | 11¼-11¾ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | .. | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,514,016 | 1 | .. | 5/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | .. | ¾-1⅛ |
| New General Traction, Ordinary | 5 | .. | ¼ |
| —— 6 per cent. Cum. Pref. | 5 | — | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,715 (Regd.) | 100 | .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | — | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | — | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | .. | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | — | 8¼-8¾ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | — | 8¼ 9¼ |
| —— 4½ per cent. Debenture Stock | 100 | — | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | — | 1 |
| —— £101,132 5 per cent. Preference | 1 | — | 1 |
| —— £523,093 4½ per cent. Debenture Stock | 100 p.c. | — | 100 p.c. |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | — | 103-106 |
| —— Deferred Stock | 100 | .. | 78-81 |
| —— 6 per cent. Cum. First Pref. | 10 | — | 13¼-14¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | — | 14-15 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | — | 5¼-5¾ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | — | 96 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | — | 100-102 |
| Oriental Telephone and Electric Company | 1 | — | ¾ 1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Passenger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 20 | 1,044 | 833 | + 211 | + 9,057h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 13 | 162 | 157 | + 5 | + 167 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 20 | 283 | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 19 | 716 | 649 | + 67 | + 1,934 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 18 | 282 | 325 | − 43 | − 275 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·62 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 20 | 179 | 201 | − 22 | − 38 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 21 | 1,692 | 1,509 | + 113 | + 3,035 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 17 | 858 | — | — | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 21 | 3,545 | 3,176 | + 369 | +19,689 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 21 | 711 | 716 | − 5 | +42,057h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 19 | 4,212 | 4,413 | − 171 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,182,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 20 | 867 | 667 | + 200 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 21 | 291 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 20 | 1,804 | 1,570 | + 230 | +22,772 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 20 | 164 | 149 | + 15 | + 207 | — | — | ,, 31 | — | 2,216,583 | 330,129h | — | — | — | — |
| Central London Railway | ,, 20 | 7,096 | 6,933 | + 163 | + 406h | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 21 | 3,177 | 3,058 | + 109 | − 617h | 6⅜ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 18 | 381 | 395 | − 14 | + 16 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 19 | 200 | 197 | + 3 | − 214 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·66 | 1,707 | 9·36 |
| Dover Corporation | ,, 20 | 162 | 170 | − 8 | + 58 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 21 | 94 | 92 | + 2 | + 38h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 19 | 3,555 | 3,735 | − 180 | — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·62 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 19 | 660 | 787 | − 127 | — | | | | | | | | | | |
| Dundee City Tramways | ,, 17 | 773 | 801 | − 28 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 20 | 600 | 499 | + 101 | + 8,473 | 10·75 | 10·75 | March 31g | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 20 | 12,917 | 12,495 | + 422 | +52,527h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | ,, 10 | 2,135 | 2,074 | + 121 | + 6,303 | 31½ | 30¼ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 20 | 1,118 | 993 | + 200 | — | 34 | 34 | March 31 | 56,631h | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 20 | 1,987 | 1,664 | + 323 | + 7,037 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 17 | 118 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 17 | 190 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 20 | 4,956 | 4,663 | + 293 | +15,515 | 77 | 77 | March 25g | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 13 | 9,471 | 9,412 | + 59 | + 2,742 | 103 | 101 | Dec. 31 | 534,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 21 | 1,472 | 1,468 | + 4 | + 358h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 14 | 9,661 | 8,539 | +1,122 | +78,978 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 132 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 20 | 75 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 20 | 3,431 | 3,011 | + 420 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 20 | 1,342 | 1,228 | + 114 | + 5,449 | 29 | 29 | Sept. 30 | 47,651 | 9,168,157 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 23 | 95 | 101 | − 5 | — | 4½ | 4½ | March 31g | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 18 | 387 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | Jan. 18 | 3,443 | 2,628 | + 815 | +45,490 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | Feb. 21 | 4,282 | — | — | — | 53½ | 53½ | Mar. 25g | 216,309 | 55,812,019 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 18 | 871 | 815 | + 56 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 21 | 1,061 | 967 | + 94 | + 2,701 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,943 | 6·4 |
| Wallasey U.D.C. | ,, 20 | 568 | 518 | + 50 | + 3,840 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## SINGLE-PHASE COMMUTATOR MOTORS AND THEIR REGULATION.

Following is a translation of a paper read by Friedrich Eichberg before one of the German electrical societies, and reprinted in the *Elektrotechnische Zeitschrift*:

### Introduction.

The domain of the single-phase commutator motor, which was abandoned in 1890 in favour of the polyphase-current motor, is exciting great interest just now, for the single-phase commutator motor is the railway traction machine of the future. That this type of motor was abandoned, as stated, is attributable to the unsatisfactory working of the commutators, and perhaps partly also to the vain hope that the single-phase induction motor could be driven with high tractive power without using a commutator.

Pioneers in the field of single-phase motors, such as E. Arnold and M. Déri, basing their work on a clear perception of the properties of commutator motors and of the single-phase induction motor, have designed motors for single-phase current, which start up as series or repulsion motors and finally run as induction machines. These motors were certainly very serviceable for small outputs and intermittent use of the commutator. It was from Déri himself, whom I assisted some years ago with the design of his repulsion motors, that I gained implicit confidence in the practical worth of the single-phase commutator motor.

The arrangements with which I shall now proceed to deal, and which lead up to a complete solution of the problem of the single-phase motor, represent a part of the results of the work which I have been engaged on, in

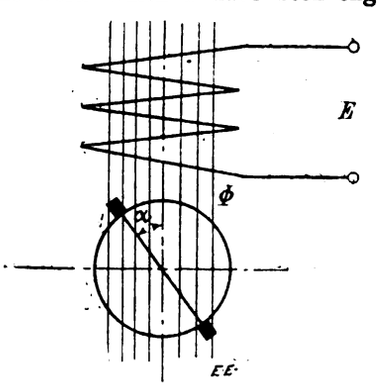


Fig. 1.

association with Mr. G. Winter, during the past four years or more.

### Phenomena Appertaining to Commutator Machines.

If an armature provided with a commutator, such as are employed in direct-current machines, be placed in an alternating field, then a two-fold E.M.F. may be induced at the brushes.

1. *An E.M.F. Produced by Rotation.*—The momentary value of this E.M.F. is always proportional to the number of revolutions, $n$ per second, the momentary value of the field, $\Phi$ (see Fig. 1), the sine of the angle $\alpha$ which the axis of the brushes makes with the axis of the field,* and the number of conductors, K, which lie in series between the brushes. The momentary value of this "E.M.F. of rotation" $\bar{e}_R$ is

$$\bar{e}_R = 2 \quad \Phi_{mom.} \, . \, n \, . \, K \, . \, \sin \alpha.$$

The factor 2 is due to the fact that the field, $\Phi$, is cut twice during each revolution; $\bar{e}_R$ and $\Phi_{mom.}$ are always proportional. Hence the "E.M.F. of rotation" is in phase with the alternating field, and always of the same periodicity as this field, no matter what the speed may be. Let $E_R$ represent the effective value of the E.M.F. of rotation; then

$$E_R = 2 \, . \, n \, . \, K \, . \, \sin \alpha \, . \, \frac{\Phi_{max.}}{\sqrt{2}} \quad . \quad . \quad . \quad (1)$$

when $\alpha = 0$, or $n = 0$, $E_R = 0$.

2. *An E.M.F. due to Induction at Rest—that is to say, Transformer Action.*—The momentary value of this E.M.F. is always independent of the number of revolutions per second, proportional to the change of the field, $\Phi$, with time, the cosine of the angle $\alpha$ (see Fig. 1), and the number of active conductors, which, in a uniformly disposed winding, is $\frac{2}{\pi} \, . \, K$. This "E.M.F. of rest" lags, therefore, behind the field, $\Phi$, by 90deg., and is expressed

$$E_J^{eff.} = 2 \, . \sim . \, \frac{2}{\pi} K \, . \, \Phi_{max.} \, . \, \frac{\pi}{2} \, . \, \frac{1}{\sqrt{2}} \, . \cos \alpha.$$

$$E_J = 2 \, . \sim . \, K \, . \cos \alpha \, . \, \frac{\Phi_{max.}}{\sqrt{2}} \quad . \quad . \quad . \quad . \quad (2)$$

Equation (1) is the well-known equation applying to the E.M.F. induced in a direct-current machine, while equation

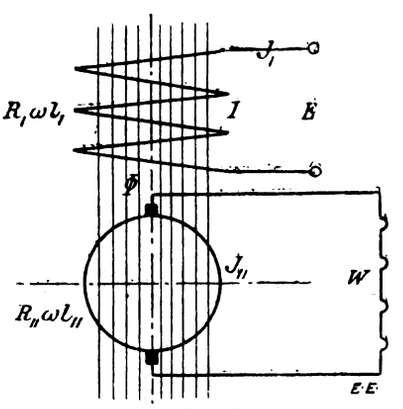


Fig. 2.

(2) is that applying to the E M.F. induced in the secondary winding of a transformer. It is immaterial that the latter takes the form here of an armature.

3. Let us in the first place look a little closer into case 2 (see Fig. 2). There is no angle $\alpha$. We will load the transformer, for instance, with non-inductive resistance. The diagram (Fig. 3) for a transformer with a commutator armature as secondary circuit is, of course, identical with one for a transformer of the ordinary type. If the external resistance, W, is known, then the magnitude and phase of $J_{II}$—that is, $J_I$ in relation to E—may be determined from the diagram. By switching in the non-inductive resistance we have forced the system to do work. All this work, however, is absorbed by the resistance. The production of a mechanical torque is impossible, because (1) the axis of the armature windings coincides with that of the magnetic field ($\alpha = 0$); and (2) the phase distortion

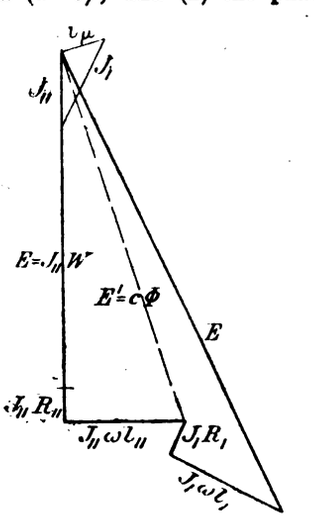


Fig. 3.

between the armature current, $J_{II}$, and the field, $\Phi$, is approximately 90deg. In other words, the equation for the torque is analogous to that applying to direct-current machines. But in addition to the power factor of this local circuit it allows also for the angle ($\phi$) between the armature ampere-turns and the magnetic field. The tractive power, Z, is expressed

$$Z = K \, . \, \frac{2}{\pi} \, . \, J_{II}^{eff.} \, . \, \frac{B_{max.}}{\sqrt{2}} \, . \, l \, . \sin \alpha \, . \cos \phi,$$

* Always referring to the two-pole Gramme armature.

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$J_{''}$ representing the total armature current, and $B_{max.}$ the mean value for the maximum density of the field round the armature. If we set down

$$\Phi_{max.} = B_{max.} \,.\, d \,.\, l,$$

$d$ representing the diameter of the armature, and $l$ the active length, we obtain for the torque, D, the equation

$$D = \tfrac{1}{2} \,.\, K \,.\, \frac{2}{\pi} \,.\, J_{''}^{\,eff} \,.\, \frac{\Phi_{max.}}{\sqrt{2}} \,.\, \sin\alpha \,.\, \cos\phi \quad . \quad (3)$$

For the condition shown in Fig. 2, $\alpha = 0$ and $\phi = 90$deg., therefore $Z = 0$ and $D = 0$.

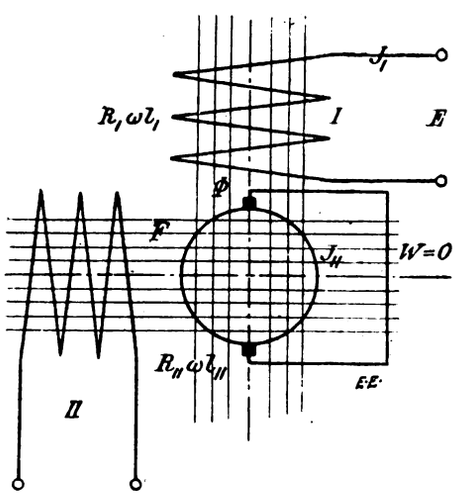


FIG. 4.

4. We might have obtained the same result in regard to the absorption of the primary work by adding a second field, F, to the field, $\Phi$ (Fig. 4), due to the winding I., the magnetic axis of this second field to be vertical to the axis of $\phi$, whose phase we must, however, by some means or other, maintain identical with the phase of the current, $J_{''}$. Let the armature rotate with the brushes in the same position. According to formula (1) there is now induced an E.M.F., or, more correctly speaking, a back E.M.F., which is in phase with $J_{''}$, and proportional to the number of revolutions per second. This E.M.F., $E_R$, corresponds

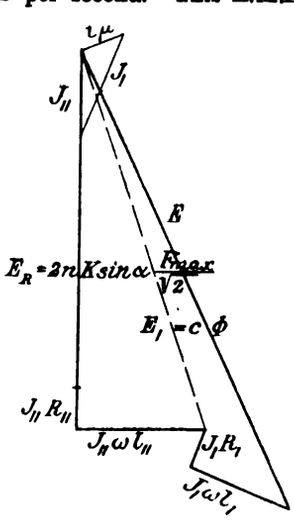


FIG. 5.

exactly to the $J_{''}$ W of Fig. 3. Indeed, we can determine the equivalent ohmic resistance, $W_0$, from the equation—

$$W_0 = \frac{E_R}{J}, \text{ in which } E_R = 2\,n\,K \,.\, \sin\alpha \,.\, \frac{F_{max.}}{\sqrt{2}}.$$

With the assistance of this field, F, the ampere-turns are enabled to give a mechanical torque to the armature, since $\alpha = 90$deg. and $\phi = 0$deg.—that is to say, the most favourable conditions exist. Instead of expending the primary energy produced by the winding I. on resistance, we create a mechanical torque through the medium of the auxiliary field, F, and so obtain a motor effect. In this particular case the torque is

$$D = \tfrac{1}{2} \,.\, K \,.\, \frac{2}{\pi} \,.\, J_{''}^{\,eff.} \,.\, \frac{F_{max.}}{\sqrt{2}}.$$

5. In this case we have the exact equivalent of the transformer loaded with ohmic resistance. Now, instead of assuming $\phi = 0$deg. (which condition represents F in phase with $J_{''}$), we will take it that $\phi = 90$deg. $E_R$ is then no longer in phase with $J_{''} R_{''}$ but with $J_{''} w l_{''}$. Assuming a turning moment in a certain direction—for instance, that which corresponds to the motor's direction of rotation with $\phi = 0$deg.—then for $\phi = 90$deg. lag, $E_R$ is in the direction of $J_{''} w l_{''}$. For $\phi = 90$deg. lead, $E_R$ will be opposite in direction—that is to say, the E.M.F. induced by rotation in the field, F, with $\phi = 90$deg. lag produces an increase of the self-induction. But when $\phi = 90$deg. lead, the E.M.F. induced by rotation will counteract the self-induction, having the effect of capacity. Diagrams representing these two extreme cases are given in Figs. 6 and 7. It is always assumed that we are able by some means or other to maintain the strength and phase of F

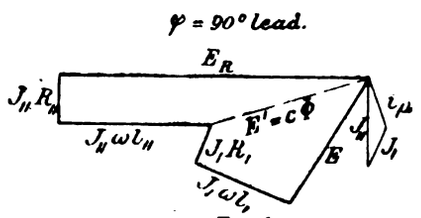


FIG. 6

constant. It follows that a wattless back E.M.F. can be generated in a commutator armature of an alternating-current machine, which is able to entirely balance or overpower the self-induction of an armature circuit. There is no need to specially emphasise the fact that in these extreme cases, where $\phi = 90$deg., it is again impossible for a torque to exist between F and the armature ampere-turns.

6. When the conditions lie between these two extremes ($\phi = 0$deg. and $\phi = 90$deg.), where $0 < \phi < 90$deg., a combined effect takes place—that is to say, the back E.M.F. is displaced by the angle $\phi$ with respect to $J_{''}$ (see Fig. 8). O $J_{''}$ gives the direction of the secondary current. $E_R$ is in phase with F, which is again constrained by some means or other to maintain a lag of $\phi$ degrees relative to $J_{''}$. Up to now it has been assumed that F is generated by a suitable winding II. on the stator.

7. Now, if instead of generating F by means of the stator winding II. we employ a revolving commutated winding II. for the purpose—say, for example, the commutator winding which is shown diagrammatically in Fig. 4 short-circuited across one axis—then we may utilise the effect of the commutated armature to suppress the self-induction, in order

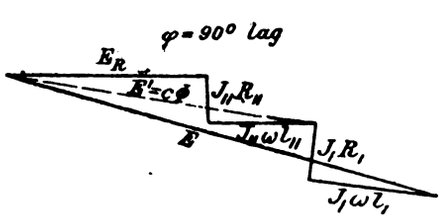


FIG. 7.

that the coil II. may counteract the inductive resistance of the circuit. This method of excitation was developed by the author and G. Winter in 1900 (see Fig. 9).

Let us assume that the current in the winding I. is opposed by resistance or by a back E.M.F. from a short-circuited system of brushes, B B, in such a way that $J_{''}$ is approximately in phase with the E.M.F., $E_J$, induced by $\Phi$ between B B. A current is circulated in the coils II. (beginning and terminating at the brushes, $b\,b$), this current being in phase with $J_{''}$. We have seen that these conditions are the most favourable for the torque. But now the torque between F (placed on the revolving armature) and the ampere-turns, $J_{''}$, has its origin in I. When the armature is revolved in F, there is now induced between B B an E.M.F., $E_R$, in phase with F and with the current. Between B B there is also generated a wattless back E.M.F. But the armature revolves just as much in $\Phi$, and through this rotation in $\Phi$ there is generated between the brushes, $b\,b$, an E.M.F. in phase with $\Phi$. However, $\Phi$ has a lead of

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nearly 90deg. relative to the current, $J_{\prime\prime}$. The back E M.F. induced between $b\ b$ possesses a lead of 90deg. relative to the current, and consequently entirely or partly suppresses the self-induction. Denoting the E.M.F., $E_R$, between B B by the symbols $E_R{}^{I}$, and that between $b\ b$ by $E_R{}^{II}$, then

$$E_R{}^{I} = 2n\,K\,.\,\frac{F_{max.}}{\sqrt{2}},$$

$$E_R{}^{II} = 2\,n\,K\,.\,\frac{\Phi_{max.}}{\sqrt{2}}.$$

The E M.F., $E_{II}$, which corresponds to the self-induction of the field-winding is

$$E_{II} = 2\sim\,.\,K\,.\,\frac{F_{max.}}{\sqrt{2}}.$$

The total E.M.F., which is required to create the field,

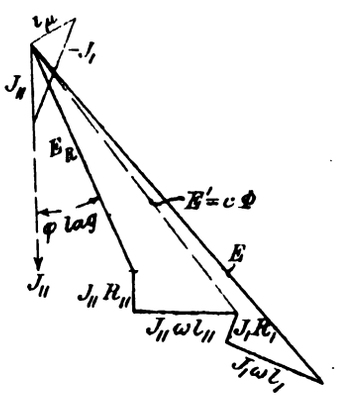


FIG. 8.

apart from the ohmic resistance and iron losses, is represented by $E_F$, and assuming the foregoing conditions may be expressed:

$$E_F = E_{II} - E_R{}^{II} = 2\sim\,K\,.\,\frac{F_{max.}}{\sqrt{2}} - 2\,n\,K\,.\,\frac{\Phi_{max.}}{\sqrt{2}}$$

$$E_F = \frac{2\,k}{\sqrt{2}}\left[\sim F_{max.} - n\,\Phi_{max}\right] \quad . \quad . \quad . \quad (4)$$

$E_F = 0$, for $\sim F_{max.} = n\,\Phi_{max.}$

$$\frac{F_{max.}}{\Phi_{max}} = \frac{n}{\sim} \quad . \quad . \quad . \quad . \quad (4A)$$

In synchronism, when $n$ is equal to the frequency, $F_{max.} = \Phi_{max.}$ Theoretically, that is to say, under the above conditions, which neglect some of the factors, $E_F = 0$. This ideal may be approached from either below or above

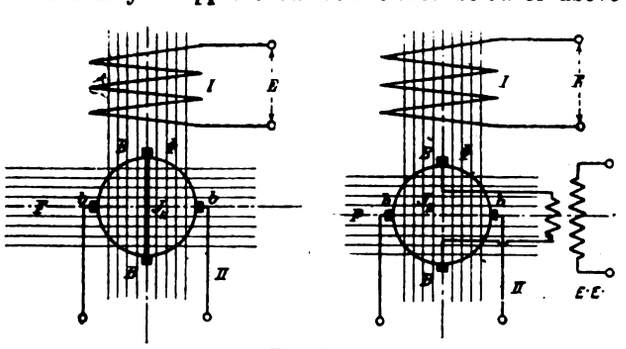


FIG. 9.

synchronous speed. It is not necessary that the winding I. should be opposed to a short-circuited armature in order to compensate the inductance of the exciting circuit. It is better to connect the brushes through some external circuit, provided $J_{\prime\prime}$ be approximately in phase with the E.M.F. generated between B B by transformer action.

8. Let us again assume that F be excited in some way—for instance, by means of a winding II. on the stator. The greatest defect which characterises all but the most recently-designed single-phase commutator motors consisted in faulty commutation—that is to say, in the short-circuit losses, due to the variation of the field, in the section of winding short-circuited through the brushes, B B (see Fig. 10). Due to the variation in the strength of the field, F, there is generated in this short-circuited section an E.M.F.,

$$e_J = 2\sim\,\kappa\,.\,F_{max.}\,.\,\frac{\pi}{2\sqrt{2}},$$

(see equation (2), $\kappa$ representing the number of short-circuited conductors.

Now, this E.M.F. effects a watt loss in the short-circuited coil, which cannot be avoided in a position of rest. The number of short-circuited conductors may be reduced, but there is a limit to what can be done in this direction. The employment of at least two independent windings offers no solution, since in reality the short-circuit is formed by two brushes (see Fig. 10A). The non-inductive resistance offered by intersecting windings is, indeed, considerably greater, but for the most part it is small as compared to the resistance of the carbon brushes, which are called upon in the first place to absorb the short-circuit energy.

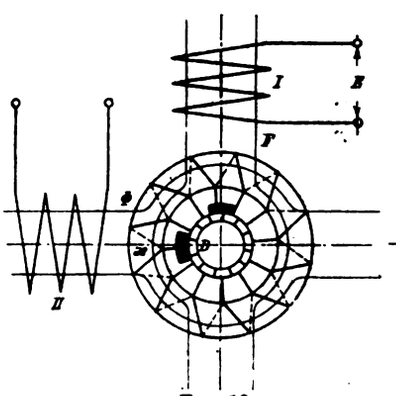


FIG. 10.

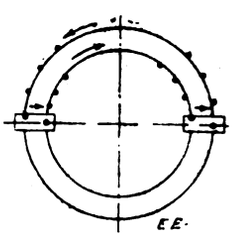


FIG. 10A.

Working on these or similar lines, then, brings us no nearer the solution of the problem. The carbon is able to carry the short-circuit energy for a short time, if care be taken in designing the machine to keep the maximum short-circuit E M F., $E_J$, within certain limits. But neither the carbon brushes nor the commutator is able to withstand the load constantly. The field, $\Phi$, again serves us in counteracting the short-circuit E M.F., $e_J$. When the armature revolves there is induced in the windings, $\kappa$, an E M.F., $e_R$, which is given by the equation

$$e_R = 2\,.\,n\,.\,\kappa\,.\,\Phi_{max.}\,.\,\frac{1}{\sqrt{2}}\,.\,\frac{\pi^*}{2}.$$

The E.M.F. acting in the section of winding short-circuited by the brushes for any speed $n$ is

$$e_R = [e_J] - [e_R]$$

(see Fig. 11). $e_J$ and $e_R$ are in phase if the phase of $\Phi$ be vertical to F. Generally speaking, $e^J$ is at right angles to F, and $e_R$ in phase with $\Phi$.

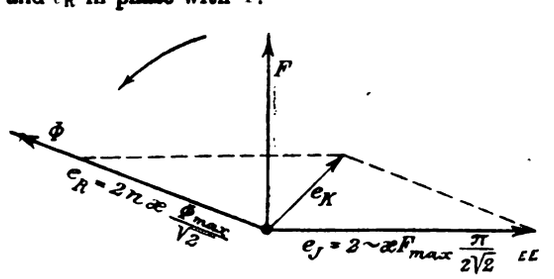


FIG. 11.

When it happens that the phases of F and $\Phi$ are superimposed

$$e_K = 2\sim\kappa\,F_{max.}\,.\,\frac{\pi}{2\sqrt{2}} - 2\,n\,\kappa\,\Phi_{max.}\,.\,\frac{\pi}{2\sqrt{2}},$$

$$e_K = \frac{2\,\kappa\,\pi}{2\sqrt{2}}\left[\sim F_{max.} - n\,\Phi_{max.}\right] \quad . \quad . \quad (5)$$

The short-circuit E.M.F., hence also the short-circuit energy is nil when

*The factor $\frac{\pi}{2}$ is introduced here because $\Phi_{max.}$ represents the time maximum, but has a local mean value.

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$$\sim F_{max.} = n \Phi_{max.},$$

or,
$$n = \sim . \frac{F_{max.}}{\Phi_{max.}},$$

or,
$$\frac{F_{max.}}{\Phi_{max.}} = \frac{n}{\sim} \quad . \quad . \quad . \quad . \quad . \quad (5A)$$

That is to say, there is a certain field ($\Phi_{max.}$) for every value of $n$ corresponding to which the short-circuit E M.F. disappears. The motor then runs as if there were no short-circuited windings. But if we compare equation (4) with (5) and (4A) with (5A), we see that the conditions required for the compensation of the inductance of the exciting coils and suppressing the short-circuit E M.F. are identical.

Or, in other words, the introduction of a field, $\Phi$, at right angles to the magnetic field, F, inversely proportional to the speed and directly proportional to F, suppresses successively both the short-circuit E.M.F., and by the excitation of F through the revolving winding, the inductance of the exciting winding.

For synchronism $n = \sim F_{max.}$ must $= \Phi_{max.}$, and as it is assumed that their phases are superimposed, this means that the ideal conditions are obtained at synchronous speeds in an alternating field.

The closer this condition is observed and the nearer the fields F and $\Phi$ are in phase, the better proportionally will be the compensation of the exciting circuit and of the short-circuit energy.

When we consider, however, that the short-circuit energy increases with the square of the short-circuit potential, it is apparent that even a partial fulfilment of the above condition conduces to a complete change in the behaviour of the motor. In the modification of $\frac{F_{max.}}{\Phi_{max.}}$ lies the possibility of attaining the sparkless running of commutator motors within wide limits.

9. The maximum possible torque depends more upon the behaviour of the commutator in an alternating-current commutator motor than in a direct-current machine. Hitherto it has been the practice to regulate the torque, which in the case of these motors also increases approximately with the square of the potential, solely by varying the potential at the motor. At the same time, in the case of series and repulsion motors, the short-circuit energy is thereby increased.

In its modified form the equation for the torque is

$$D = C . (N J) . F \quad . \quad . \quad . \quad . \quad (6)$$

Moreover, if F be excited on the rotor $(N J) = N_r J_r$; but if, on the other hand, it be excited on the stator, then $(N J) = N_s J_s$.

C is a constant given by the electrical and magnetic details obtaining in the motor.

Of the two factors included in this equation (6), which we will term the equation of commutation, (N J) is proportional to the current to be commutated, since a current proportional to (N J) must be reversed under the brushes, B B. Commutation comes first into consideration with increasing speed, because the so-called reactance pressure is proportional to the number of revolutions. But the case as regards the second factor, F, is very different. The short-circuit losses in starting up are given by the value $a F^2$, $a$ being a constant governed by the number of short-circuited turns and the resistance of these turns and the brushes. As the speed increases the short-circuit energy diminishes (see equation (5), when there is a cross-field. For starting it is, therefore, advantageous to keep the factor F within given limits at the cost of the factor (N J). If the short-circuit energy diminishes as the speed increases, we allow F to increase, and (N J) to be reduced. In order, therefore, to utilise the commutator in the right way, Winter and I have resorted to the arrangement shown diagrammatically in Fig. 12. The exciting circuit can be controlled independently of the primary voltage by connecting the winding circuit I. with the exciting circuit through a series transformer provided with means for adjusting the ratio of transformation:

F is proportional to $i$;
(N J) is proportional to $J_1$;

$$\frac{J_1}{i} = \frac{1}{u};$$

if $u$ represents the ratio of the number of primary turns in circuit I. to the number of secondary turns in circuit II. By varying the ratio of transformation, we are able to control the ratio of F to (N J). In this manner we can obtain the most favourable conditions for commutation at any speed. By changing the transforming ratio, $u$, we can impart to the whole system an impedance which is variable within wide limits. The highest value for this impedance corresponds to a small number of secondary turns, and its lowest value to the greatest number of primary turns. Hence it is possible to utilise the motor up to short-circuit current without overloading the commutator—at any rate, not with short-circuit energy due to commutation.

*(To be continued.)*

## SPEED TORQUE CHARACTERISTICS OF THE SINGLE-PHASE REPULSION MOTOR.

BY WALTER I. SLICHTER.

The following is an abstract from the *Electrical World* of a paper recently read before the American Institute of Electrical Engineers: Mr. Slichter said that for some months past he has been in charge of a series of experiments with various types of alternating-current motors, during which much attention was given to alternating-current commutator motors. The repulsion motor resembles very much a regular direct-current armature in an induction motor field. The resemblance to the induction motor is carried still further in that there is no electrical connection between the primary and secondary. This makes it possible to wind the primary for a high line voltage, while the voltage of the secondary winding is chosen at such a value as may be commutated satisfactorily, since it is short-circuited on itself through its brushes.

The motor has the same characteristics as the direct-current series motor—namely, maximum torque at starting, increasing torque with increasing current and decreasing speed, and comparatively constant efficiency through a wide range of speed. The maximum speed of the motor is limited only by the load and impressed voltage, and has no relation to the synchronous speed. Due to the reactance of the motor circuits, the power factor at starting is low, and will be with any alternating-current motor, but in the repulsion motor a low power factor does not mean small torque. On the contrary, the maximum torque occurs simultaneously with the lowest power factor—that is, at starting. The power factor of the repulsion motor rises very rapidly with the speed; it reaches a good value at one-third synchronous speed, and values near to 90 per cent. are obtained over a considerable range of speed. For this reason a large number of poles is not necessary, and frequencies of 25, 40, and even 60 cycles may be employed.

The rotating conductors of the secondary cutting the primary flux generate a leading E.M.F., which causes a leading current to flow therein, and gives the high power factor of the motor. In the plain repulsion motor this leading current never reaches a value great enough to compensate entirely for the magnetising and other wattless currents at available speeds, but the phenomenon is utilised to obtain unity power factor in the compensated type by the addition of a second circuit. The inherently good power factor of the repulsion motor makes it possible to use larger clearance between field and armature than is permitted in induction motors, thus greatly increasing its value in railway work where comparatively large air gaps are necessary The curves given are partly from test and partly from calculation of motors having air-gaps on a side of $\frac{1}{8}$in. or more. The air gap of corresponding stationary induction motors would be ·040in. and more. The efficiency, while not so good as in a direct-current motor, is yet very good, reaching values of from 80 to 85, including gear loss for sizes ranging from 50 h.p. to 200 h.p. Commutation at normal speeds is inherently good, due to the revolving field. As the speed decreases the current increases rapidly, producing a tendency to spark, but, with the reduced

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voltage of starting, the rush of current is limited to values within the range of good commutation, as in the direct-current motor. At higher speeds, ranging above 1½ times

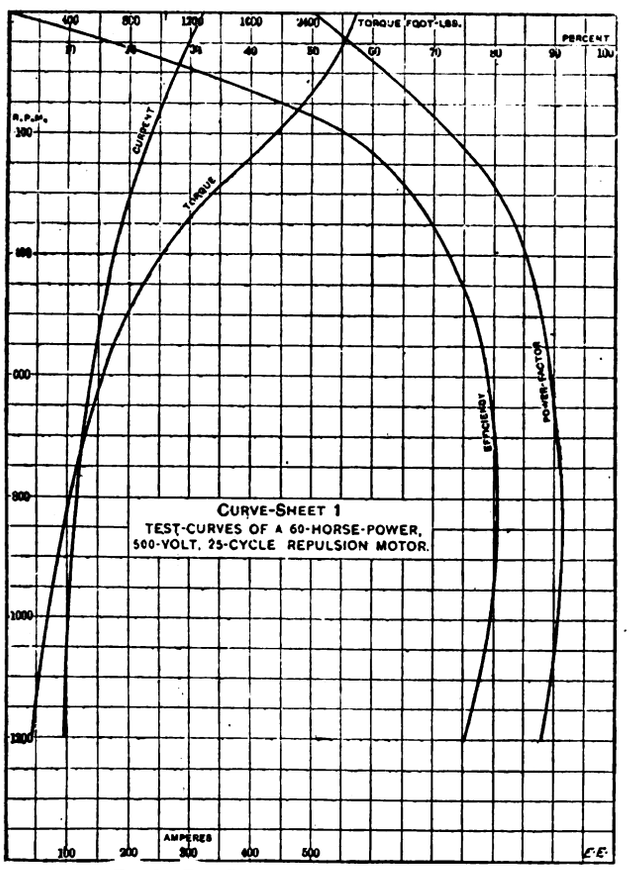


FIG. 1.—Test Curves of 60-h.p. Repulsion Motor.

synchronism, the frequency of commutation becomes high, and sparking appears.

The motor whose curves are reproduced in Fig. 1 will start with 75 per cent. of full voltage and twice full-load

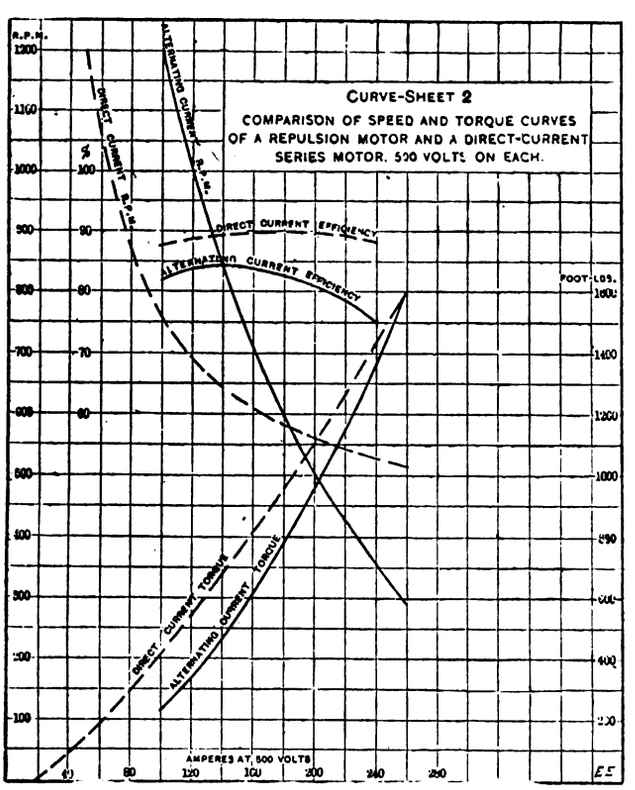


FIG. 2.—Curves of Repulsion and Direct-Current Motors.

current with no trouble from sparking. As these curves are prepared upon a railway motor basis, and full-load current will produce a rise of 75deg. C. after one hour's run, the ability of the repulsion motor successfully to commutate overloads is equal to that of the direct-current series motor; in fact, better, due to the short-circuited commutator, which makes flashing over impossible. Fig. 1 shows the characteristics of a repulsion motor plotted with revolutions per minute as a base. These curves are taken from tests on a 60-h.p., 25-cycle, 500-volt motor; they show the rapidly rising efficiency and power factor and the large torque at starting. The starting torque is 2,300 foot-pounds with an input of 325 amperes, and the normal torque during acceleration, 450 foot-pounds at 750 revolutions and 125 amperes. Thus the starting torque is five times normal and the starting current 2·6 times normal; or the torque per ampere at starting is 1·92 times what it is at normal speed, should occasion demand the full starting capacity of the motor. This statement gives an idea of the speed characteristics of the motor, which are even better shown in Fig. 2. The full lines refer to a later type of repulsion motor and the broken lines to a standard direct-current series railway motor; these curves are plotted in the usual way with current as a base. This shows that the torque increases more rapidly with increasing current in the repulsion motor than in the series; and, conversely, that the speed of the repulsion motor increases more rapidly with decreasing current than in the series motor. Efficiency, including gear loss, is given and is 84·5 per cent. at the maximum for the alternating-current motor. This motor was designed with the steep speed characteristics for acceleration work, while the motor whose characteristic curves are produced in Fig. 4 is designed for constant-speed running, and has not such steep curves but better constants at light loads.

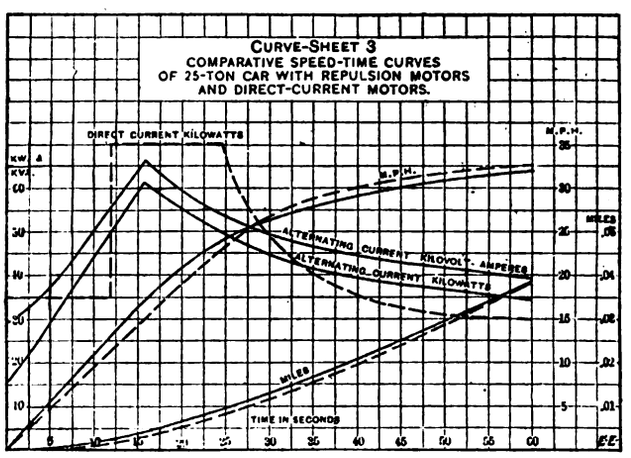


FIG. 3.—Comparative Speed-Time Curves of 25-ton Car with Repulsion and Direct-Current Motors.

The characteristics show the repulsion motor to be admirably adapted for acceleration work, the efficiency of acceleration being higher than in direct-current work, due to the possibility of obtaining fractional E.M.F.'s with alternating currents without introducing the dead resistance losses of the direct-current system of control. This is shown in the curves on Fig. 3, which gives the acceleration curves from test of a 25-ton car equipped with two 60-h.p. repulsion motors. The full lines indicate the repulsion motor characteristics, and the broken lines those calculated for a direct-current equipment. The gearing is chosen for the same free running speed—33 miles per hour—the same average acceleration, and the same distance covered in 60 seconds. For the direct-current motor the curve of kilowatts input, miles per hour, and miles travelled, are given as calculated, and for the alternating-current motor the kilovolt-ampere input, kilowatt input, miles per hour, and miles travelled from test. The repulsion motor remains on the controller only 16 seconds, and the direct-current motor 25 seconds. The maximum power taken by the direct-current motor is 70 kw., and by the repulsion motor 61 kw., or 67 kilovolt-amperes. At the end of 25 seconds the total kilowatt-hour input in the two cases is ·375 for the direct current and ·30 for the alternating current. At the end of 60 seconds both cars have covered a distance of ·039 mile and have reached practically the same speed of 32·5 miles per hour, the kilowatt-hour input being ·72 for the direct current and 685 for the alternating current. By comparing the areas of the kilowatt curves in the two cases, the gain, or rather the saving, by the

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ure of the alternating current is readily seen. It is also worthy of note that the volt-ampere input of the alternating-current motor is least at starting—that is, the line current is least. As this is the time at which the power factor is lowest, it is seen that the effect of the low power factor on the regulation of the system is much modified by the small value of the current.

Fig. 4 shows the calculated characteristics of a 175 h.p. railway repulsion motor having an air-gap of ·15in. and wound for 1,500 volts and 25 cycles. The efficiency, including gear loss, is 85 per cent. at the maximum and the power factor is 93. Such a motor is designed for heavy, slow-speed locomotive work, which is probably one of the most promising fields for the alternating-current motor. It is readily seen how well it is adapted for freight haulage by the fact that the efficiency of 85 per cent. is attained at a speed as low as 500 revolutions, thus permitting a speed of 12 to 15 miles per hour with a good gear reduction. Thus the repulsion motor is well adapted for acceleration work, as well as for efficient running at light loads, and having good constants at low speeds, is well adapted for freight haulage at low speeds. The curves given in the paper all refer to the simple repulsion motor. There are many variations of the repulsion motor, more or less complicated, from which a better power factor

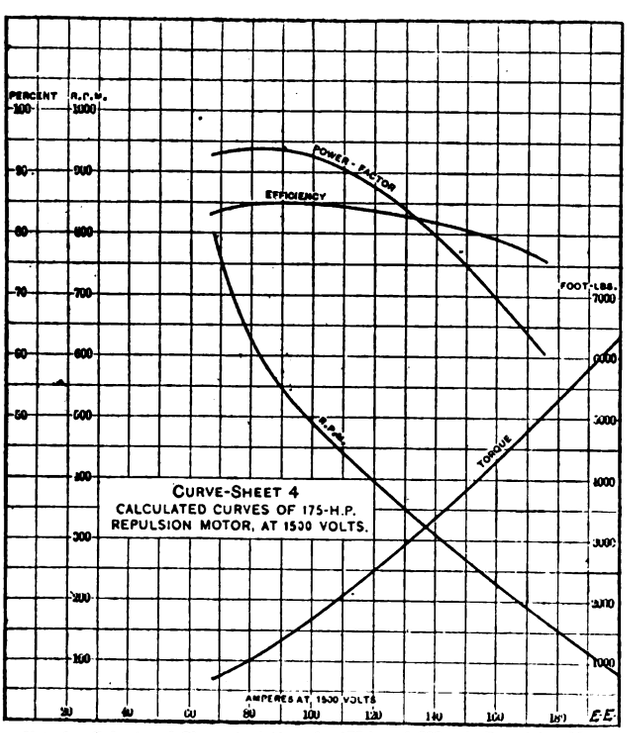


FIG. 4.—Calculated Characteristics of a 175-h.p. 1,500-volt Repulsion Motor.

and even a better efficiency have been obtained in test, but Mr. Schlecter said that a description of these various schemes, with their characteristics, would require sufficient space to warrant a distinct paper, and intimated that such a paper would be presented before the institute at some future date.

## SHOULD ELECTRIC SUPPLY UNDERTAKINGS ADVANCE MOTORS ON HIRE OR HIRE-PURCHASE SYSTEMS?*

BY SIDNEY E. BRITTON, ASSOCIATE MEMBER.

When some of my friends heard that I proposed to ask the Glasgow Section of the Institution of Electrical Engineers this question, and at the same time make an attempt to answer it, they informed me I should bring a hornet's nest around my ears. Well, gentlemen, if what I have to say is as successful as that predicted, I shall leave this meeting well satisfied with the time spent in my endeavour to develop my ideas. For having tried the hire and hire purchase system in Motherwell, and found it fully justifying my hopes in aiding the success of the electricity department there, I naturally feel somewhat inclined in weighing the *pros* and *cons.* of my question, "Should electric supply undertakings advance motors on hire or hire-purchase?" to give the *pros* the most favourable hearing. At the same time I have tried with a perfectly unbiassed mind in writing this paper to deal with each side of the subject fairly, giving neither the preference, and I look to you at the close of this short paper to give me the benefit of your ideas and experience, and so possibly enlighten me with disadvantages which I have hitherto overlooked.

Some months ago I read with keen interest the discussion by the Glasgow Corporation on this question, and, I confess, with no little disappointment, and may I say surprise, at the decision come to—viz., "referred back to committee for further consideration"—but still, upon the second time going through the objections raised, I was forced to come to the conclusion that it was a wise decision, for from those I feel the scheme set forth was not thoroughly understood, and time makes so many things clear. An electrical supply undertaking in a big city, dealing as it does with wealthy manufacturers who can afford to keep up-to-date and expend what capital they choose, and having a large diversity of power users, certainly does not need the stimulus in its supply that does an undertaking in a small town. Still I venture to state, whether in this city or any other, there is always to be found the smaller man, who, having practically no capital at his command, is always ready, if he be a truly business man, to keep as up-to date as his richer competitor, and is really glad to hire or purchase by instalments that which he could not readily obtain if a lump sum were required. So that in helping him, and looking at an electrical supply undertaking from a purely business point of view, one is always bringing grist to the mill in enlarging a day load, which, however big, one likes to see daily grow bigger, and in these days of competition and go-aheadness, whether in a profession or business, it is unwise to let slip a particle of anything that adds in any degree to success.

But I am running ahead. In bringing this question before this section, representing as it does almost every branch of electrical engineering, I do so with the hope that all here directly interested will express their views, for it is in these—shall I say debates?—that industries are often advanced, and so perhaps you by so doing will be assisting the electrical industry of this country. In almost every engineering paper are to be found articles giving instances of electrical power, and the rapid headway it is making in superseding steam, gas, and such like means of obtaining power. While that is so, there is still a very large field for electrical power, which I am confident can only be developed by the adoption of a system of hire or easy purchase controlled by the supply undertaking, whether it be under the control of municipality or private enterprise. Therefore I think that there is no necessity to bring municipal trading into this question.

Now, what is the meaning of hire and hire-purchase of motors? Briefly, this: Motors are purchased by a supply undertaking from reliable motor manufacturers, and in the case of hire lent to power users at a certain rent per annum, the motor remaining the property of the undertaking. In the case of hire-purchase, motors are lent to power users, who in return make at certain periods part payment of the capital cost of motors plus, say, some 10 or 15 per cent. on the outstanding amount; and at the end of one, two, three years, or even longer, as the case may be, the motor becomes the entire property of the hire-purchaser. Some undertakings include interest, sinking fund, repairs, renewals, and general superintendence in the amounts charged. Others merely include interest, sinking fund, and general superintendence. Which is the more correct is a matter of opinion, but for my part I prefer the latter, chiefly that it relieves the undertaking of a liability which can only be guarded against in a speculative fashion. Also it puts a responsibility on the consumer which practically enforces him to take greater care of the motor than he otherwise would do; and the consumer who best attends to his motor is benefited by less repairs, renewals, inconvenience, and expense which will otherwise occur should the motor not be properly cared for. The electric motor

* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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is almost universally known as a useful, simple, yet wonderful piece of machinery. In most cases all the operator has to do is to put his hand to the motor starter, and it seems pleased to the work it is called upon to do. Such a machine cannot help making many friends in this country of industry.

One of the great aims of the station engineer is to find work for his generating plant during the day, so as to spread the standing charges over as great a part of 24 hours each day as possible, instead of the hours of darkness only. To obtain this end every user of power must be encouraged and catered for. Some seem to think this day load is merely an advantage to the supply undertaking. While it is an advantage to the undertaking, it must not be forgotten that it is also an advantage to all classes of consumers, whether they be private consumers for lighting or for power, or street-lighting, because the greater the production the cheaper the rates of supply, and the cheaper the rates of supply the greater the number of consumers, and the greater the number of consumers the greater will be the advancement of the electrical industry. These are some of the reasons why the station engineer is anxious to obtain every consumer possible. It is also because he is fully alive to the importance of this, and anxious to supply energy at low rates to every possible consumer, that he endeavours to advance motors on hire or easy purchase. Some may say that in supplying a consumer with a motor on the hire or hire-purchase system you are making him pay a rent for the advantage which is helping those free of this rent to obtain cheaper energy. That is so, but he is gaining at the same time for the extra charges the advantage of having a reliable motor supplied him, whereas, if left to his own devices, anything might be pushed into his service. Is not the supply undertaking helping him to make money more expeditiously than if he were still muddling along with manual labour or an obsolete steam or gas engine, and so making, as it were, compound interest on his outlay? So that, if he is making the returns of the supply station larger, he is also adding to, and probably his business is progressing considerably in return for his outlay.

Then again, the question may be put, why should a consumer have a more reliable motor through these means? The answer is, there is not one of us present but knows full well the inferior machinery upon the market nowadays, and I say any station engineer, for his own and his station's credit, would be the last to supply anything but a thoroughly well-tested make of motor to any one of his consumers. The table appended will give an idea of what has been done by 30 electric supply undertakings throughout the country. This table must not be taken as up-to-date, neither must it be taken as showing all the undertakings advancing motors to consumers. It is submitted more as a practical illustration of the immense amount of good done to users of power and manufacturers of motors by the enterprise of these undertakings, who have adopted the hire and hire-purchase system. It shows a total of 3,193 motors connected, of which 1,885 are advanced either on hire or hire-purchase. I lay stress upon the good done to manufacturers of motors, for my experience leads me to believe that fully 90 per cent. of these motors would never have been used by the present users had it not been for the systems in vogue by the undertakings named. From the table it will be observed that at Motherwell 30 motors are on hire or hire-purchase. From personal knowledge of the consumers using these 30 motors, I feel confident that not one of them would have the use of a motor to-day had there not been in vogue the system of hiring-out motors. Not only has the demand for motor power been improved at Motherwell by these systems, but also for lighting. In the majority of cases a week or so after a motor is in use, the consumer is so delighted that he cannot rest until he enjoys the advantages of electric light also, which means additional business for wiring contractors.

I know that some manufacturers appear to be very much against these schemes, but business men are quite alive to the fact that if they can see a satisfactory return in laying out capital to purchase a motor outright, and have that capital at hand to invest, it should be to their advantage to do so rather than hire from a supply undertaking. In the great majority of cases the power users who take advantage of these systems are not those who are willing to, or could afford to, buy motors outright. On the contrary, it is the class already mentioned viz, those in business in a small way and those with insufficient capital. In dealing with this class of power users it is surprising how great a number would continue in the same groove in which they have been moving for years if it were not for such an inducement offered them by these means, some of them even preferring manual labour to launching out into expense of which they have had no experience, and which, having little or no knowledge of matters electrical, they look upon much in the light of a risky experiment. Then, again, there is the man starting business with very little capital. He would rather purchase a second-hand gas-engine than a motor—at least, that is my experience. There are manufacturers who recognise the benefit derived from these systems, for I can recall to mind at the present moment the names of several firms of high repute and good business standing who have already endeavoured to organise schemes in connection with supply undertakings, whereby motors would be advanced on hire or hire-purchase by the manufacturer to consumers. It is, therefore, self-evident that some quite realise that the advancement of motors is a means of reaching a demand for electrical power which is known to exist and can only be obtained by these systems. At the same time, it creates another outlet for the supply of their goods, and puts electrical power within reach of every class of power users.

For my part, I cannot see why there should be objections raised against a corporation letting out motors on hire or hire-purchase when it has an electric supply undertaking. We do not hear objections raised when the supply is controlled by private enterprise with private money, or private enterprise with corporation money. On the contrary, these private supply undertakings generally advance motors, heating and cooking utensils, arc lamps, and fit up installations generally, for the consumption of electrical energy for almost all purposes, with great satisfaction and benefit to consumers and themselves, and not a dissenting voice is heard. There may be a few manufacturers and agents who object to corporation undertakings supplying on this system, but who are they? If you make enquiries you will find that the great majority of the objectors are those who make a very poor article, agents representing a poor article, or foreign manufacturers, who find it difficult to do business with supply undertakings, whether they be controlled by corporation or private enterprise. Unfortunately for the British electrical industry, these objectors (although very rarely) are sometimes able to influence this question when the electrical supply undertaking is controlled by a municipality.

Referring to the column of the appended table, headed "Number of motors on hire and hire-purchase," 1,885 motors are purchased and advanced to consumers by the electric supply undertakings, and if their experience is similar to mine (and I see no reason why it should not be), then it is quite evident that the electrical industry has been benefited to a appreciable extent by the adoption of these systems, and not retarded as some would have us think. For the sake of argument, let us take £50 as representing the cost of each motor, to include meter, wiring, switches, starter, and other incidental expenses to fitting up of motors complete for use. On this basis 1,885 motors represent an expenditure of £94,250. Although only 30 undertakings are given in the table there are something like 80 advancing motors on these systems. Now, dealing with the latter number, and supposing that an average of 12 motors per annum are advanced for three years by each undertaking, and again taking £50 as representing the cost of each motor fitted up, we have 2,880 motors and an expenditure of £144,000 during three years. It may be of interest to some to extend this form of argument to all the electric supply undertakings in Great Britain. In round figures there are 350, and if, on an average, each advanced 12 motors per annum for three years at a cost of £50 each as above, we have a total of 12,600 motors and an expenditure of £630,000. My estimates of £50 per motor, etc., and 12 motors per annum for each undertaking are, I think, inclined to the low side, but should you think them

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both excessive, and reduce them 25 per cent., you will have 9,450 motors and an expenditure of £354,375—*i.e.*, exceeding £100,000 per annum—quite a respectable addition to the electrical industry. But this is not all. These systems add to the number of consumers for lighting, and it is necessary to provide plant at the power-house to generate the energy required. When all these issues are considered I think you will agree with me that it is impossible to estimate the impetus that might easily be given to the electrical industry if all those interested in the manufacture and fitting up of electrical apparatus generating and supplying electrical energy, would do their utmost to encourage the supply of electric motors to consumers by electric supply undertakings.

I submit I have proved that in the interest of manufacturers of electrical apparatus, of contractors, of supply undertakings, and of all classes of consumers of energy, unstinted encouragement should be given to those who wish to advance electric motors on hire and hire-purchase system to consumers who have not the capital at hand to purchase outright, and who, but for the hire and hire-purchase system, would drag on without electric energy till the crack of doom.

| Local authority or company supplying the current. | Number of motors at work. | Number of motors on hire or hire-purchase. |
|---|---|---|
| Aberdeen Corporation | 250 | 143 |
| Bolton Corporation | 112 | 56 |
| Bradford Corporation | 913 | 641 |
| Brighton Corporation | 169 | 28 |
| Bristol Corporation | 227 | 42 |
| Derby Corporation | 176 | 135 |
| Halifax Corporation | 67 | 15 |
| Salford Corporation | — | 20 |
| Sheffield Corporation | 167 | 143 |
| Norwich Electricity Company, Limited | 143 | 12 |
| Portsmouth Corporation | 96 | 68 |
| St. Helens Corporation | 97 | 81 |
| West Ham Corporation | 60 | 25 |
| Blackburn Corporation | 110 | 75 |
| Bromley (Kent) Electric Light and Power Co. | 15 | 10 |
| Burnley Corporation | 51 | 34 |
| Bury (Lancs.) Corporation | 64 | 33 |
| Ilford Urban District Council | 23 | 18 |
| Keighley Corporation | 24 | 16 |
| Leigh Corporation | 45 | 22 |
| Maidstone Corporation | 18 | 10 |
| Melton Mowbray Electric Light Company | 17 | 10 |
| Nelson Corporation | 21 | 19 |
| Northallerton Electric Light and Power Co. | 14 | 14 |
| Shipley Urban District Council | 20 | 19 |
| Farnworth Urban District Council | 44 | 37 |
| Guernsey Electric Supply Company, Limited | 60 | 40 |
| Huddersfield Corporation | 90 | 80 |
| Motherwell Corporation | 82 | 30 |
| Accrington Corporation | 18 | 9 |
| | 3,193 | 1,885 |

## COMPANIES' REPORTS.

### WESTMINSTER ELECTRIC SUPPLY.

The report of the directors for the year 1903 states that the supply of current, which on Dec. 31, 1902, was provided for the equivalent of 602,976 lamps of 8 c.p., had increased by Dec. 31, 1903, to the equivalent of 662.129 lamps, and applications for supply continue to come in at a satisfactory rate. The length of roadway in which continuous-current mains have been laid now exceeds 73 miles, making about 279 miles of ways, into which upwards of 230 miles of copper (strip and cable) have been drawn. In addition, three miles of trunk mains (12 miles of ways) are laid in the Company's area to connect the stations with the Central Electric Supply Company's station at St. John's Wood. The system of public lighting undertaken by this Corporation continues to give great satisfaction. The station of the Central Electric Supply Company at St. John's Wood has been at work and has supplied a considerable amount of current to this Company during the year. In the initial stages of working the cost of production is necessarily high, but the increased demand during the current year will enable the Central Company to supply at a considerably lower rate to the Westminster and St. James's Companies. A copy of the accounts of the Central Electric Supply Company is enclosed for the information of shareholders. The directors have acquired from the Duke of Westminster a long lease of a site in Duke-street, Mayfair, for the provision of an underground transforming station. The contract for the building works (which has already made considerable progress) has been placed with Messrs. George Trollope and Sons, Limited, and the first section of plant for the equipment of the station is on order. This station will be ready for the heavy load of next winter, when the capital expended on the work will commence to be remunerative. The result of the year's working is again very satisfactory, and the directors are pleased to be able to recommend the payment of an increased dividend. Having in view the desirability of a further reduction in the rates for supply, such reduction tending in the earlier stages to affect the balance available for distribution to the shareholders, they have thought it advisable, with a view to this and other contingencies, to carry forward a larger amount than in previous years, pending the increase in revenue which may be expected to follow. An interim dividend at the rate of 13 per cent. per annum on the ordinary shares and the dividend on the 5 per cent. preference shares for the half-year ending June 30, 1903, has been distributed. After allowing for depreciation sinking fund, etc., the net balance is £49,586. 4s. 4d., from which must be deducted the second half-year's dividend on the preference shares, which absorbed £3,357. 3s. 8d., leaving a balance of £46,2.9. 0s. 8d. Out of this the Board recommend the payment of a dividend at the rate of 14 per cent. per annum, less income tax, for the past half-year, carrying forward a balance of £9,494.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 54,895 | 5 | 10 |
| Purchase of current from the Central Company | 18,537 | 11 | 3 |
| Distribution of electricity | 6,519 | 4 | 4 |
| Arc lamps—cleaning recarboning, etc. | 5 200 | 15 | 4 |
| Rents, rates, and taxes | 16 350 | 15 | 8 |
| Management expenses | 13,460 | 16 | 1 |
| Law and parliamentary charges | 233 | 2 | 9 |
| Sinking fund and depreciation account | 28 774 | 0 | 0 |
| Special charges—insurance, etc. | 3,338 | 12 | 2 |
| Total expenditure | 147,310 | 3 | 5 |
| Balance to net revenue account | 83,168 | 9 | 8 |
| | £230,478 | 13 | 1 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current by meter, less bad debts | 201,853 | 19 | 5 |
| Public lighting, including rental, etc., arc lamps, etc. | 21,317 | 13 | 7 |
| Rental of meters, etc., on consumers' premises, etc. | 7,246 | 5 | 1 |
| Transfer fees | 60 | 15 | 0 |
| | £230,478 | 13 | 1 |

| Abstract of Balance-Sheet. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 940,755 | 0 | 0 |
| Amount received on founders' shares cancelled | 5.0 | 0 | 0 |
| Sundry creditors | 20,732 | 16 | 10 |
| Unclaimed dividends | 38 | 18 | 6 |
| Deposits by consumers | 129 | 10 | 0 |
| Debenture interest accrued, less income tax | 4,174 | 5 | 4 |
| Depreciation account | 113,070 | 19 | 1 |
| Sinking fund | 24,240 | 9 | 3 |
| Reserve fund | 11,252 | 12 | 2 |
| Net revenue account, less interim dividends | 49,586 | 4 | 4 |
| | £1,164,480 | 15 | 6 |

| | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended on works | 941,376 | 7 | 6 |
| Stores in hand | 3,659 | 9 | 8 |
| Sundry debtors for current supplied | 65,021 | 13 | 6 |
| Other debtors on open accounts | 4,229 | 1 | 11 |
| Cash at bankers and in hand | 23,067 | 14 | 8 |
| Temporary investments | 20,330 | 1 | 7 |
| Investments at cost | 27,974 | 1 | 7 |
| Share capital and stock, Central Electric Supply Company | 75,505 | 18 | 0 |
| Advances under house-wiring agreements | 155 | 14 | 3 |
| Deposits with vestries, etc. | 3,170 | 12 | 10 |
| | £1,164,480 | 15 | 6 |

Statement of Electricity Generated, Sold, etc.

| | | |
|---|---|---|
| Board of Trade units generated | | 14,216,263 |
| Quantity utilised. Sold to consumers | 13,086,596 | 13,246,834 |
| Quantity utilised. Used on works | 160.238 | |
| Quantity expended in distribution. In batteries | 25,905 | 874,351 |
| Quantity expended in distribution. In feeders | 848,446 | |
| Total quantity accounted for | | 14,121,185 |
| Quantity unaccounted for | | 95,078 |

Number of lamps on circuit, 662,129.

### POOLE AND DISTRICT ELECTRIC TRACTION.

The report of the directors for 1903, to be presented at the meeting on the 16th inst., states that the additional outlay on capital account has amounted to £3.115, and the total capital expenditure to date now stands at £67,787. Receipts on revenue account amounted to £15 661, and expenses, including £351 for loan interest, to £9 993, leaving a profit of £5,668, to which should be added £959 brought forward from last account, making £6,628 available for distribution. The directors recommend that there should be placed to credit of depreciation and reserve fund £1,000, and, after paying a dividend at the rate of 10 per cent. per annum, there remains to be carried forward £628. The number of passengers carried was 2,428,212, an increase of 309,526. The same number of cars has been in service during 1903 as during the preceding year. The Christchurch and Bournemouth Tramways Act, 1903, received the Royal assent on Aug. 11, 1903, and extended the time for the completion of the works authorised by the Christchurch and Bournemouth Tramways Act, 1900, until Aug. 6, 1906. The Bournemouth Corporation Tramways Act, 1903, authorising, *inter alia*, the purchase of the Company's undertaking, having been passed, negotiations are proceeding with a view to carry into effect the agreement between the Corporation and the Company which has been confirmed by this Act of Parliament.

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## NOTES.

**Electrical Contractors' Dinner.**—The third annual banquet of the London Electrical Contractors' Association will be held on Wednesday, April 13, at the King's Hall, Holborn Restaurant, at 7 p.m. Applications for tickets (8s. 6d. each) should be made to the hon. secretary of the association, at 141, Fenchurch-street, E.C.

**Electric Power on Ships.**—Mr. D. K. Roberts read a paper before the Bristol Channel centre of the Institute of Marine Engineers recently on the application of electric power to cargo steamers. Mr. Roberts in his paper advocated the adoption of electrical driving for all auxiliary plant on board cargo steamers. He held that these, supplied from some efficient steam dynamos in the engine-room, would result in the more rapid and economical handling of cargo. The paper contained comparative figures of cost for steam and electrical auxiliaries.

**The Snowstorm.**—The heavy falls of snow this week have been responsible for serious breakdowns in the telegraph and telephone systems, but the low temperature accompanying the fall has tended to keep this damage much below what it otherwise would have been. The heaviest falls appear to have occurred in the Kendal district, where communication by telegraph was completely interrupted. At Barrow-in-Furness the snow interfered with the new tramway service, and a large number of telegraph and telephone wires were down in the immediate vicinity.

**Electric Pumps in South Africa.**—In our issue of Jan. 8 we described some electrical motors connected to mining pumps which had successfully withstood immersion under between 500ft. and 1,000ft. of water for 2½ years. One of our readers in South Africa now writes to inform us that these pumps, of which there were 12, were manufactured by the General Electric Company of New York. They were each of 50 h.p., and were of the three-phase type, being wound for 110 volts and 60 cycles. It will be remembered that after this long immersion the motors were only dried and then put to work again.

**Folkestone Tramways.**—Folkestone seems to be the happy hunting ground for inventors of surface-contact systems of electrical traction. The members of this Corporation will, if the present condition of affairs goes on, be able to start in business as professional experts on this subject. Practically every system we know of has been explained to the Council, and the last news shows that the Kingsland mechanical surface-contact system is on view at the Masonic Hall. We are afraid that Mr. Merz, who is to report on the various systems to the Corporation, will find difficulty in getting his clients to come to a definite decision one way or the other owing to the diversity of their own opinions on the matter.

**Snowdon Electric Railway.**—The scheme which has been authorised by the Light Railway Commissioners for an electric light railway with overhead trolley wire equipment between Beddgelert and Bettws-y-coed, is meeting with considerable opposition from an æsthetic point of view. The road is one of the most picturesque in the United Kingdom, and it is claimed that it will be spoilt by the laying down of this railway. On the other hand, the railway would be the means of making this route available for a very much larger number of travellers, and it remains to be seen if the advantages gained from electric traction will not more than compensate for the presence of the overhead wires along the road. We understand that the Commissioners were prepared to introduce a clause to secure most careful treatment, from an æsthetic point of view, of certain portions of the route.

**Wireless Telegraphy and the Government.**—Rumours are afloat of a possible agreement between Mr. Marconi and the Post Office, by which the former will be in a position to establish wireless telegraphy in this country on a commercial basis. It seems that there is now a disposition on the part of the Post Office to accept the experience of the Admiralty as having established the practicability and efficiency of the Marconi apparatus. An amicable agreement with the British Government it may be taken for granted is a condition precedent to the success of Mr. Marconi's scheme for a Transatlantic wireless telegraph service. Mr. Marconi himself is very sanguine as to the final issue of a wireless service between the American Continent and the British Isles, and ultimately he hopes to establish similar communication between Italy and this country and Italy and Argentina.

**International Code Telegraphy.**—The Postmaster-General has forwarded to the London Chamber of Commerce a copy of the revised rules respecting code language and cipher in international telegraphy, which will come into force on July 1, 1904. The Postmaster-General has added a letter to the compilers of codes, who, it is understood, are drawing up new editions, pointing out that whilst the conference in London in 1903 had decided to admit artificial combinations on the same footing as real words, the admission of such artificial combinations to the benefit of code language rested on the assumption that they would be easy to transmit, and the use of expressions which are difficult to pronounce, and consequently to transmit, would be regarded as a breach of the spirit of the regulations, which should be avoided by the public in the interests of the rapid and accurate transmission of their telegrams.

**Technical Education in South Africa.**—The announcement of the appointment of Prof. Hele-Shaw to organise technical education in South Africa was made in these columns some few weeks ago, and we are glad to hear that a start has already been made. On Feb. 1 arrangements were completed for holding the first and second years' courses of the South African School of Mines at Johannesburg, the first and second courses being taken, as at present, at Cape Town. The general curriculum is as follows: (1) mechanical and electrical engineering and engineering drawing; (2) principles of mining and mine surveying. The fourth year's class will embrace (1) mining economics, (2) surveying, (3) treatment of minerals, (4) assaying, (5) mechanical engineering, and (6) electrical engineering. The senior professor and professor of mechanical and electrical engineering is Mr H. S. Hele-Shaw, and the assistant professor Mr. John Orr, of Kimberley.

**St. Marylebone Lighting.**—Another hearing in the Law Courts, before Mr. Justice Buckley, has given the St. Marylebone Corporation an extension until April 30 for the completion of their purchase of that portion of the Metropolitan Supply Company's undertaking within the borough boundary. The consideration for this extension has been fixed at £15,000, to be paid before the end of the present month. The supply company have asked to be heard before the Select Committee which will consider the Bill promoted in Parliament before the Borough Council, but owing to an objection this question will have to be settled by the Court of Referees. It will be an interesting point as to whether the company is, under the present circumstances, entitled to be heard as a ratepayer. The Corporation is making application to the London County Council for a loan of the amount yet to be authorised by the Bill. This Bill is to be amended to allow of the Corporation leasing the undertaking to a company if desired.

**Technological Scholarships.**—The educational department of the County Council for the West Riding

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of Yorkshire have just issued Part 2 of their programme for 1904, which deals with scholarships, free studentships, and exhibitions. The dates for applications for these various educational aids are given on the first page, and they should be consulted promptly by any Yorkshire students, as the closing date for certain of the scholarships is the 21st inst. The details given of the large number of scholarships and exhibitions available is also worthy of careful study, and the County Council is to be congratulated on the wide scope of its programme. There are offered this year four technological scholarships, each of the value of £60. The awards are made for one year, but they will be renewed for a second year if satisfactory progress is made, and for a third year under special circumstances. The selection of candidates will be mainly based on results obtained both at examinations under the South Kensington department and the City and Guilds of London Institute.

**A Switchboard Fire.**—We learn that a fire occurred behind the Trafford Park power station switchboard on Friday morning at seven o'clock, due to an overheated cable end dropping out of its socket and going to earth on the iron framework. Considerable sparking ensued, and the rubber cables in the vicinity were burnt up, also the wooden platform, before the flames could be got under. A booster was short-circuited past immediate redemption, and the connecting leads to the other booster were burnt up. The machines had to be shut down for an hour or so, and later on supply at 500 volts only between outers was substituted for the usual 250 volts on either side for part of the day. An annoying part of the affair was the fact that fire-resisting cable should have been substituted for the present equipment a short time ago, but other machinery overhauling work had been done by the staff instead. Otherwise the load could have been transferred from the damaged to the sound booster in a fraction of the time that it took to extinguish the flames, and to get fresh cables connected. The occurrence also draws attention to the trouble which may arise from using cables of too small a sectional area, or from imperfect soldering between the cable and socket. The more mechanical such connections can be made the better.

**London Traffic Commission.**—At a meeting of this Commission last week Lieut.-Colonel Crompton, R.E., gave evidence which will be interesting to electrical engineers, although it may not be endorsed by many of them. His remarks as to the immediate improvement in the state of the London traffic if heavy vehicles were kept close to the kerb will be endorsed, however, and we quite agree with him that there should be improvement in the roadways. He advocated the London County Council buying up corner houses at the important corners, and thus providing more road space at these points. Another measure proposed by him was the provision of alternative routes for congested traffic, which routes might be either underground or overhead. He was opposed to the construction of tramways in Central London. It is with his general statement, however, that electric tramways do not afford rapid transit that electrical engineers will differ. It is interesting also to compare the preference given by Lieut.-Colonel Crompton to motor omnibuses with the statement recently issued by the London General Omnibus Company. It was stated in the daily papers only last week that this company, which is most concerned in motor traffic and has tried a large number of motor 'buses, has not up to the present been able to obtain anything which is likely to be at all a success commercially. Earl Russell also gave evidence at the same meeting and advocated the construction of more viaducts. For instance, there might be one from Fleet-street to Ludgate-hill. His next proposal was that radiating thoroughfares should be driven from the heart of the town to the outskirts. Such roadways would have to be 120ft. wide at least, and must cross most of the existing roadways by bridges, in order that the traffic on them might not be obstructed. Four lines of electric tramway should be run under the surface—two for slow traffic and two for fast traffic—with stopping places at half-mile intervals. Foot passengers would cross by over-bridges. The total cost of such roads, together with the acquisition of property, might average £2,000,000 a mile.

**German Electrical Combine.**—A considerable amount of information has now been issued as to the amalgamation between the Allgemeine-Gesellschaft of Berlin, on the one hand, and the General Electric Company of New York and its European offshoots, on the other. These statements were prepared for the shareholders of the German company, who have now sanctioned an increase in the share capital from £3,000,000 to £4,500,000. A large portion of this additional capital is required for the absorption of the Union Electricity Company of Berlin, and for cementing an alliance with Messrs. Brown, Boveri, and Co. With regard to the agreements between the American General Electric Company and the Berlin Allgemeine Company, relating to the interchange of patents, the limitation of markets and the joint development of the Curtis and Riedler-Stumpf steam-turbines, it appears that an agreement with the British Thomson-Houston Company has also been concluded by the Berlin company in regard to the export trade. In addition to this, the British Thomson-Houston Company is afforded certain facilities, including the right to financial participation in the English branch of the German company (the Electrical Company), and in a company which may be formed in England for the actual manufacture of Nernst electric lamps. On the other hand, the Berlin company reserves to itself the right of exporting electric manufactures to England in addition to steam-turbines, the construction of which has already been commenced at the British company's works at Rugby.

**The Metric System.**—Last September Mr. Joseph Chamberlain issued a circular dispatch to all the Colonies requesting a statement of their views upon a resolution passed at the recent conference of Colonial Premiers in London with regard to adopting a metric system of weights and measures for use within the Empire. Replies have now been published, and they may be summarised as follows: The metric system is already used in Mauritius and Seychelles. The following are favourable to its adoption: Australia, New Zealand, Cape of Good Hope, Transvaal, Orange River Colony, Southern Rhodesia, Gambia, Northern Nigeria, Gibraltar, British Guiana, Trinidad, Leeward Islands, Windward Islands; also, with a reservation that it must be adopted in the United Kingdom or in the Empire generally, Sierra Leone, Southern Nigeria, Ceylon, and Falklands. Hong Kong would take common action with other Colonies. The States of New South Wales, Victoria, and Western Australia are also favourable, but, together with South Australia and Tasmania, consider that the matter is one for the Commonwealth Government. Fiji is doubtful, but must follow Australia and New Zealand. British New Guinea would go with Australia. Jamaica and British Honduras need the adoption of the system in the United States of America. The practice of India is important to the Straits Settlements, who would be followed by Labuan; and the Bechuanaland Protectorate would follow the rest of South Africa. St. Helena, Cyprus, Lagos, Wei-hai-wei, Barbados, and Bahamas are, on the whole, unfavourable. The Gold Coast Colony and the State of Queensland are prepared to adopt, but consider that incon-

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venience would occur. Natal cannot consider the matter until some general lines of legislation have been agreed upon by his Majesty's Government. No definite answer has been given by Newfoundland, Malta, or Bermuda. Canada has not yet replied. Writing from memory, the resolution of the Colonial Premier in favour of the adoption of the metric system was permissive only, and did not involve, as the most advanced advocates of this system wish, the abolition of our present system of weights and measures.

**Competition of Electricity with Gas.**—A meeting of the London and Southern District Junior Gas Association was held last Friday at the Regent-street Polytechnic. An interesting paper was read by Mr. F. Ainsworth, of Ilford, on "Domestic and General Gas Supply," in which the author gave the results of his personal observations and experience in the matter. Coming from Ilford, where the competition has been, and is, most keen, the author's facts are most interesting. Mr. Ainsworth complained of many things, but especially of the electric incandescent street-lighting carried out regardless of expense. The supply to the tramways cost 2d. per unit, whereas the Council supplied small motors at 1¼d. per unit to compete with gas-engines. The conditions of supply may, however, not be the same. Free wiring slot meters installed in small houses, etc., also seem to have been deprecated by the author. The main fact, which is most valuable in face of the usual figures published in the gas interest, is that the Ilford Gas Company found electricity at 5d. per unit a serious competitor to gas at 3s. 6d. per 1,000 cubic feet. In the course of the discussion, one gentleman remarked that everything was topsy-turvy now to what it used to be. In the old days, if anyone wanted a gas service, he had to go to the outer office of the inspector's department of the gas company, take off his hat, carefully wipe his shoes, and speak nicely to the inspector; and then, in course of time, he would get his request complied with, after signing a very strong agreement and depositing some good sovereigns. All this had passed, however, and they were concerned now with the present and the future. There was no doubt that electric lighting was a very keen rival to the gas companies; they must admit this, and then make preparation to compete with it. For instance, taking the London area, it was totally different from others that might be represented there that night. They found that the three principal gas companies were constantly losing consumers by the hundred. That was to say, they were taking out meters sometimes running into four figures. It would be apparent to all that, in the case of a large improvement like the thoroughfare from the Strand to Holborn, when the County Council pulled the houses down the meters came out in very large numbers, and they were not replaced, because the space was filled up with very large buildings which were at once wired for electricity. It was then explained that the increased demand for gas-engines had kept up the quantity of gas used.

**Electric Railways.**—On Friday evening last the lecture at the Royal Institution was given by Mr. Alexander Siemens, who chose for his subject "New Developments in Electric Railways." The lecture was largely illustrated by lantern slides, which enabled Mr. Siemens to explain clearly the details of the Berlin Overhead Railway, the Langen mono-rail line between Elberfeld and Barmen. He explained that these lines, which were comparatively short ones, resembled tramways in the character of their traffic, continuous-current motors were employed, using currents at low voltage, but for main lines it was evident that the requisite energy must be supplied by high-tension currents. With this conviction, in 1892 Messrs. Siemens and Halske had shown experimentally at Charlottenburg a small line working with a three-phase high-tension alternating current collected from overhead conductors, and in 1898 they constructed a similar line in which a current with a potential of 10,000 volts was employed. This latter was the forerunner of the high-speed trials of last year on the Marienfelde-Zossen military line. In November, 1899, a syndicate was formed to carry out these trials, and two firms, Messrs. Siemens and Halske and the Allgemeine Electricitäts-Gesellschaft, were asked to design cars to attain a speed of 125 miles an hour. Various preliminary experiments had first to be carried out, and the actual trials did not begin till 1901. The permanent way not being in very good condition, the highest speed attained in that year was 100 miles, but the trials were sufficient to demonstrate the adequacy of the system of construction used for the conductors, the collectors, the motors, etc. It was not possible to arrange for the relaying of the line in 1902, but in 1903 it was brought up to the standard of a Prussian main line for express traffic, with the addition of special guard rails, which, however, in fact, were not required; and in the autumn the cars of both firms attained speeds of over 125 miles an hour. It might be said, therefore, that the technical problem of applying electric traction to main lines at high speeds was solved. But it was premature to say electricity could be generally adopted on them. On the Zossen line there was no curve of less than 2,180 yards radius, and the worst gradient was 1 in 200; on existing lines the conditions were very different, and if the same results were to be repeated it would be necessary to build them in a similar manner. This would require a very large outlay, which could only be warranted by an enormous traffic, and it must be remembered that the economical result would always decide the issue, though due consideration should be given to the proverb "Time is money." In the course of his lecture Mr. Siemens also referred to other instances of the use of high-tension currents for electric traction, such as the three-phase system of Messrs. Ganz on the Lecco-Sondrio Railway, and the single-phase systems of Mordey and Jenkin, Lamme, the Union Electric Company of Berlin, etc.

**Electric Traction on Ordinary Railways.**—On Feb. 13 delegates of the Swiss Government Commission for Electric Plant and of the Swiss State Railways inspected the experimental electric traction plant made by the Maschinenfabrik Oerlikon, near Zürich, with reference to the tests which are to take place on the Seebach-Wettingen line of the Swiss State Railways, roughly 12 miles. An electric locomotive of 400 h.p., fed by single-phase current at pressures up to 15,000 volts, was run on the temporary track. This locomotive is a new improvement in the development of electric traction on railways, and the first test has shown the possibility of conveying current to railway trains on even very long lines in an economic and essentially in a simple way. The economy is effected by the possibility of collecting very high-tension current, and the simplicity is due to the use of single-phase current combined with a special device for collecting the current designed by the company. The experimental locomotive is able to pull on the level a 500-ton goods train—*i.e.*, about 30 loaded trucks—at a speed of 25 miles an hour. The necessary current collected from the wire is only 37 amperes, which corresponds approximately to that taken off a trolley line by a fully-loaded tramcar at a pressure of 500 volts, whilst in the case of the locomotive the high-tension makes up the necessary energy of 400 h.p. with this small current. The new current-collecting device patented by the Maschinenfabrik Oerlikon has been specially designed for high-tension

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and single-contact lines, and differs essentially from what has been done up to the present in this direction, especially with regard to simplicity and durability. The contact line in the open country consists of a single strong wire, which is not fixed on brackets or suspended above the track, but is clamped on the heads of the insulators themselves on the top of the poles at the side of the track at a height of 16ft. to 17ft. The space above the track is, therefore, completely free, and such contact lines can be run on both sides of the track, either connected or independently. Another notable feature is that repairs can be made on the contact lines without obstructing the track. It is only at junctions where several tracks run parallel or cross each other, or in tunnels, stations, or under bridges, that the contact lines are run over the middle of the track, as in electric tramways. The current collector follows automatically without shock or sparking the contact line whatever its position relative to the track. This method of collecting the current permits of its adaptation to existing railways whatever their clear profile. In contrast to the contact arrangements as used up to the present, the contact piece of the Oerlikon device, the only part subject to wear and tear, is of extremely small mass (about 3lb. of metal tubing), is cheap, and easily renewed. The device collects the current at any speed, in any direction without adjustment, and with the contact wire in any position relative to the track. The collector cannot possibly foul or tear down the contact line. Should the contact piece break or derail, which is a very remote possibility, it would fall back into such a low position that no part of it could touch the contact line.

**British Patent Law.**—In our last week's issue we gave a complaint made by Mr. W. Lowry on the action of the English patent law as preventing rather than encouraging invention. We are pleased to see in this *Journal* of the Society of Arts Mr. C. D. Abel replying to Mr. Lowry, and voicing more fully our expression of opinion last week. Thus, Mr. Abel says the United States and German patent laws may be well enough in theory, but in actual practice they are tyrannical, and operate to the prejudice of the inventor, inasmuch as in both cases the inventor is under the complete thraldom of an opiniated examiner, with the result, firstly, that he is forced to divide the subject-matter that is covered by one British patent into a number of separate patents, entailing a corresponding increased cost to the inventor. Secondly, he has to argue with the examiner—for years sometimes—before the latter will allow that the inventor has any patentable invention at all, and he may have to appeal (in the case of the United States) first to the Board of Examiners-in-Chief, then to the Commissioner of Patents, and then possibly to the Supreme Court, before he can get his patent allowed, all of which, of course, may run the inventor into very great expense, as patent attorneys and counsel do not work for nothing. Thirdly, the inventor must word his claims, not as he considers best for the protection of his invention, but as the examiner thinks fit; and the views of the examiner in this respect are most peculiar, and not conducive to a plain and straightforward expression of the invention, that anyone could readily understand. This is due (I am now speaking of the United States) to the existence of the following four main rules that have been laid down by the examiners of late years: (1) You cannot have a patent for a method of operating unless this can be expressed entirely without reference to apparatus or machinery; (2) you must not, in a claim for construction of apparatus or machinery, introduce any description of the manner in which it operates—your claim must be limited to the enumeration of the cranks, levers, cams, etc., that constitute your machine; (3) you cannot in one and the same patent include a method of operation and the machine or apparatus by which that method of operating is carried out; (4) if your invention is capable of being carried out by several modified arrangements, you must take out a separate patent for each such modification, as each one is considered a separate invention. The result of all these wonderful rules is that the poor inventor is obliged to go to the expense of perhaps half a dozen patents to secure what he has got covered by a single patent in England; that frequently he cannot protect the most vital part of his invention at all—namely, a certain method of operating involved in the apparatus he has invented—and that he has to undergo interminable arguments with an opiniated examiner before he can convince him that he has any patentable invention at all. Mr. Abel also gives figures to prove that in spite of the examination the proportion of patents held to be invalid in Great Britain, Germany, and the United States respectively is practically the same, notwithstanding the strict examinations in the latter two countries for novelty.

**The Northampton Institute.**—The prize distribution at the above institute on Friday last was well attended by prominent men interested in technical education. Lord Kelvin distributed the prizes, and in the course of his speech said he had had an opportunity of seeing part of the electrical engineering department of the institute, and he had been greatly struck with the splendid arrangements in the engineering laboratory for giving scientific instruction in the most practical way. A large proportion of the students were already engaged in practical work, beginning to earn or earning their livelihood, and it must be a great benefit to them to have the scientific instruction which the institute afforded. The scientific aspect of this work was more interesting to him than he could express. When they thought of the great discoveries of Faraday in England and of Henry in America, and the succession of workers from their time to the present day who had added so much to our knowledge, they could not help being struck with the enormous progress which science had made within a comparatively short period; and perhaps that progress had been even more remarkable and striking at the beginning of the twentieth century than during the whole of the nineteenth century. Many of these discoveries were for the moment in the realm of pure science, presenting no prospect of practical application; but what was to be thought of a scientific investigator who only looked for an immediate practical application of the result of his labours? The electrical discoveries of Faraday and Henry would never have been made if those great men had contented themselves with asking, *Cui bono?*—who will benefit by them? Even at the Northampton Institute he trusted that at least part of the object of the instruction was to give happiness to those who were learning, and to give them some insight into the laws of Nature. He believed that the everyday workman would be all the happier for knowing something of the laws of Nature developed in the work he was called upon to perform. The habit of mind of thinking scientifically and bringing scientific knowledge to bear on the practical work of life would not only contribute to the work being well done, but would largely contribute to the richness and mental wealth of the world. He trusted that the students would learn a good deal at the institute which would remain with them and be a valuable possession to them as long as they lived. Prof. Walmsley, in the course of his annual report, said that on the educational side the work done by the students continued to be satisfactory, and the average number of

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hours worked per student was again high. These student hours, in his opinion, was a better test of the work done by the institute than either the number of individual students or the number of class entries. The total worked was over 95,000, excluding all who had not reached 20 hours. As remarked in previous reports, the very specialised work of the institute does not lend itself well to brilliant results in outside examinations and competitions, but the successes obtained both in examinations and competitions were gratifying. In the examinations of the City and Guilds of London Institute a number of medals and prizes were obtained, and in the open competitions for the London County Council's scholarships in artistic crafts work, 14 exhibitions and scholarships were obtained as against eight in the preceding year. The electrical engineering department still continued to attract by far the greater number of students, and its work was steadily developed during the period under consideration, especially in the direction of the laboratory work and equipment. Laboratories, workshops, and lecture-rooms are now overcrowded, and students have been turned away in greater numbers this year than before. Additional accommodation was very urgently required. Prof. Walmsley also referred to the special work in technical optics done at the institute. Speaking of his tour in the States, he said that on his return he had recommended that the day courses in engineering should be extended from two to four years, and that, if possible, arrangements should be made for two periods of six months each in commercial workshops to be included in the training. Before his tour he considered that the two years' course followed in the pioneer classes was far too short for the work to be done efficiently, and this conclusion was so materially strengthened during his tour that he had no hesitation in making the recommendations which were adopted by the governing body. The programme of music and the exhibition of the workshops and laboratories were as interesting as usual.

**Transatlantic Engineering.**—At their ordinary meeting on Thursday evening last week the members of the Institution of Electrical Engineers engaged in a well-sustained discussion on Transatlantic engineering and engineering schools—a subject which had been introduced by Dr. R. Mullineux Walmsley at the previous meeting in an exhaustive paper, and the discussion of it opened by Prof. H. E. Armstrong. Personally, Prof. Armstrong took a rather sceptical view of American ways and American ideas of things, and declared that American experience was not going to be of very much use to us except in teaching us what not to do. American colleges were behind us from the practical point of view, and we had not such an enormous amount of leeway to make up. Indeed, they had scarcely emerged from the academic stage, and there was a lack of depth in a large part of the American training. In England the endeavour should be to throw a larger proportion of the training on to the works, and thus encourage development on the practical side. Major-General Webber reopened the discussion at last week's meeting by giving a *résumé* of the proceedings at a conference held last September under the auspices of the Education Board, at which representatives of many scientific institutions, including this institution, were present. The outcome of this conference was that it was suggested that there should be one common standard for examination of students who had completed their course of secondary education. It seemed to him that the suggestion that there should be a "culture" or "leaving" examination outside the examinations now enforced by the Institution of Civil Engineers would be acceptable to all. Quoting the words of one of our ablest statesman, he was of opinion that students between the age of 12 and 16 should learn to think Imperially just as American students learnt to think "Americanly." Mr. Symons, chairman of the Students' Section of the Institution, followed, remarking that American students had many more opportunities of gaining knowledge than English students, and he advocated the extension of the present system of giving courses of lectures on special subjects. Prof. Unwin thought the suggestion that we were far behind America in technical education was somewhat exaggerated. His own feeling was that on the whole the English student entering a technical college was better prepared than the American student. Referring to college curricula, he advocated students specialising in one particular subject in the fourth year, but not before. He eulogised the college workshop, but held that it in no way obviated the necessity for proper workship training afterwards. He doubted very much whether it was desirable for lads to enter the engineering profession unless they could support themselves for the first five years. The discussion was continued by Mr. A. P. Trotter, who quarrelled with the phrase, "technical education," declaring that the education should come first. He asked, Was it the manufacturers' fault that they didn't appreciate the student turned out by the colleges, or was it the fault of the colleges in not supplying the right article? So-called technical education should be directed very much more than it was to the general principles of the science, which, if properly learnt, a man of ability could apply in a practical manner afterwards. Prof. MacCormack emphasised the importance of secondary education and of instilling in students the principles of science. He thought that when colleges had before them a scheme approved by manufacturers and engineers generally, they would set about adopting that scheme, and the only thing that would be wanting was money to enable the scheme to be carried out properly. Dr. Glazebrooke argued that the root of this question lay in the question whether the colleges were turning out the right sort of material for manufacturers, and expressed the hope that the enquiries which were now going on would have good results. He questioned whether it was necessary or indeed wise to fit up our laboratories on the colossal scale adopted in America, and advocated simple apparatus for giving instruction in preference to elaborate equipments, which tended to become more or less museums, and often defeated their own object. Mr. Harrison eulogised the work of the unendowed institutions, and urged that manufacturers with large works at their disposal should come to the help of the colleges and grant facilities for students to pick up practical knowledge at their works. Some remarks followed from Mr. W. R. Cooper and Mr. Buckmaster. The latter thought that what most employers wanted in a student was the power of calculation, the power of expression, the power of observation, and the power of drawing. Dr. J. A. Fleming referred to the special work of engineering education in London, where there were at the present time 12 institutions in which there were fairly well-equipped engineering laboratories, and where, including evening classes, there were over 6,000 students taking instruction in engineering. What we lacked in London as compared with Continental and American cities was the want of coherence and specialisation in our teaching. Mr. Lineman and Prof. Smith also spoke, the latter contending that much of the money laid out on engineering laboratories was ill-spent. Dr. Walmsley shortly replied. In the main he agreed that the English student entering a college was as well prepared as his American *confrère*, but only in certain instances, as, for example, in the case of such colleges as the Central Technical. He said he would communicate his reply in full to the *Journal*.

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# BRIGHTON MUNICIPAL TELEPHONES.

This telephone undertaking has been at work unofficially for some months, but without making any charge to what may be now termed the subscribers. In starting the undertaking the Corporation decided that they would not make any charge for the service until 750 instruments had been connected. This number has now been reached, and from March 1 the Corporation telephone exchange at Brighton enters into the commercial stage. The telephone license for the Brighton district was issued to the Corporation in April, 1901, and it will expire in 1926. It was not, however, until March last year that construction work was first commenced. The scheme has been carried out under the advice of Mr. A. R. Bennett as consulting engineer, and Mr. D. J. Barnes, the resident engineer and manager, has had charge of the undertaking from the first. The chairman of the Telephone Committee at Brighton is Alderman H. Carden, and his energetic control has kept the undertaking well before the public since the informal opening on Oct 5 last. Alderman Carden believes in active competition, and, as has been noted in our columns, his actions have not always had the appreciation of the National Telephone Company. One of the chief causes of friction has

MR. D. J. BARNES, RESIDENT ENGINEER AND MANAGER.

ALDERMAN H. CARDEN, CHAIRMAN OF THE BRIGHTON TELEPHONE COMMITTEE.

MR. A. R. BENNETT, CONSULTING ENGINEER.

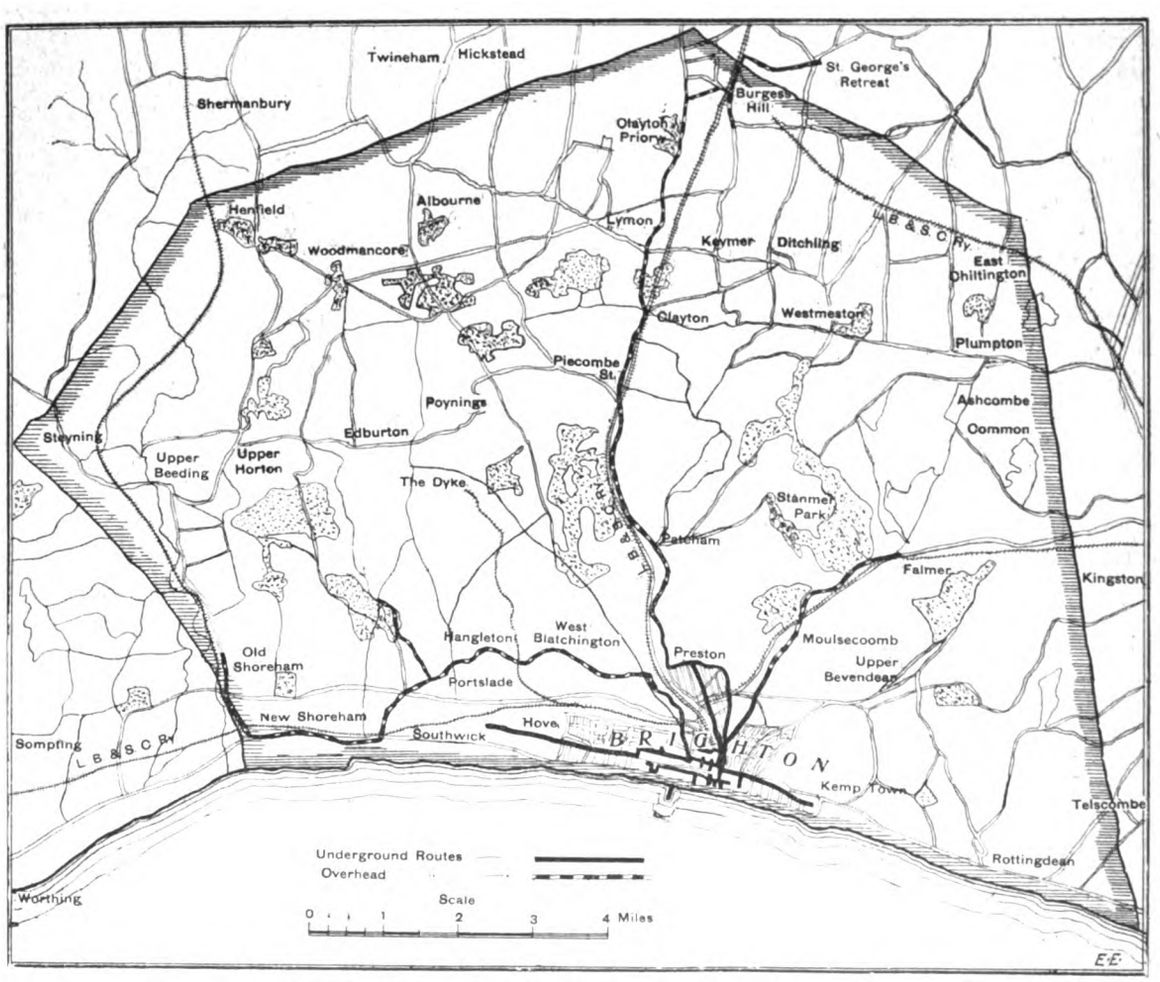


FIG. 1.—Map of the Brighton Telephone Area.

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been the fact that the Corporation has been giving telephone service without making any charge for the same. The assistance of the Postmaster-General has been sought to prevent this, but the matter is now cleared up by the

FIG. 2.—Laying the Telephone Ducts at Brighton by Messrs. W. T. Henley and Co.

initiation of charges as the agreed number of subscribers has been exceeded. Before proceeding to describe the technical details of the undertaking, it will be interesting to give the commercial figures connected with telephone connection on the two systems. On the Corporation exchange the subscriber has four options He may pay £5 10s. for unlimited service or £3. 10s. together with 1d for every outward call. The charge for unlimited service on a two-party line is four guineas, and on a four-party line £3. It is a satisfactory feature, however, that at Brighton only a very small proportion of the subscribers come under the last three rates. At the time of our visit, when there were 639 instruments connected, only 18 subscribers were on the

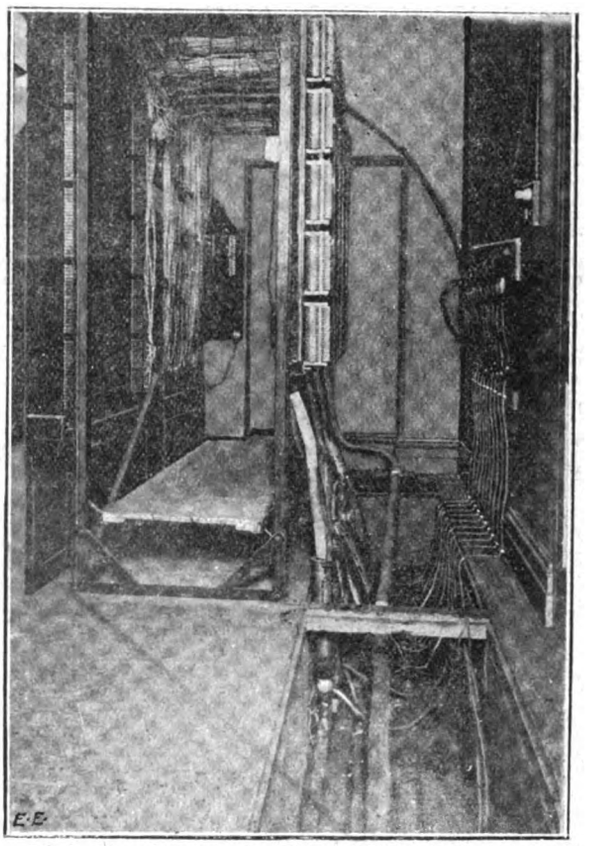

FIG. 4.—View of the Incoming Cables and Frames for Heat Coils, Lightning Arresters, Testing, etc.

message-rate system of charging and none on the party line. The National Telephone Company previous to the introduction of competition were charging £10 for unlimited service. This they are unable to reduce without making a similar reduction in a number of other towns of about the same size as Brighton. In order, therefore, to compete they have introduced limited service rates which are as follows: A subscriber may pay £5. 10s. per annum, which includes all calls up to 2,500 each year free, or £5 per annum to

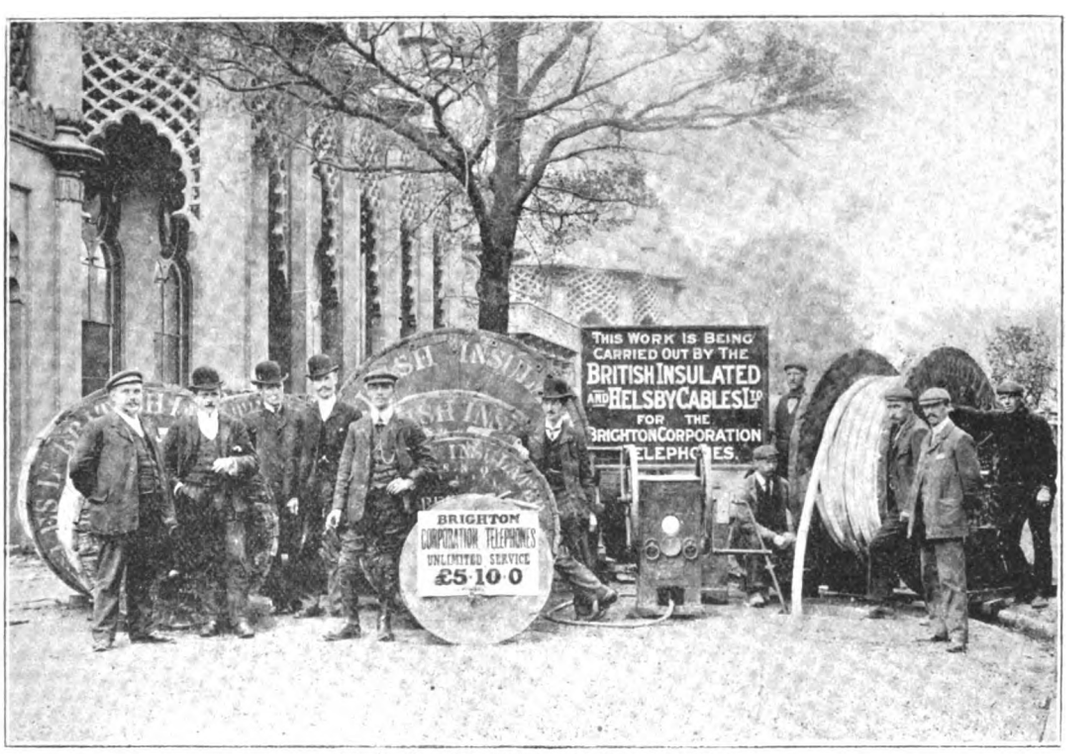


FIG. 3.—The Cable-Laying Equipment at Brighton.

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include all calls up to 1,800. Any messages above these are charged at ½d. per message. On a two-party line unlimited service is given for £3. 10s. Again, on a 10-party line subscribers must guarantee 1d. per day and pay 1d. for all calls. On a 20-party line the annual charge of 25s. must be guaranteed and ½d. per call. It will be seen that these scales make the National Telephone Company's service more reasonable than connection to the Corporation system. Besides this, the company have entirely reorganised their exchange and distributing system so as to bring it thoroughly up to date. It will be interesting to see what the result would be of an application asking the company to introduce the same terms in other towns where there is no competition. This was tried at Bournemouth, but up to the present without success. In designing the telephone system for Brighton the Corporation have, on the advice of their consulting engineer, gone into the matter on a large scale. Thus the present switchboard is put up for 1,000 subscribers, and extensions making it a 2,000-subscriber board are already on order. The underground cable system has been laid down for 2,000 subscribers, and ample spare

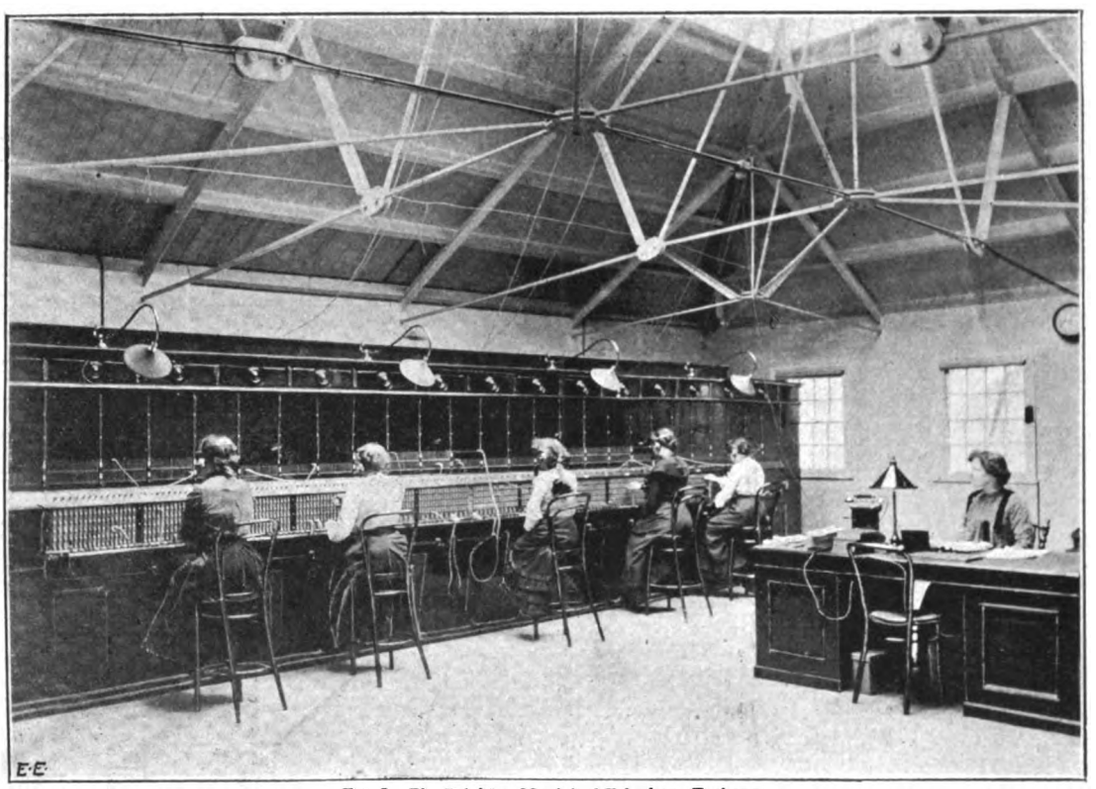

FIG. 5.—The Brighton Municipal Telephone Exchange.

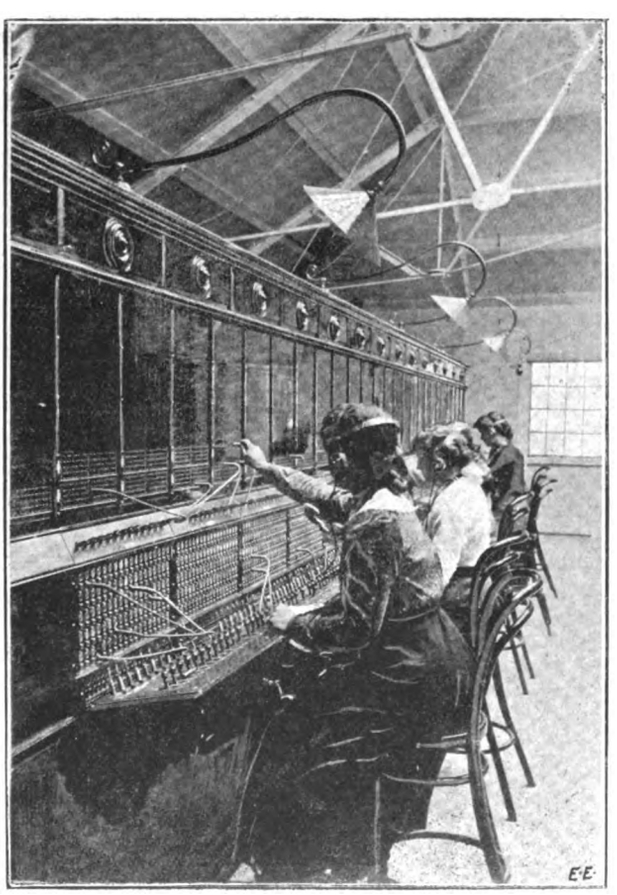

FIG. 6.—Side View of the Switchboard.

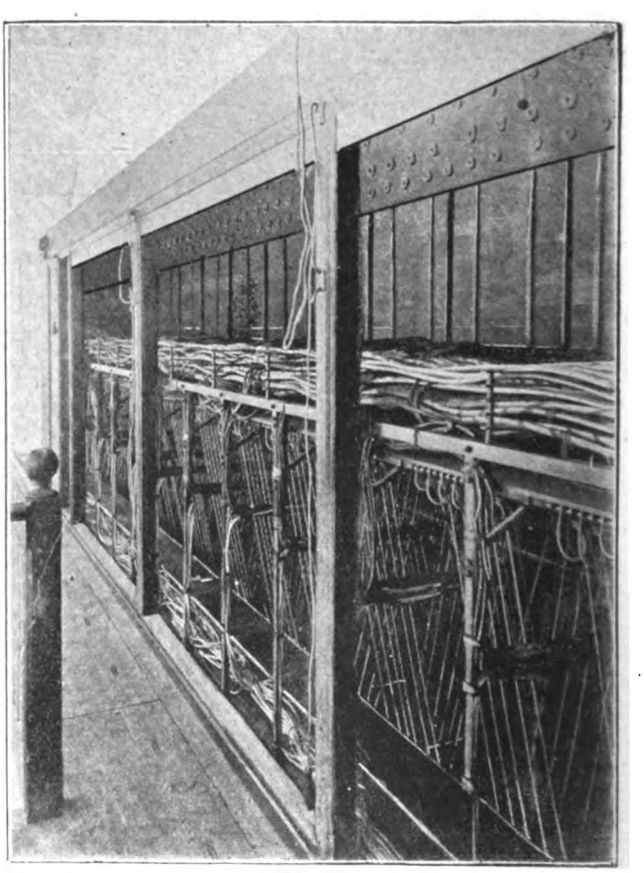

FIG. 7.—The Back of the Brighton Switchboard.

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ducts provided for more cables in the future. Again, the Corporation have obtained a loan of £47,000 for telephone apparatus, out of which only £26,000 has been spent at the present time. At the time of our visit, apart from the subscribers connected, which numbered nearly 700, there were no less than 900 waiting for connection, so that the above provisions for extension will soon be needed. Within the year from the opening up of the ground no less than 33 miles of ducts have been laid, into which 19 miles of cable had been drawn. Also some 230 miles of overhead wires, carried on 609 poles, had been erected. For this work No. 18 wire is used for connecting up subscribers, and No. 14 wire for the main junctions.

The map (Fig. 1) shows the area over which the Corporation of Brighton have to give telephone service, and also indicates the work which has been done up to the present. The black lines, or filled-in roadways, represent those roads in which cables have been laid, and the dotted lines indicate the junction wires which have been carried overhead to outlying districts. The longest junction line at present is that to Burgess Hill, which is carried overhead from a point half a mile beyond the borough boundary. The sub-exchange opened at Burgess Hill has been most successful, and already 42 subscribers have been connected to it. Junction wires to Old Shoreham have also been constructed. There will in the future be considerable extensions in the junction-wire system, but up to the present the energies of the staff are being devoted to the work within the borough boundary, and to the connecting up the large number of applicants, which can be more easily dealt with.

The underground cables are drawn into Doulton ducts of the same type as were used within the London area. These were laid and all the street work done by Messrs. W. T. Henley's Telegraph Works Company. In Fig. 2 we illustrate some of this work in progress, and the octagonal ducts can be seen being laid in concrete. In certain of the main streets the ducts for the telephone cables were laid under the tramway track before the telephone department commenced working. This saved a considerable amount in opening up the street, but it has increased the cost of drawing-in, as access can only be obtained to the ducts when the tramways are not working. The whole of the cables used up to the present have been manufactured and laid by the British Insulated and Helsby Cables, Limited. Nineteen miles of cable have been drawn into ducts, in which case the cable is lead-covered only. A few of the extensions to the terminal poles are made with armoured cable laid in wooden troughing. In all cases the insulation of the two wires for each subscriber is of paper, and there is a considerable amount of air-space around the copper cores, which decreases the specific inductive capacity. The largest-sized cable used in Brighton at present contains 312 pairs of wires; the smaller sizes used for distribution contain respectively 12, 24, and 48 pairs. In the illustration (Fig. 3) we show the cable-laying equipment at work. In the centre is seen the air-pump by which dry air is forced through the cable in order to remove any moisture before the ends are sealed. This photograph is taken outside the old Pavilion, above the kitchen of which the telephone exchange has been erected. In Fig. 4 we illustrate

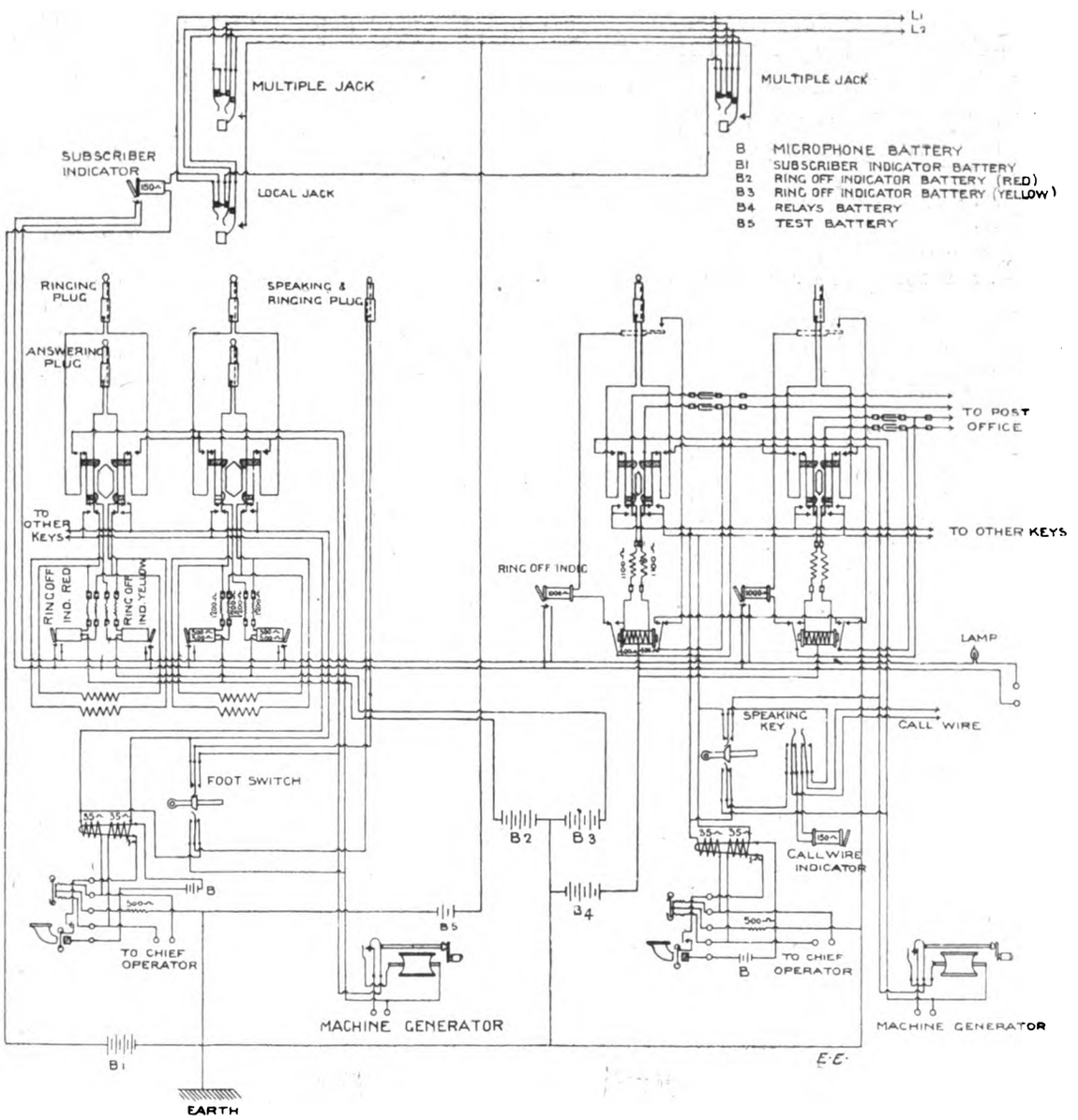


FIG. 2.—Diagram of Connections of the Ericsson Bell Telephone Company's Telephone Switchboard at Brighton.

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the first floor under the exchange, at the point at which the lead-covered cables are brought in. By a neat arrangement of air-pipes, seen to the right of the illustration, dry air can be forced under pressure into any or all of these cables. The lead pipes used for this purpose are connected through air cocks on a common main to this pump. They start from the lead covering immediately below the pothead in which the joints are made. Air pressure is obtained from a motor-driven air-pump, and in the event of a leak occurring, the leaky cable can be located by turning off the air-cocks one after another. Up to the present, however, there has been no trouble due to leakage in the lead envelopes of the cables.

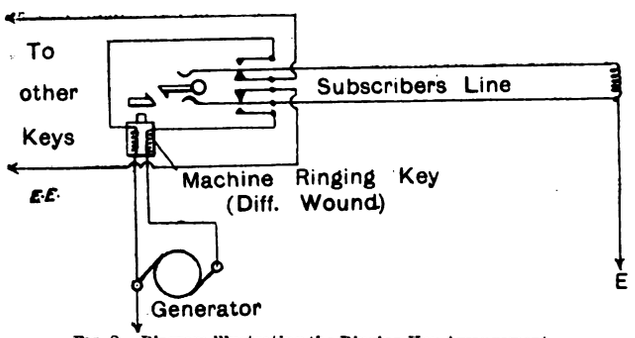


FIG. 9.—Diagram illustrating the Ringing Key Arrangement.

In Figs. 5 and 6 we give views of the exchange itself, which is situated on the first floor. The room is exceedingly well lighted, and there is ample room in it for the extension of the board until 4,500 subscribers have been provided for. In Fig. 7 a view is given of the back of this switchboard, which is screened from dust by means of roller blinds. These were, of course, pushed up out of sight at the time the photograph from which this block was prepared was taken. The details of the board, which was supplied by the Ericsson-Bell Telephone Company, are good, and the work of erection under Mr. Barnes's supervision leaves nothing to be desired. In order that our readers may follow the details of this exchange, we give in Fig. 8 connections of the same from the cross connecting and test frame. On leaving the "pothead" on the underground cable, the wires rise to the tabs on the heat coil and lightning arrester strips immediately above on the cross connecting and test frame. They are then carried across the frame by means of asbestos-covered wire to the test jacks at the opposite side of the frame. From thence they are carried to the switch-room on the floor above in asbestos-covered cables, each containing 20 pairs. They are then soldered to the line springs of the multiple jacks, as shown in the diagram, and then branched off to the corresponding jacks on each section. Full advantage is taken of the "branching" system for speaking purposes, but it will be noted that for calling, the "series" system is adopted. This avoids the necessity of using relays (with their *many* disadvantages) for cutting out the calling indicator. When the subscriber lifts his telephone to call the exchange, L1 is momentarily earthed, thus closing a circuit from the calling battery through the subscriber's indicator, the inner springs of the answering and multiple jacks to L1, and back to the battery by earth. When the operator inserts the answering plug the inner springs are parted, thus cutting off the calling battery and indicator, and the fifth spring is pressed against the stud in connection with the "engaged" test battery, which is thus connected to the bush of each multiple jack. Having now indicated how a call is received, we turn to the cord connections. The combined speaking and ringing keys are shown in the through position in the diagram. In reply to a call, the operator inserts the answering plug in the calling subscriber's jack, which is situated immediately below the corresponding line indicator (at the same time restoring the indicator automatically), pulls the key over to the speaking position, and ascertains what number is required. This done, she makes the engaged test in the ordinary way, touching the bush of the wanted subscriber's jack with the tip of the ringing plug. If the line is engaged in another part of the room, she is immediately warned that such is the case by a click in her receiver. The connections which effect this are easily traced on the diagram, and are as follow: The test battery being connected to the bush of the jack as already explained, the current is conveyed from the tip of the ringing plug through two outer springs of the key (the key already being in the speaking position), half the secondary winding of the induction coil, half the operator's receiver, and the 500 ohms resistance coil back to the battery. If there is no click, and the wanted line is, therefore, disengaged, the ringing plug is pushed home, and the subscriber called by pushing over the lever of the key to the ringing position, which operation switches the current from the motor-driven magnets on to the line. On letting go the lever, the key returns to the through position automatically.

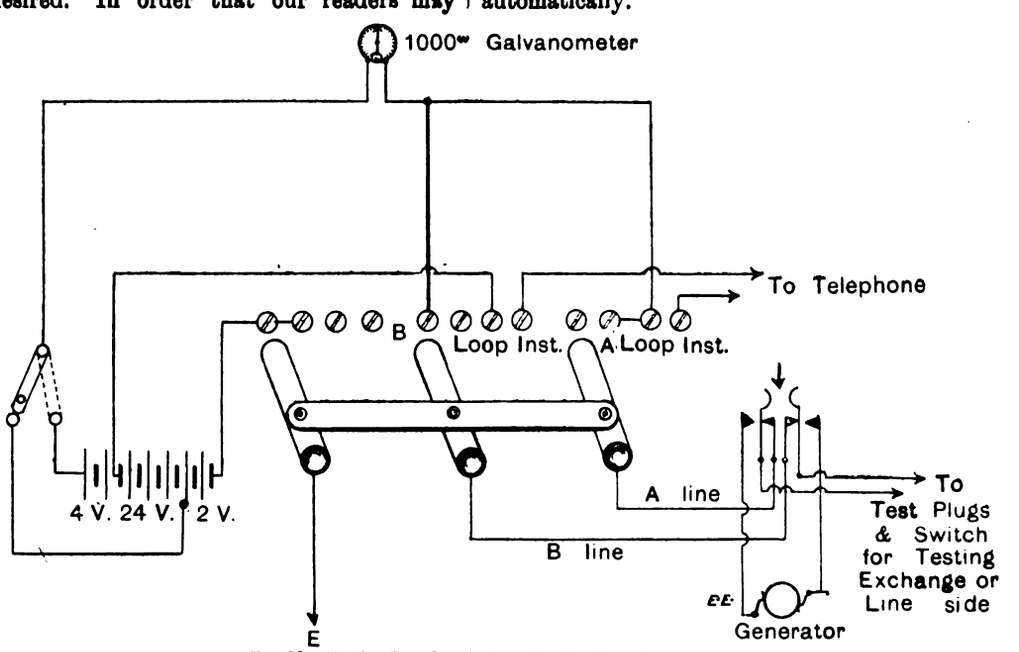


FIG. 10.—Testing Board as designed by Mr. R. Dolman.

The clearing indicators are wound so that it is possible for subscribers to ring through to each other without calling the exchange. This prevents the operator's time being taken up in ringing subscribers a second time if they are dilatory in answering, and so helps the speed of switching. It will be noticed that there are two clearing indicators, one corresponding to the answering plug and the other to the calling plug. When the called subscriber answers, the latter indicator drops and shows the operator that all is well with the connection. It is then restored mechanically. When either subscriber replaces his telephone the line is momentarily earthed, as in calling, and completes a circuit from the battery to the centre point of the clearing indicator, speaking key, and plug to line, back to the battery

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by earth. The two lines being divided by means of the transformer only, the indicator corresponding to the subscriber who replaces his receiver drops. The operator does not clear until the originating subscriber's indicator drops. When the cords are replaced, the clearing drops are restored automatically.

We now come to the connections of the Post Office section (shown on right of diagram, Fig. 8). The subscriber desiring a trunk connection makes the call in the usual way, and the operator passes it on to the Post Office by means of an outgoing call wire which is within reach of any operator at the board. Until the call matures it is dealt with by the Post Office operator, who then passes her demand to the Corporation junction operator over the call wire in exactly the same way as an incoming call, at the same time giving the number of the junction she requires the subscriber on—thus, 500 on 6. Each of the junction wires ends in a plug on the Corporation board. The operator then takes up plug No. 6, makes the engaged test in the usual way, and presses the plug home. She then pushes the key to the ringing position, and on this section of the board it remains there until the subscriber answers the ring, when it returns automatically to the through position. The reason for this is that if the

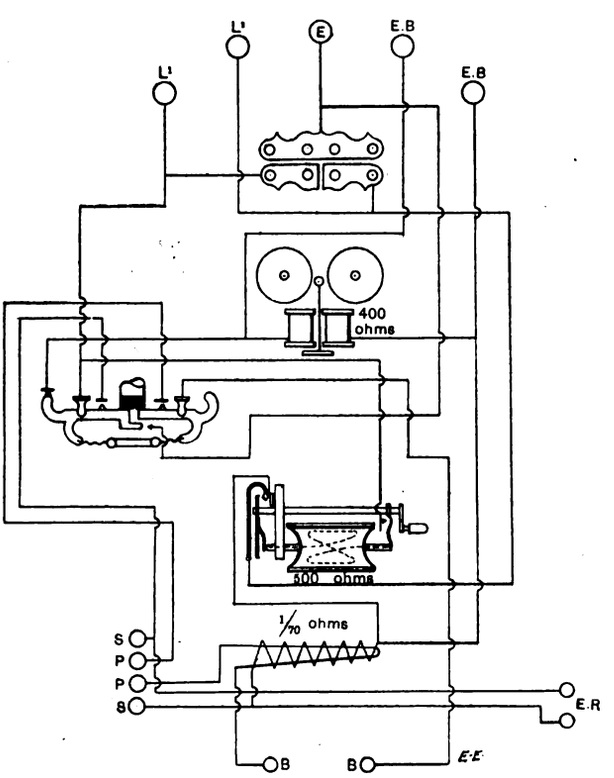


FIG. 11.—Diagram of a Subscriber's Instrument. E R shows the points where the extra receiver can be connected.

key were in the through position before the subscriber answered, the Post Office would receive a false clearing signal through the line being earthed when the telephone was removed. The method of obtaining this result is seen in the separate diagram (Fig. 9). When the key is pressed to the ringing position, the current is sent out through a double-wound electromagnet, the armature of which is provided with a clutch which holds the key back. So long as the current is passing through both the wires the magnet is not energised, but so soon as the subscriber raises his receiver one side of the line is momentarily earthed, and (the ringing generator being also earthed) the current ceases to flow through one wire of the coil (having a path of less resistance through the earth), the magnet is energised, and the armature attracted, thus releasing the key, which then returns to the through position.

When the subscriber replaces his telephone on completion of the conversation, a circuit is closed from the battery, through the relay, resistance coil, key, plug, and line, back to the battery by earth. This energises the relay, attracting both tongues, which are retained in this position by the current from the same battery now obtaining its circuit through the coil of the relay, the contact point and tongue on the left-hand side to line A, through the Post Office clearing indicator (thus signifying that the conversation is finished) back through the B line, tongue and contact on right-hand side of relay, to battery. Having now received the clearing signal, the Post Office operator withdraws the plug and causes a current to flow to line of equal voltage to that flowing from the Corporation battery, but in the opposite direction, thus neutralising the effect of the latter on the retaining relay. The tongues of the relay now fall to their normal position, and the Post Office current has a circuit through the Corporation clearing indicator and plug-socket contact, thus indicating that the line may be cleared. The junction operator then withdraws the plug, which, on returning to its socket, breaks the circuit, and the position is normal.

The apparatus used for "rough testing" the lines was designed by Mr. R. Dolman, the chief inspector, and is exceedingly simple and easy of manipulation, as will be seen in the diagram (Fig. 10). The switch has four

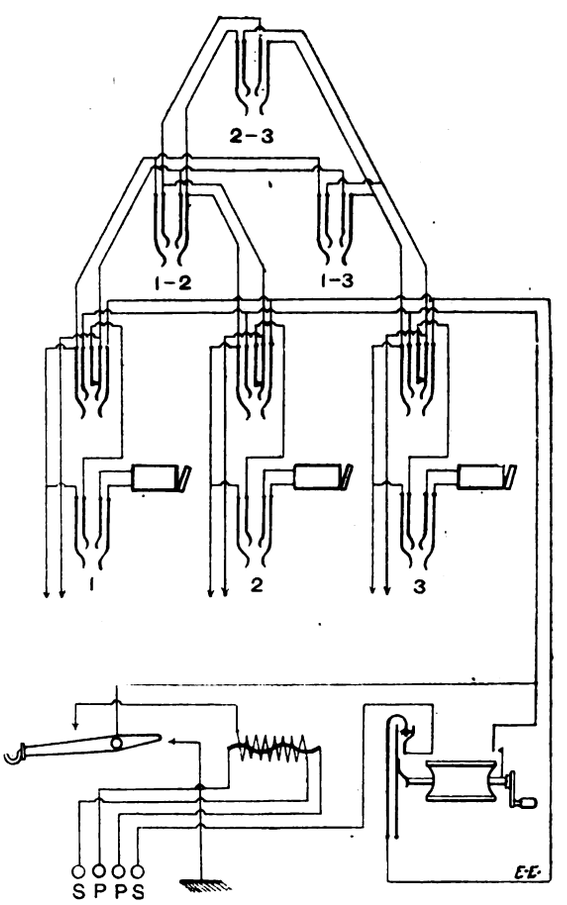


FIG. 12.—Plugboard Connections for Three Subscribers' Instruments on One Line.

positions—viz.: (1) to detect an earth fault on the B wire; (2) to detect an earth fault on the A wire; (3) to detect a short-circuit or disconnection on the loop or a fault in subscriber's instrument; (4) speaking position. If an earth fault is being tested, the two-volt battery is first used so as to obviate any damage being done to the galvanometer if the earth should be of low resistance. If it is of high resistance, the two-way switch on the left is turned to the right, thus bringing in the full voltage. For the loop test the four-volt battery is used. It will be seen that with the main switch to the left the B wire is under an earth test. By moving the switch one stud to the right the A wire comes under a similar test, the two left-hand studs holding the earthed battery (of either voltage) for both the A and B wires. To make the loop test the switch is moved three studs to the right, which disconnects the earthed battery and brings a small voltage in circuit with the galvanometer and the loop. To bring the telephone in circuit, the switch is moved full to the right. An ordinary intermediate-through switch is used to switch the apparatus to line or exchange side at will. The mechanical part is arranged so that it combines ease of manipulation with the maximum stability. It is also seen that the running

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generator is brought in circuit through an ordinary six-point plunger key, so that subscribers' bells may be adjusted under ordinary working conditions.

The ringing current inside the station is provided by an Ericsson-Bell magneto, which is driven by a belt from a small Lundell motor. This motor, which is about ¼ h.p., is supplied from the town main. At the present time the current for signalling is obtained from Leclanché cells, but these in the near future are to be replaced by secondary batteries. The whole of the instruments were also supplied by the Ericsson-Bell Company, and Fig. 11 gives a diagram of their connections. It will be gathered from the above that the common battery at the exchange gives the call when the subscriber lifts the receiver from the hooks, but that the magneto of his instrument is used for through ringing, which arrangement has many advantages. A neat device for three-subscriber instruments connected to a common line is shown in Fig. 12. By means of this a plug connects any one instrument on to the exchange and all the cords usually employed are avoided.

The progress made at Brighton must be exceedingly gratifying to the Corporation, and we were pleased to see that such good work was being done in every department of the undertaking. Mr. D. J. Barnes, the resident engineer and manager, and his assistant, Mr. W. C. Gardner, have under them a keen and efficient staff, with the result that the cost per instrument connected is being kept down well within Mr. A. R. Bennett's original estimate of £23. 10s. This fact and the large amount of loan already obtained will give the undertaking every chance of being a commercial success before any further loans have to be obtained. It is at the enquiries respecting applications for further loans that opposition can most effectually be brought to bear against such municipal undertakings. If for this reason only, the Brighton Corporation have done well in making up their minds in the first instance to spend a sufficiently large sum to give the undertaking a really fair start.

The telephone department at Brighton have also undertaken the equipment and, we believe, maintenance of the fire-alarm system, which has involved the laying down of 31 signalling stations, the apparatus being of the General Electric Company's make. Bells have also been laid on from the fire brigade station to 50 firemen's houses. As is to be expected, the Corporation have strongly supported their own undertaking, and have given it a large amount of work to do in connecting up all the waterworks pumping stations to each other and to their central office. This alone has involved 26 miles of loop.

In conclusion, we have to thank Mr. A. R. Bennett and Mr. D. J. Barnes for their courtesy in affording us an opportunity for the preparation of this article.

## MANCHESTER SECTION DINNER.

The third annual gastronomical function of the Manchester Section of the Institution of Electrical Engineers was held at the Grand Hotel, as usual, on the 26th ult., under the chairmanship of Mr. E. W. Cowan. The diners were fewer in number than last year, but the proceedings from beginning to end were of a most convivial character, and may be best described in the words of the advertisement of a certain comedy: "It started with a chuckle—it ended with a yell!" The good example of the first of these dinners, as to the menu being scheduled in our native tongue, was not followed, but neither was the bad example of last year as to unlimited oratory.

After the loyal toasts had been honoured, more or less musically, that of the Institution itself was proposed by Mr. T. L. MILLER (president of the Liverpool Engineering Society), coupled with the names of the absent president and the local chairman. Mr. Miller was in favour of the time limit, and considered that long speeches and short-circuits were equally to be avoided, especially at night-time The parent Institution would become rejuvenated from contact with its branches, as old people feel younger by association with their juniors. He would cordially welcome Mancunians when they paid their official visit to his society in Liverpool. He thought that Mr. Gray's absence was possibly caused by the lamented death of Mr. McMillan, and concluded by passing a high compliment to Mr. Cowan for his labours in connection with the section.

Mr. E. W. COWAN, in replying, said that the Manchester Section was worthy of the industry, and he hoped that it rendered service to it. Their meetings were equally devoted to work and the pleasure of foregathering, and this intercommunion tended to remove hindrances to advancement such as he had referred to publicly lately. He mentioned the approaching reunion with the Liverpool Engineering Society, and hoped that the travelling facilities between the two towns might soon be increased, as after a recent dinner there he had found it impossible to get home the same night, which was a cause of domestic trouble that did not need referring to further. He certainly had done his share of work as secretary, but latterly had less and less to do, until now, as chairman of the section, he did nothing at all but sit in a conspicuous and embarrassing position at meetings and watch the other people work. He called for an expression of opinion from the assembly as to the work of the present hon. secretary, Mr. P. A. Ramage, which expression was promptly given, upstanding, with the help of the piano, and to the drinking of an unofficial toast. Resuming, Mr. Cowan spoke of the high-speed living in vogue, and indulged in prophetic utterances which made the company's mouths water as to the prospects of good trade and the universality of electric application in the future. These prognostications included the electrification of the railways, the supply of electricity at a farthing a unit, the use of radiators instead of fires, and the razing of chimneys. Electric trams and the overhead contraptions that obscured the beauty of the Manchester sunsets were to be done away with; all vehicles would be propelled by motors, noiseless and scentless, upon clean cement roadways, and horses were to be exiled without the city gates. Further, treasure-seeking operations in public roads by municipal and cable-makers' navvies would cease, and he hoped that the profits resulting from these positive and negative changes would go into the pockets of the assembled company, not excepting himself.

The toast of "Our Guests" was proposed by Dr. BOWMAN, who stated that he had met no more sociable people than the Local Section for the interchange of information and the destruction of edibles dear to L***** M***.

Mr. E. M. LACEY responded for the strangers present, and commented on the "poor old parent Institution," which had to put up with papers not comparable with those given to its progeny. He had much pleasure in meeting the leading engineers of the leading city of the leading county of the best country in the world.

Dr. SCHUSTER proposed the toast of "The Scientific and Technical Societies of Manchester," although he did not know any scientific societies that were not technical, and if there were any technical societies that were not scientific Heaven help them! Societies were divided into two classes—those who dined together once a year and those who did not; and, generally, they were institutions for talking shop. The old philosophical societies were the originators of the modern movement in this direction, and they were still interesting as affording an opportunity of talking nonsense without being found out.

Mr. A. SAXON, president of the Manchester Society of Mechanical Engineers, responded to the toast, and brought up the matter of a common meeting-place and library for the various Manchester technical societies (which was discussed at the same function two years ago), towards the acquisition of which his society was willing to heartily assist. Electrical and mechanical engineering overlapped so much that it was difficult to say where one began and the other ended; they certainly could not do without one another, and he could assert that electricity had been of much good to the mechanical industry.

Mr. C. D. TAITE, of Salford, toasted "The Entertainers," and Mr. A. S GILES, of Blackburn, as one of the singers, rose to respond, but was not permitted to sit down until he had given another song, the company being unanimous in supporting the Chairman's request for the same.

As an instance of the convivial character of the dinner

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it may be mentioned that the choruses of the various songs given throughout the evening were heartily sung by the audience, and, further, that the Chairman's suggestion of "Auld Lang Syne" as the meeting broke up was taken advantage of with crossed arms and clasped hands, together with the aid of chairs and tables for the quite unnecessary purpose (at that stage of the proceedings) of super-elevation.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

667. State clearly the advantages of three-phase working over single-phase, both as regards transmission, generation, and also motor use.—R.

668. Can steel be commercially manufactured by means of electricity? If so, describe some process that has been practically tried.—W. R. A.

### ANSWERS.

*Question No.* 659.—Explain fully and give proof of Scott's method for transforming from a two to three phase system of current.

*Answer to No.* 659 (*awarded* 7*s.* 6*d.*).—In the vector diagram (Fig. 1) if N $E_1$, N $E_2$, N $E_3$, be the vectors of three

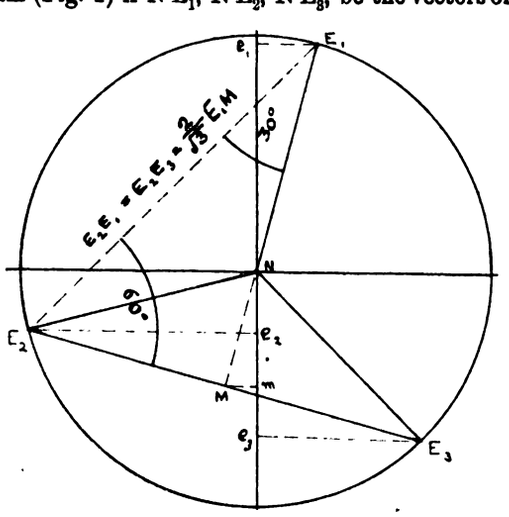


FIG. 1.

E M.F.'s arranged at thirds of a phase to each other it is evident that the projections of N $E_1$, N $E_2$, N $E_3$, on the vertical give the value of the instantaneous values of the E.M.F.'s in phase 1, 2, 3 respectively with respect to the neutral point, at the same instant that $e_2$, $e_3$ gives the instantaneous potential difference between the outer points of phases 2 and 3. Imagine phases 2 and 3 to be joined by a winding subjected to the same alternating field as windings 1, 2, and 3, and assume that the introduction of this winding does not upset the symmetry of the three E.M.F.'s as regards phase-position and amplitude. It is apparent that the middle point, M, of this winding will possess a potential exactly opposite in phase to the free end, $E_1$, of the first phase, and the instantaneous value of its E.M.F. with regard to the neutral point will be shown by the projection of N M on the vertical, N *m*. If the voltage across $E_1$, M, and $E_2$ $E_3$ be measured, it follows that since their amplitudes are in the proportion of $\sqrt{3}$ : 2 (from the properties of triangle, $E_1$ M $E_2$) the effective E.M.F.'s across these points are also in this ratio; it is also seen that the phase of $E_2$ $E_3$ is in quadrature with that of $E_1$ M. If, therefore, two windings in quadrature having turns in the ratio of 2 : $\sqrt{3}$, one end of the latter winding being connected to the middle point of the former, be rotated in a magnetic field, E.M.F.'s differing a third of a phase from each other will be set up at their free ends. Put in another way, if fluxes of magnetism of equal strength but in quadrature be impressed in two coils, and if both these fluxes follow the sine law of variation, the E.M F.'s at the free ends of these coils will differ a third of a phase from each other, and will be of equal amplitude with regard to a neutral point situated a third of the way along the winding having the smaller number of turns (which is connected to the middle point of the larger winding) from the point of junction of the two windings.

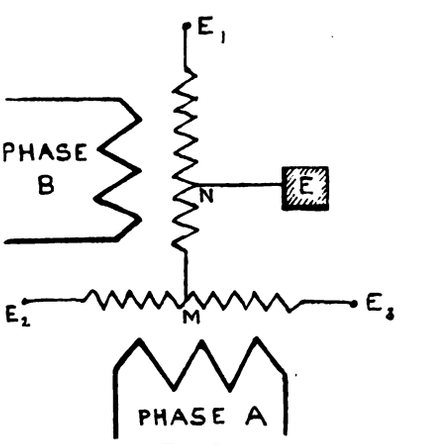


FIG. 2.

Fig. 2 shows the practical application of this demonstration in Scott's method of conversion from three-phase to two-phase, or *vice versâ*. The arrangement consists of coupling one end of the (high or low tension) secondary of one transformer to the middle point of another transformer secondary. The transforming ratio of the first is to that of the second as $\sqrt{3}$ : 2. Hence, if equal E.M.F.'s differing in phase by a quarter period be applied to the primaries of these transformers, E M.F.'s differing by a third of a phase are produced at $E_1$, $E_2$, and $E_3$. If it is necessary for safety's sake to earth the neutral or balance point, the earth-plate must be connected to point N such that the number of turns between M and N is one-half the number between N and $E_1$, when the amplitude of voltages between E $E_1$, E $E_2$, and E $E_3$ will be equal. It is obviously a balanced system, however, if no earthing point is used, and the phase conversion is reversible.—J. A. S.

*Answer to No.* 659 (*awarded* 7*s.* 6*d.*). — The Scott method of phase transformation finds practical application in cases of three-phase transmission, where, possibly owing to oversight on the part of the engineers, two-phase plant has been installed. By reference to the accompanying

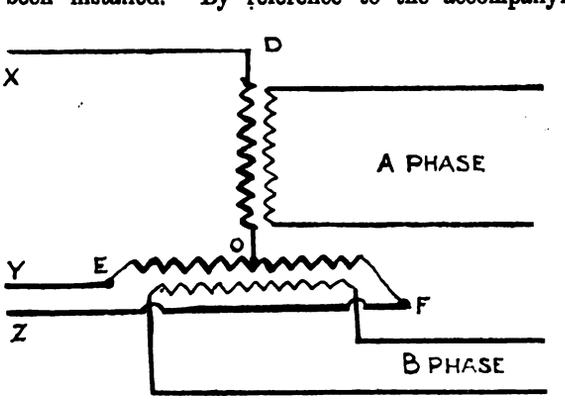


FIG. 1.

diagram the general connections will be seen. The two-phase current is sent into two transformers which have different ratios of transformation. If, for the sake of simplicity, we take the ratio in case of A phase as unity,

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the ratio in the B phase will be $\frac{2}{\sqrt{3}}$ (=1·16). Further, the windings of the secondary of the B phase transformer are divided into two equal ranges, and to the centre one end of the secondary of A phase transformer is connected. The remaining three ends of the secondaries of the transformers then provide the three-phase currents. To explain the theory of the arrangement, we must remember that the voltages in the two phases, A and B, and, therefore, also the voltages in the secondaries, differ in phase by 90deg. Remembering this, we can proceed to draw out vector diagrams for the voltages between the points D, E, and F. Starting from E, we may represent the voltage across E O by a horizontal line, M N, in Fig. 2. The voltage across O D is then represented by N P at right angles, and of such a length that $\frac{E O}{O D} = \frac{1}{\sqrt{3}}$. Then M P will represent the voltage across E D. Now take the voltages between D and F. We have P N corresponding to N P as before for

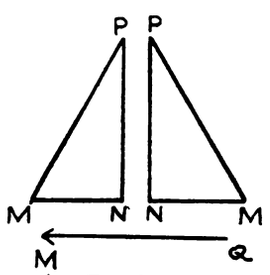

FIG. 2.

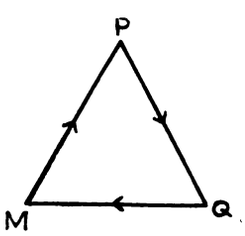

FIG. 3.

voltage across D O. Voltage across O F is then represented by N Q, which, of course, is the same length as M N. Compounding P N and N Q, we have P Q as the voltage across D F. Then the voltage across F E is, of course, simply Q M. Taking the voltages across the points E, D, and F as thus found, and plotting them to continuously follow one another, we see they form the closed equilateral triangle M P Q (Fig. 3). This is because we took the ratios of transformation above specified, for they gave the length of $M P = \sqrt{(M N)^2 + (N P)^2} = M N \sqrt{1+3} = 2 M N$—that is M Q—and the angle P M N becomes 60deg., because $\tan 60\text{deg.} = \sqrt{3} = \frac{P N}{M N}$.

Having now proved that a three-phase voltage is produced across the points D, E, and F, and noted the different voltages the transformers must be designed to stand, we may consider what currents the two phases A and B supply when the three-phase side is evenly loaded. To consider the currents which flow in transformer windings, it is best to consider the ampere-turns, all the number of turns on

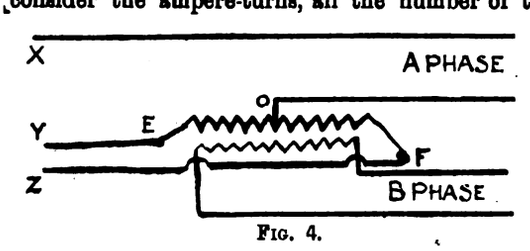

FIG. 4.

the A phase primary and secondary and on the B phase primary, N, then on the B phase secondary we have 1·16 N turns. Then take current in X phase at any instant as I sin $\theta$, the currents in the Y and Z phases are I sin ($\theta$ + 120deg.) and I sin ($\theta$ + 240deg.) respectively. The current in secondary of A phase transformer will therefore be I sin $\theta$, and the ampere-turns N I sin $\theta$. As the number of turns on primary is the same we shall have an equal and opposite current. Therefore, current which is being supplied by A phase is I sin $\theta$. Now with regard to B phase transformer. The ampere-turns on windings from E to O are ·58 N I sin ($\theta$+120), and on windings from O to F are ·58 N I sin ($\theta$ + 240). Therefore, total ampere-turns between E and F are ·58 N I sin ($\theta$+120) + ·58 N I sin ($\theta$+240) = − ·58 N I sin $\theta$.

The number of turns on primary is N, therefore current in phase B is ·58 I sin $\theta$—that is to say, the two phases, A and B, are not equally loaded with current, the current in B being ·58 of that in A. It should be noted that the point, O, cannot be taken as the neutral point for balancing a star network, because the voltages across O D, O E, and O F are not equal. It is interesting to also point out that an exactly similar arrangement can be used on generators for producing three-phase current from a two-phase wound machine. The two ranges are wound on the armature corresponding to E F and O D. The phase E F has 1·16 more conductors than O D, and one end of the latter is connected to the middle of the former, the remaining three ends then being brought to the slip-rings. If the ratio of transformer in A phase (Fig. 1) is 1 : 1, the simplified arrangement shown in Fig. 4 may be used, thus dispensing with one transformer altogether.—C. T. R.

*Answer to No.* 659 (*awarded* 5*s.*).—Scott's method of converting two-phase current into three-phase, and *vice versâ*, is an arrangement of transformers such that, by taking two

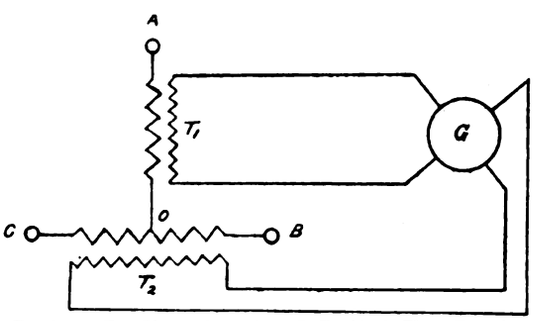

FIG. 1.—G, Two-Phase Alternator; T1 T2, Single-Phase Transformers; A B C, Three-Phase Terminals.

E.M.F.'s in quadrature, a resultant E M.F. is obtained so displaced with relation to one of the original E.M.F.'s as to lead it by 120deg.; and as a second resultant E M F. is obtained lagging 120deg. after the before-mentioned E.M.F., we thus obtain the conditions required for three-phase currents, and it only remains to so arrange the various voltages that we may have an equal E.M.F. in each phase.

The arrangement and working are as follows: Fig. 1 represents two independent single-phase transformers, the primaries of which are supplied with current by the two-phase generator, G. The secondary of transformer, $T_1$, is connected to the middle point, O, of the secondary of $T_2$. The phase displacement of the primaries is 90deg., whilst that of the secondaries will be 90deg. behind their respective primaries when they are on open circuit. The voltage generated in the secondary of $T_1$ is represented in Fig. 2 by A O, and that of half the secondary winding of $T_2$ by O B. As these are

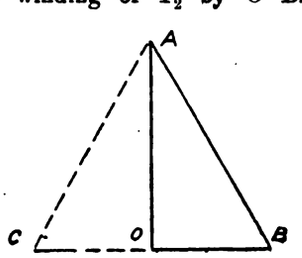

FIG. 2.

in quadrature, A B is the resultant voltage and relative displacement of same. In the same way, A C is the resultant between A O, and the other half the secondary of $T_2$. Now, if we want the secondary voltage of $T_2$—*i.e.*, C B in Fig. 2—to equal A B, it will be necessary to arrange the windings of the two secondaries so that C B : A O : : 2 : $\sqrt{3}$. On first looking at Fig. 1, it might be inferred that the three-phase connections were star connected, but on closer inspection they will be seen to be mesh, and that Fig. 2 is really a clock diagram, from which it will be seen that the three voltages obtained are similar to a three-phase mesh-connected alternator, the E M.F.'s following each other at intervals of 120deg. The equality of the voltages, as mentioned above, holds good at all loads providing the balancing is perfect and the quality of the load is the same. As, however, unequal loading is bound to occur, and consequently the quality (if a mixed load is catered for, such as transformers, motors, and lighting)

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with the resultant difference of power factor on the various phases, this variation in lag of the current in the three phases is more detrimental to good regulation of the resultant voltages than with an ordinary three-phase transformer. The leakage is also variably affected.

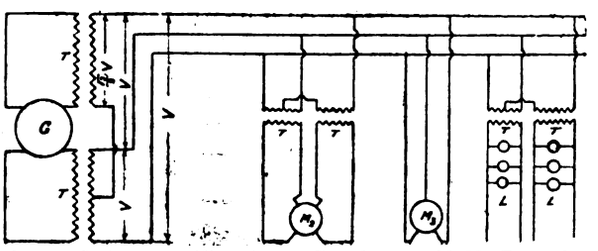

FIG. 5.—G, Two-Phase Alternator; T, Transformers; $M_2$ $M_3$, Two and Three Phase Motors; L Lamps.

Fig. 3 shows diagrammatically an installation on this system; but why not generate three-phase current? Three-phase distribution is, of course, preferable both on account of less copper in the mains and more satisfactory working. Such a mixed system as is depicted in Fig. 3 is most probably an unknown quantity in England. The application of this conversion is interesting, and probably its best use, outside the laboratory, would be to act as a stand-by in a three-phase private plant, where the local supply is two-phase, or *vice versâ*.—W. W.

*Answer to No.* 659 (*awarded* 5*s.*).—The method of Mr. C. F. Scott for changing a two-phase into a three-phase system is shown diagrammatically in Fig. 1. The two-phase lines are connected to the primaries of two transformers,

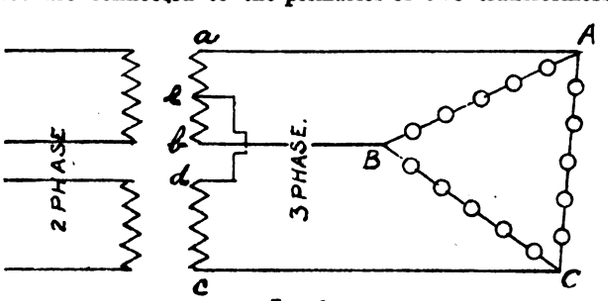


FIG. 1.

the secondaries of which feed the three-phase system. If one transformer be wound with a ratio of 10 to 1, the other must have a ratio of 10 to $\frac{\sqrt{3}}{2}$. Let $a\ b$ be the secondary of the transformer 10 to 1, and $c\ d$ that of the one wound for 10 to $\frac{\sqrt{3}}{2}$. $d$ is connected to the middle point of $a\ b$; the leads for a three-phase system may then be taken from $a$, $b$, and $c$. For a proof: with radius equal to 1 describe a circle, and from the same centre, with radius equal to $\frac{\sqrt{3}}{2}$, draw another circle. Take any radius, A B, to represent the E M F. in $a\ b$; draw A $d$ at right angles to A B. Bisect A B in E, then A C, the resultant of A E and A $d$, will represent in magnitude

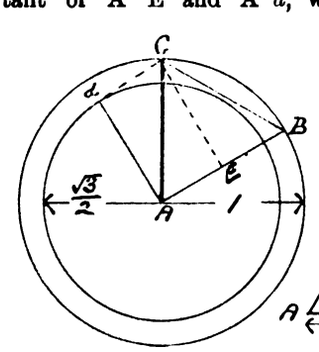


FIG. 2.

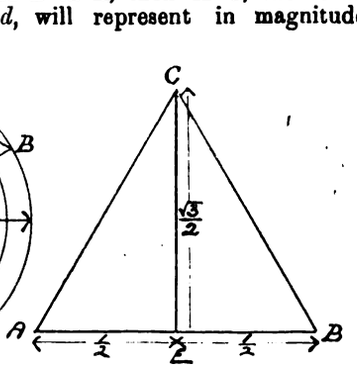


FIG. 3.

and direction the resultant E.M.F. of $c\ d + e\ b$. A $d$ is drawn at right angles to A B, as, being from the two-phase supply, the difference in phase of the E.M.F.'s is 90deg. A C is equal to A B, because $A C^2 = A E^2 + C E^2$—that is, $A C = \sqrt{\left(\frac{\sqrt{3}}{2}\right)^2 + \left(\frac{1}{2}\right)^2} = 1$. Again, as the triangles A E C, B E C are equal in all respects, therefore A B C is an equilateral triangle. There are then three E.M.F.'s at A, B, and C, each having a phase difference from the others of 60deg. Fig. 2 is the construction for this proof. Fig. 3 is the explanatory diagram given in several text-books. One terminal of the secondary having the fewer number of turns is connected to the middle point of the other secondary. C E is drawn at right angles to A B, and, as before, A B C is an equilateral triangle. With this method of connecting up the current may be generated and distributed by two-phase, transmission over intervening distances being by three-phase. There is by this means a considerable saving in cables.—M. M.

*Question No.* 660.—Discuss the advantages and disadvantages of putting the equalising bar in a traction and lighting station behind the main switchboard, or in a trench under engine-room floor, beside machines, with equalising and series diverting switches on generators.

*Best Answer to No.* 660 (*awarded* 10*s.*).—When the equalising bar is placed behind the traction board the conditions are as follows. Three cables, each of sufficient section to carry the full output of each machine, are taken from the positive and negative terminals, and the other end of the series winding of each machine to the main switch-

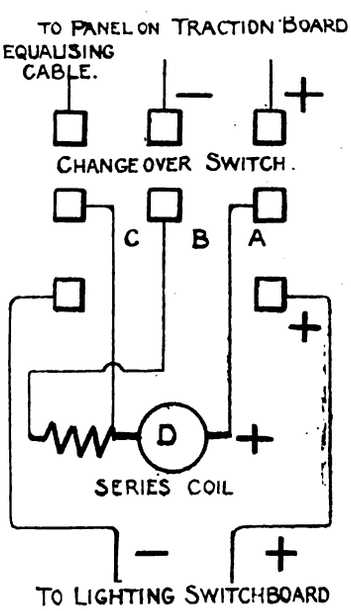


FIG. 1

board. Here they are connected to change-over switches, so that any machine may be put on either the traction or lighting bus bars as desired. On the traction side of the change-over switches there are three contacts from which cables go to the panel for each machine. The sketch (Fig 1) shows the arrangement in a station I am connected with. It will be seen that the cable, C, when the dynamo, D, is on lighting is the negative cable, but when the dynamo is on traction it acts as the equalising cable, and the cable B, which before was not in use, now acts as the negative cable. It is because of this arrangement that all the cables must be of the same cross-section. The switchboard attendant has full control of all switchgear. When the equalising cable runs below the engine-room floor, the change-over switch is either fixed to the dynamo itself, or else to some support close by. Four cables now run from each machine, one pair to the lighting switchboard and one pair to the traction board. The arrangement is now as shown in Fig. 2. The engine-driver will now probably be the person to operate the change-over switches.

As to which is the best arrangement, that has to be decided by the circumstances at each generating station. Supposing that the traction board was some distance away from the lighting switchboard, it would then be most economical to have the change-over switches on each machine, as a great saving in cable might thereby be effected. Whenever the traction and lighting switchboards are close together, the

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best plan is to have the equalising bar behind the traction switchboard. The advantages of this system over the other are as follows: (1) Less first cost owing to the saving effected by only having three cables from each machine instead of four. (2) In getting another machine on to the traction load there is less chance of the change-over switch being left in the wrong position. The driver may forget to close the switch, and the attendant is waiting in vain for the volts to appear in order to parallel the machine on the 'bus bars. This is not such a small matter as it may appear, as through this cause the dynamo may generate

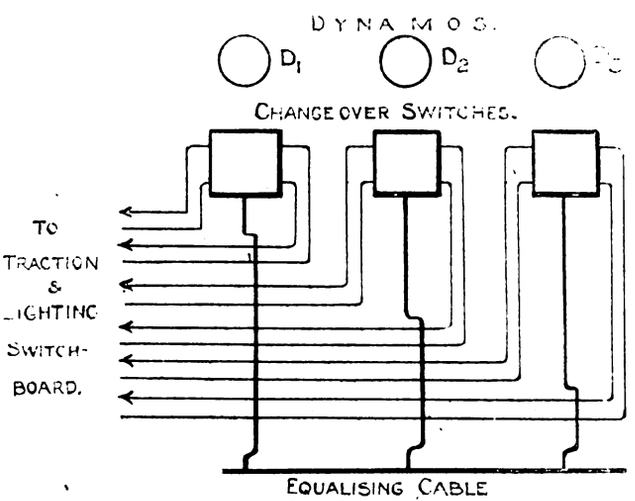

FIG 2.

an excessive voltage, and possibly damage the insulation somewhere. (3) It is an advantage to be able to pull out the equalising switch of a machine just being paralleled on the 'bus bars. If the dynamos supplying the traction load are rather overloaded, and it is desired to parallel another machine in order to help them with the load, when the equalising switch is closed, in order to help the new machine to generate, it robs the other machines of some of the current in their series coils, and thus lowers the 'bus voltage. If the peak of the load comes now, then away go the volts, and they can only be kept up by pulling out the equalising switch of the new machine and waiting for the load to decrease slightly, when it should be put in again, and if things are now satisfactory the machine paralleled on the 'bus bars. (4) The change-over switches being either on one of the switchboards or mounted close by, are more likely to be kept clean and cool. Whenever possible ft is advisable to have the series coils connected to the negative poles of the dynamos, as then there are fewer points at high potential—*i.e.*, only the positive terminals, the negative and equalising terminals being at earth potential.—W. A. T.

*Answer to No.* 660 (*awarded* 7*s.* 6*d.*).—We will first consider the method of bringing the equalising connections

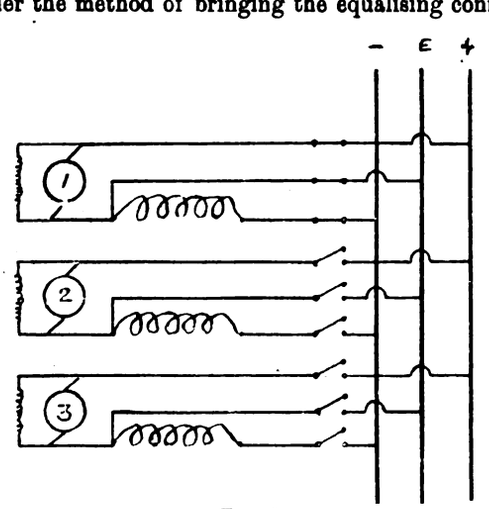

FIG. 1.

of compound generators up to the switchboard (Fig. 1). The advantage of this method is that the equalising switches are under the direct control of the switchboard attendant. It is usual to place the equaliser switches between the two main switches of each set, and so interlocked that it must be closed before either of the main switches, thus ensuring the right polarity of the oncoming machine, and also that it should take up its proportional share of the load. Practically the only objections to this arrangement that the writer can see are: (1) it is rather more costly than the method to be described later, as it means longer cables and rather more expensive switchgear; (2) slightly more complicated switchboard connections; (3) it means more careful calculation and work to ensure that the conductivity of the equaliser circuit of each generator has the same ratio to the conductivity of all equaliser circuits in multiple as the output of each generator bears to the total output. If this is not so, the total load will not be divided between the different machines in proper proportion to their respective outputs.

We will now consider the method of running the equaliser cables in a trench or culvert in the engine-room floor (Fig. 2). This method is undoubtedly the better way if the generators are simply "tied" together permanently by the equaliser, as is done in some power stations. If, however, there is an equaliser switch mounted on the dynamo frame itself or on a pedestal by the side of each dynamo, the disadvantage arises of having a separate switch, as there is a danger of the machine being thrown into circuit before it is equalised. In order to provide against this, the equaliser switch is sometimes mechanically connected with the engine throttle, so that the switch must be closed before the throttle can be opened. This seems the only drawback of running the equaliser in a trench with separate switches, but it certainly is simpler and cheaper.

The latest American practice is to have the switch on a pedestal, as last described, for larger units, and mounted on

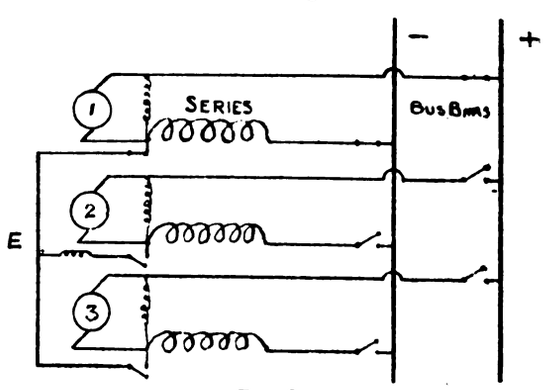

FIG. 2.

the board between and interlocked with the positive and negative switches for the smaller units.—MAGNUS H. VOLK

*Answer to No.* 660 (*awarded* 5*s.*).—When a compound-wound machine is arranged to run also as a shunt machine, the equaliser switch is used as positive switch, the positive switch for compound running being left open. The crowded condition of the back of double-pole switchboards, and the risk of short-circuits arising therefrom, has led to the use of single-pole boards for large machines. The circuit breaker, main negative switch, and ammeter are mounted on the board, but the positive and equaliser switches are mounted on a pedestal near the machine or on an insulating slab on machine frame. Since positive and equaliser switches are of practically the same potential, their proximity does not involve risk of short-circuit. The positive 'bus bar is located centrally under the floor and extended to feeder 'bus through station panel of switchboard. By this arrangement the series field are very closely paralleled, both ends of each series winding being tied by short runs to 'bus bars in close proximity to machines. The positive 'bus bar is made short, and all positive machine leads to this 'bus are of same length to ensure close equalisation. Only one lead, the negative, runs from each generator to switchboard; the positive leads of all machines being carried to the feeder section of the board through a single 'bus connection. In cases of reversal or shut down when running station at nearly full capacity, facility in working all switches with the least possible delay is of the greatest importance. Having positive and equaliser switches

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mounted on or near machines is a decided disadvantage from this point of view. With generators of small capacity or where distance of generator from switchboard is short and fairly uniform for each generator, it would probably be considered advisable to mount on each generator panel three single-pole quick-break switches, arranged as positive, negative, and equalising respectively, circuit breaker, ammeter, field rheostat, field switch, voltmeter plug, and recording wattmeters; having also the usual separate feeder panels and instrument panels.—D. S.

*Answer to No.* 660 (*awarded* 5*s.*). — An equalising bar, coupling all positive terminals of compound-wound generators directly together when running in parallel (Fig. 1), is chiefly for the purpose of keeping the

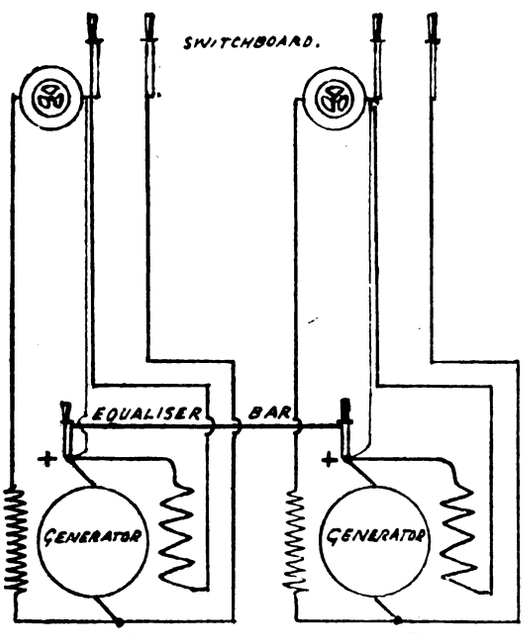


FIG. 1.

same E M.F. across the shunt fields of all the generators, thus preventing reversal of polarity or any set taking more or less than its share of the load, due to the different characteristic of the generator or bad governing of the prime mover. Therefore, it follows that the connection between the machines must be of as low resistance as practicable, and must be of less, or at least the same, conductivity as path *via* series winding and 'bus bar on switchboard, so that any equalising current will flow along cable provided for that purpose; and so to ensure this without having to use a very much heavier cable than the main leads, the equalising bar is not run up to the switchboard (which is usually some distance away), but laid directly between

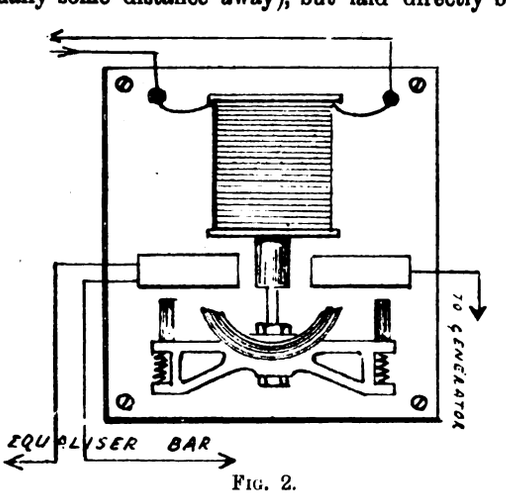


FIG. 2.

the machines and switches with ample contact surface and cross-section, placed either on the machines or on pillars near by. Another reason why the equaliser bar is not run to switchboard is, of course, the cost of the cable, which, if for large units, would be an expensive item. The disadvantages of having the bar and switches near machines are: (1) that the switchman has to come down from gallery to operate switch, and in case of emergency this would be a great drawback; (2) departure from the idea of having all switches under the eye of the attendant, so that in case of mishap he would see the situation at once without having to think. To overcome these difficulties the equaliser switches could be placed near machines and be operated from main board mechanically or electrically, as shown in Fig. 2, by closing or opening small switch or switchboard.—A. T.

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## STREET CONGESTION.

The Traffic Commission enquiring into the congestion in London streets is obtaining a number of suggestions, good, bad, or indifferent, many impossible owing to the remedy being worse than the disease. The London problem differs largely from that in other busy centres, in that it is not complicated by the tramway question. If, however, the advocates of tramways have their way, this trouble will be added to others. That it is real will be seen from the admissions of Mr. John Young, the able general manager of the Glasgow tramways, in a report he has submitted to the Tramways Committee. In the report he says: "It must be recognised that the rapid development of our tramway system is largely contributing to the congestion I have referred to. The tramway system is not only serving the interests of Glasgow proper, but also of Greater Glasgow. And it is the centre of Glasgow with which practically all the extended routes must be connected. Should, therefore, a central relief bridge on the site I suggested be agreed upon in order to provide additional facilities for the general traffic to get through the centre of the city, it seems worthy of consideration whether, under the circumstances, a proportion of the capital cost might not form a charge on the tramways department." Probably there is no living superior to Mr. Young as an organiser and as a farsighted man for seeing coming difficulties. It is well, then, to have his opinion that congested streets become more congested by the admission of tramways. The fact seems so clear as to require no consideration, yet the argument of the tramway-at-any-price man is usually based upon an opposite condition, that tramways relieve traffic. It never seems to have occurred to most people that a frequent service necessarily means a greater use of the street surface. We have always in any discussion on tramways to say that under proper conditions such aids to locomotion are admirable. Our objection is when they are so situated as to increase congestion—that is, mainly in old, narrow-streeted, busy towns. When the streets are wide, the traffic little, with no possible chance of interference, tramways may be justified; at any rate, no one would think of condemning them.

Mr. Young's report contains two very important conclusions. The first, as stated, is that in Glasgow tramways add to the congestion, and we extend this by saying the same result obtains everywhere, the conditions being similar. The second point is that "a proportion of the capital cost might form a charge on the tramways department." If that conclusion is generally accepted, it amply vindicates our criticisms from the earliest period of tramways—viz., that unless the conditions are favourable they should run on their own ground and not be placed in the public streets. Mr. Young's proposition comes to this—tramways have proved detrimental to other traffic, hence tramways should pay the cost of restoring facilities to other traffic equivalent to that which has been taken away. This conclusion shows the good, solid, sound sense of its author. We, however, shall be agreeably surprised to see it accepted, and for these reasons. Let us take a concrete example—the London County Council's tramways. If these tramways were saddled with the cost of the loss they occasion, they could not be run so cheaply as they are, and if they had to provide equivalent facilities for traffic to those taken away, they could not be run at all. The loss because of these tramways falls upon all the users of the streets in which they run that are in any way impeded in the use of those streets. As we have long since pointed out, the individual loss is small—the cumulative loss, however, must be very large. Further strenuous efforts are being made to extend

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these tramways in directions in which we think they are likely to increase congestion, while no suggestion is being made that the capital account of the tramways undertaking shall be saddled with the whole cost of providing equivalent facilities to those taken away. Glasgow will do the right thing if it accepts upon its tramway undertaking the responsibility suggested.

## MUNICIPAL TELEPHONES.—III.

Perhaps our best plan in this controversy is now to touch on two or three minor points, and first "spares."

The critic says: "One of the principal objections that has been made to the municipal telephone estimates is that they do not sufficiently take into account the necessity for surplus plant."

Here, again, the whole question is one of difference of opinion between experts, and has nothing to do with municipal telephony. The critic merely says he differs from Mr. Bennett—that is all. He quotes Mr. Herbert Laws Webb, and seems to abide by the opinion Mr. Webb expressed, that "the usual margin of spare plant was about 35 per cent. . . ." and that at Glasgow "a margin of only 20 per cent. of spare plant was absolutely impracticable." Further, the critic, after referring to the original Glasgow estimates, says "the surplus plant provided in this estimate is only a little over 17 per cent. of the total, a lower figure than that pronounced to be impracticable in 1897." Fancy a critic not seeing in 1903 the fatuousness of these remarks, from the very fact that whatever has been done at Glasgow has at any rate been found to be practicable—not impracticable; but here again, what really has an estimate which was not carried out to do with work that has been carried out? Now a word on the general point. We appreciate Mr. Webb's remarks. He has been a careful observer, but an engineer who troubles his head about a definite figure of the kind without considering conditions which vary is not worth his salt. Emphatically, the engineer who designs for a larger number of spares than is absolutely necessary is a fool—not an engineer at all. The percentage of spares depends absolutely upon local conditions, and when the exchange has reached a fairly developed and constant position, the less the percentage of spares the better for the whole concern. The mathematical law relating to spares is rigid, accurate, and unimpeachable. If the critic does not know this, the sooner he furbishes up this part of the subject the better. We will only suggest that the value of a spare depends upon its being used within a given time, otherwise the loss will be greater than the laying of a line when it is wanted. See. Could anyone pen a greater absurdity than this? "If we include the spare plant in calculating the average capital cost per working subscriber's line—*which is the proper way of using the figures* (the italics are ours)—we find that the Glasgow estimate of 1900 works out at £23. 1s. per line." Really the writer displays a lack of imagination. That poor estimate, and that poor engineer—but, Mr. Critic, suppose 80 or 90 cent. of the spares taken up next year, what is the value per subscriber's line then? Evidently not £23. 1s., but considerably less. You may have 1,000 lines and a single subscriber, or 1,000 lines and 999 subscribers. Is it not absurd to argue that the whole cost of the installation is to be put on the one line one day and the next divided among 999 lines? A manufacturer may have 99 per cent. of his machinery standing still one month, and all his machinery running night and day the next month. Does he charge the customer for the product of the 1 per cent. of the machinery with the standing charges of all the machinery? Of course not; nor is that course pursued with telephone lines. The best engineer is he who, carefully considering all the circumstances of a particular case, keeps the unremunerative part of an installation at a minimum. Spares and surplus may be any percentage, the exact figure being determined by the prevailing conditions. If our contention is correct, the argument of the critic must be considerably modified. He is on the right tack when he says: "Each working line must carry a certain proportion of spare plant, and each working line must not only pay its own way, but also that of its share of spare plant." This statement is true, but needs a good deal of explanation. As we have previously shown, a calculation based upon this idea during the first few weeks, or even the first few years, of working is utterly misleading and radically wrong; hence we think Glasgow right and the critic wrong when the latter goes on to say, "Therefore the estimating of the spare plant as a separate item, giving the idea that it can be brought wholly into use at a fixed price to give a fixed additional working capacity, is most misleading, and has partly helped to give currency to the delusive figures on which municipal telephony so largely relies." What, in the name of goodness, are the "spares" for—to be brought into use or to rot? If to be brought into use, they become productive; if to rot, the engineer who put them there, as we have previously said, is a fool. The critic really feels that all the high-falutin' nonsense he has written needs qualification, and he hedges by saying: "At the very beginning this would give exaggerated figures, *but when a system has been working for two years, and has practically caught up its orders* [the italics are ours], this method gives a correct index of the capital cost per subscribing line." These words give his whole show away. He neither proves that two years really brings full and complete development any where much less in Glasgow, nor that Glasgow has "practically caught up its orders"—hence his lucubration so far as Glasgow is concerned is valueless. Did he read the report? It says, "About 800 orders remained to be executed" Let us assume these were orders from new customers; it then means that 10 per cent. or thereabouts of catching up remained to be done, and we may assume that the spares would come in handy for the work. A point ignored or forgotten by the critic is that in underground work "spares" need ducts, and mathematics again come into play—ducts filled with spares, or ducts waiting to be filled, or ducts or no ducts, all depends upon the length of time everything is spare. The great aim of an engineer is to bring as much as possible of his plant into a revenue-making position at the earliest moment, and to keep unproductive capital low. In any underground system of telephony the important question is not spares, but conduits, and, as has been said, the conduit capacity is partly a mathematical problem and partly a question of experience—the latter must be depended upon to determine the probable requirements.

The question of depreciation must be left for another article, and when this has been considered, all that remains for comment is the indictment of the accuracy of the accounts. The critic writes over four columns to show how badly the accounts are kept and how misleading they are. Here are two sentences indicating his views: "The remarkable point is the small amount of wages paid, considering the size and extent of the system. . . . If it really *is* [the italic is not ours, but the critic's] done, the Glasgow Corporation would seem to have solved a problem almost as important as that of perpetual motion—the problem of getting work done without pay." A Glasgow correspondent, giving us information on this point, says:

> "One would have thought that the fact of accounts
> "having been compiled by competent officials audited by
> "a first-class firm of chartered accountants, reviewed by
> "a financial committee, and homologated by the
> "Corporation itself, was a sufficient proof to the
> "most fastidious critic, and fully demonstrated to
> "every reasonable mind the accuracy of the telephone
> "accountancy both in principle and details."

The critic's case is a purely hypothetical one, and depends absolutely upon the correctness or incorrectness of his assumptions, for he refuses the audited figures, and imagines what he thinks ought to be. A large part of his case depends upon the amount of constructional work done by the Corporation's own men, and if he is wrong about this, his grand castle of cards falls. Let us give the critic's own words: "The staff shows a net decrease of 32 since May 31, 1902, when it numbered 628. The principal decrease has taken place in the construction force, the 'outside superintendent' having now a force

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of 213, as against 315 last year. There are also reductions in the engineering force. There was an increase of 71 in the operating staff and slight increases in the office force, the net result being, as we have said, a reduction of 32 in the total staff." . . . Further on his comment is, "This shows that the new construction work done by the department itself in 1903 was on a greatly reduced scale." We have said if this and like assumptions are wrong, the critic's case fails. What are the facts? Quoting from an authoritative source, which says, "Let it be known once and for all that the construction work of the Glasgow Corporation telephone department for the year ended May 31, 1903, was practically done out and out by the department's own workmen, with the exception, of course, of the switchboard." . . . "The original staff of 315 was very fully maintained to the close of 1903."

Here, then, are conflicting statements incapable of reconciliation. If the authority we have quoted is correct, the assumptions of the critic are wrong, and his suggested mixing of accounts incorrect.

## FORTHCOMING EVENTS.

SATURDAY, MARCH 5.

**Institution of Electrical Engineers.** — Students' Section: At 9.30 a.m., visit to Messrs. J. I. Thornycroft and Co., Limited, Chiswick, W.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture III.).

**Glasgow Scientific Society.** — At 7.30 p.m., ordinary meeting. Paper: "British Competition and Manufacture," by Mr. M. Pickstone.

**Birmingham Association of Mechanical Engineers** —Ordinary meeting. Paper: "Present Position of Trade in South Africa," by Mr. Ben. H. Morgan.

MONDAY, MARCH 7.

**Society of Arts.**—At 8 p.m., Cantor lecture by Mr. Bertram Blount on "Recent Advances in Electro-Chemistry" (Lecture I.).

**Society of Engineers.**—At 7.30 p.m., "Some Recent Work for Water Supply at Penzance" by Mr. F. Latham.

TUESDAY, MARCH 8.

**Institution of Electrical Engineers.**—Glasgow Section: At 8 p.m., "Electrical Coal-Cutting Machinery," by Mr. Sam Mavor; and adjourned discussion on "New Methods of Electrical Winding Gear for Collieries and Allied Purposes," by Mr. Maurice Georgi.

**Institution of Civil Engineers.**—At 8 p.m., "The Erection of Iron Bridges," by Mr. Russell Scott Scholefield.

WEDNESDAY, MARCH 9.

**Society of Arts.**—At 8 p.m., "Mechanical Piano Players," by Mr. J. W. Coward.

THURSDAY, MARCH 10.

**Royal Institution.**—At 5 p.m., Prof. H. L. Callendar on "Electrical Methods of Measuring Temperature" (Lecture III.).

**Institution of Electrical Engineers.**—At 8 p.m., "The Railway Electrification Problem and its Probable Cost for England and Wales," by Mr. F. F. Bennett; "The Rated Speed of Electric Motors as affecting the Type to be employed," by Mr. H. M. Hobart.

**Birmingham Students, Civil Engineers.**—"Fluid Friction in Pipe Bends," by Mr. C. W. Alexander.

**Liverpool Engineering Society.**—"Steam-Boiler Failures," by Mr. J. R. Smith.

**Institution of Electrical Engineers.**—Dublin Section: At 8 p.m., "The Supply of Electricity to Small Towns," by Mr. T. Tomlinson.

**Institution of Electrical Engineers.**—Leeds Section: "The Electrical Equipment of an Engine Works," by Mr. H. O. Wraith.

**Camera Club.**—"Lightning and the Science of Protection therefrom," by Mr. Alfred Hands.

FRIDAY, MARCH 11.

**Royal Institution.**—At 9 p.m., "The Motion of Viscous Substances," by Prof. F. T. Trouton, F.R.S.

**Physical Society.**—At 8 p.m., "The Whirling and Transverse Vibrations of Shafts," by Dr. C. Chree.

**Institution of Civil Engineers.**—Students' Section: at 8 p.m., "The Premium System of Payment for Labour," by Mr. W. G. Banister.

**Junior Institution of Engineers.**—At 3 p.m., visit to the works of the Electrical Power Storage Company at Millwall.

SATURDAY, MARCH 12.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture IV.).

**West Hartlepool Scientific Society.**—Paper on the "Three-Wire System."

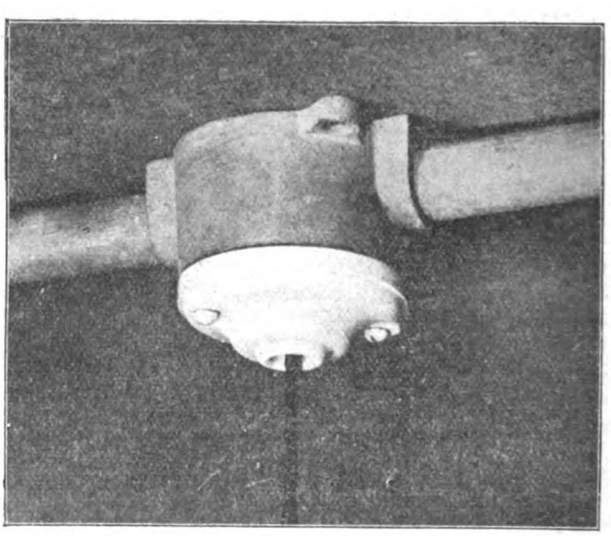
## TRADE NOTICES AND NOVELTIES.

### New "Ediswan" Catalogues.

The Edison and Swan United Electric Light Company, Limited, still continue to send out new literature. This time we have received from them two handsome new catalogues—namely, Section II. (ship, factory, and mine fittings) and Section VI. (artistic electric light fittings). These catalogues have a distinctive design on the cover, which is of rough art paper, in blue and brown respectively. Catalogue Section II., as its title suggests, comprises a variety of electric light fittings of the watertight order. We do not remember to have previously seen a catalogue of this class of fittings only, such articles being usually listed in a larger catalogue of electric light fittings generally. The present one should, therefore, form a handy list for all buyers of these fittings. The designs are on the usual well-known lines, but have a strength and solidity about them which is a credit to Ponder's End, where they are made. This catalogue should be very useful for all shipbuilding and mining engineers, and also for all those who have their own plant running in factories, etc. Catalogue Section VI. is a much larger and more elaborate production. It comprises 96 pages of fittings of all sorts, ranging from the smallest accessories and pendants to large and elaborate electroliers, standards, and lanterns. Some of the designs are very beautiful, and special prominence has been given to the "Arte Nouveau," for which we understand there is a steady demand. It is, of course, impossible to describe these fittings; they should be seen. We should also mention that several supplementary pages have been issued in the form of leaflets which were too late for insertion in the catalogue. In conclusion, we should like to compliment the "Ediswan" Company on the good style in which these catalogues are printed; so much importance is attached nowadays to a well-got-up catalogue, and we notice that the "Ediswan" Company are printing all theirs on art paper.

### New Pattern Ceiling Rose.

We are indebted to Messrs. Dorman and Smith, Ordsal Station Electrical Works, Salford, Manchester, for particulars



New Pattern Ceiling Rose.

of a new ceiling rose which has been introduced by them with the view to cheapen the cost of wiring when conduits are used. The porcelain rose is in one piece only, the terminals being sunk into the porcelain on the inside, so that there is no necessity for a separate cover. The terminals are large and substantial, and are suitable for looping through for the main wires to be carried on to the next ceiling box without break. The pendant flexible is first attached to the terminals through a deep V-shaped cord gripping formation in the ceiling rose. The rose with its pendant flexible is then attached to the jointing box by two screws as shown in the accompanying illustration. Iron jointing boxes are stocked, two ways and four ways screwed ½in. gas thread or ⅝in. and ¾in. Simplex.

### For the Drawing Office.

We have received from William Tylar, 41, High-street, Aston, Birmingham, a sample bottle of his ferro-bleach. This fluid is used for producing white lines, correcting plans, titling, etc., on ferro-prussiate paper. It is claimed that it does not rot the paper or spread itself—the finest lines being preserved—and that it is speedy in action. A few strokes of a clean pen, charged with the bleach, on a piece of ferro-prussiate paper convinced us of the justice of the above claims. The fluid should certainly prove of value to all who have to deal with blue and white prints.

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### Polyphase Induction Motors.

From Messrs. Griffith and Biliotti, 8, John-street, Adelphi, Strand, W.C., we have a price-list of their S.C. type induction motors for polyphase currents. The firm have specialised the manufacture of this type of motor at their Railway Foundry and Engineering Works, Reading, and claim to have thereby succeeded in placing on the market a machine of first-class quality which can compete in price with those of foreign manufacture. The motors listed range in output from 1 h.p. to 30 h.p. Data as to the efficiency, etc., for each size are given, also the leading dimensions of motors suitable for two or three phase currents at 50 ⁓, and for pressures up to 500 volts.

### Catalogue.

Messrs. Heaton and Smith, Limited, Salford Switch Works, Frederick-road, Pendleton, Salford, Lancashire, have issued a catalogue of the entire stock-in-trade of dynamos, motors, instruments, switches, fuseboards, electroliers, brackets, etc., which Messrs. Wheatley Kirk, Price, and Co. have been instructed by the liquidator to sell by public auction. The sale commenced yesterday, and will be continued to-day.

## RAILWAYS (ELECTRICAL POWER) ACT, 1903.

The following are the rules just made by the Board of Trade with respect to applications under the Railways (Electrical Power) Act, 1903. This Act, it will be remembered, is to facilitate the introduction of electrical power on railways. The rules commence with notices of proposed application.

1. Notice (hereinafter referred to as "the notice") of intention to apply to the Board of Trade for an order under the Railways (Electrical Power) Act, 1903 (hereinafter referred to as "the Act"), must be published by advertisement in each of two consecutive weeks (*a*) in the *London*, *Edinburgh*, or *Dublin Gazette*, according as the general offices of the railway company applying for the order (hereinafter called "the promoters") are situate in England, Scotland, or Ireland respectively; (*b*) in at least one local newspaper circulating in every county or borough or urban district in which is situate any part of that portion of the railway to which the order applied for relates; and (*c*) if it is proposed to take lands or to construct works in any county or borough or urban district other than the foregoing, then in at least one local newspaper circulating in that county, borough, or urban district. A copy of each of the *Gazettes* or newspapers containing these advertisements must be sent, when published, to the Board of Trade.

2. The notice must be subscribed with the name and address of the promoters or their responsible agents and must (*a*) state generally the objects of the intended application; (*b*) if it be intended to modify any working agreement, specify the company or person with whom such agreement subsists; (*c*) if it is proposed to take any land under the order applied for, describe the land proposed to be taken, stating the quantity thereof and the purpose for which it is proposed to take it; (*d*) name (1) a place where copies of the draft order will be obtainable on payment of not exceeding 1s. per copy, and where (if it is proposed to take any lands) a plan of the lands to be taken and a book of reference to the plan made in accordance with these rules and in these rules referred to as the plan and book of reference, will be deposited for inspection, and (2) a date, not later than three weeks after the first advertisement of the notice, after which copies of the draft order will be so obtainable and the plan and book of reference will be so on deposit for inspection; (*e*) state that any objections must be made in writing to the Board of Trade in accordance with these rules, and a copy thereof sent to the promoters.

3. Copies of the draft order (and, if lands are proposed to be taken, of the plan and book of reference) must be deposited by the promoters within three weeks after the first advertisement of the notice, with the clerk of the council of any county, borough, or urban district in which any part of that portion of the railway to which the order applied for relates, or any works proposed to be constructed, or any lands proposed to be taken are situate.

4. A copy of the draft order and of the notice must be deposited by the promoters within three weeks after the first advertisement of the notice with the Treasury, the Postmaster-General, the Commissioners of Works, and the Commissioners of Inland Revenue, and in any case in which lands are proposed to be taken within 300 yards of land belonging to the Crown or to the Duchies of Cornwall or Lancaster, at the offices of the Commissioners of Woods, the Duchy of Cornwall, or the Duchy of Lancaster, as the case may be. A copy of the plan and book of reference, if any, must at the same time be deposited with the Commissioners of Works. In the case of railways in Scotland a copy of the draft order and of the notice must also be deposited with the Secretary for Scotland, and in the case of railways in Ireland with the Chief Secretary to the Lord-Lieutenant and with the Commissioners of Public Works, Ireland, at their respective offices in Dublin.

5. If any other railway company has running powers over that portion of the railway to which the order applied for relates, a copy of the draft order and of the notice must be sent to each such company within three weeks after the first advertisement of the notice.

6. Any objection to an application to the Board of Trade for an order under the Act must be made in writing to the Assistant Secretary, Railway Department, Board of Trade, within three months after the first advertisement of the notice, and a copy must at the same time be sent to the promoters or their solicitors or agents.

7. If the promoters propose to take under the order any part of a common as defined by Section 21 of the Light Railways Act, 1896, or any easement over or affecting any such common, they must send intimation in writing within three weeks after the first advertisement of the notice to the Board of Agriculture and Fisheries, describing the common affected and the mode in which it is affected.

8. If lands are proposed to be taken, the plan and book of reference referred to in the notice must be deposited by the promoters within three weeks after the first advertisement of the notice at the place named in the notice, and shall be open to inspection at all reasonable times. The promoters shall supply copies of the draft order on payment of not exceeding 1s. per copy at the place and after the date named for that purpose in the notice.

*Plans and Book of Reference.*

9. Every plan made for the purpose of these rules must be drawn to a scale of not less than 4in. to the mile, and must describe the lands intended to be taken, and unless the whole of such plan shall be upon a scale of not less than ¼in. to every 100ft., an enlarged plan shall be added of any building, yard, courtyard, or land within the curtilage of any building, or of any ground cultivated as a garden, proposed to be taken, on a scale of not less than ¼in. to every 100ft.

10. The book of reference made for the purpose of these rules shall contain the names of the owners and reputed owners, lessees or reputed lessees, and occupiers of all lands and houses proposed to be taken, and shall describe such land and houses respectively.

*Notices to Owners, Lessees, and Others.*

11. Within three weeks after the first advertisement of the notice the promoters must serve a notice on the owners or reputed owners, lessees or reputed lessees, and occupiers of all lands intended to be taken describing in each case the particular lands intended to be taken, and enquiring whether the person so served assents to or dissents from the taking of such lands, and requesting him to state any objections he may have to such lands being taken. Every such notice shall be in the form set out in the schedule to these rules, or in a form to the like effect.

*Application to the Board of Trade.*

12. Every application to the Board of Trade for an order must be made within a month after the first advertisement of the notice, and must be under the seal of the railway company applying for the order, and must be accompanied by (*a*) three copies of the draft order and notice, and, if it is proposed to take land under the order, of the plan and book of reference; and (*b*) if it is proposed to raise additional capital, an estimate of the expenses to be incurred for the purposes of the order, including the expense of acquiring land, and of the incidental expenses; and (*c*) a list, with their postal addresses of the owners or reputed owners, lessees or reputed lessees, and occupiers on whom notices have been served; and (*d*) a list of the councils with whom copies of the draft order have been deposited under these rules.

13. (*a*) A statement so far as can be made, whether the owners or reputed owners, lessees or reputed lessees, and occupiers, on whom notices have been served in each case assent, dissent, or are neuter, must be deposited with the Board of Trade on or before the last day of the month after the month in which application was made; (*b*) such proofs must be furnished as the Board of Trade may require of compliance with these rules before they take the application into consideration; (*c*) a certificate that the members of the railway company applying for the order have assented to the application for such a resolution as is required by the Standing Orders of Parliament in the case of an application to Parliament by such company must be deposited with the Board of Trade before an order will be granted.

14. Notices and any other documents required or authorised to be served under these rules may be served by delivering the same to or at the residence of the person to whom they are respectively addressed, or, where addressed to the owner or occupier of the premises, by delivering the same or a true copy thereof to some person on the premises; or if there is no person on the premises who can be so served, then by fixing the same

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on some conspicuous part of the premises; they may also be served by post by a prepaid letter. Any notice by these rules required to be given by the owner or occupiers of any premises, may be addressed by the description of the "owner" or "occupier" of the premises (naming them) in respect of which a notice is given without further name or description.

*Fees.*

15. On or before lodging any application the undermentioned fee, which has been fixed by the Treasury, on the recommendation of the Board of Trade, must be paid by the promoters to the Board of Trade by cheque in favour of an assistant secretary of the Board of Trade—viz., for each application the sum of £50.

*General.*

16. All communications to the Board of Trade should be on foolscap paper and written on one side only, and should be addressed to the Assistant Secretary, Railway Department, Board of Trade, S.W.

17. The Interpretation Act, 1889, applies for the purpose of the interpretation of these rules as it applies for the purpose of the interpretation of an Act of Parliament.

FRANCIS J. S. HOPWOOD, Secretary.

Board of Trade, 7, Whitehall-gardens, S.W.,
Feb. 17, 1904.

## THE NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

The annual general meeting of this association was held on Tuesday last at the Hotel Cecil. The report of the committee for the past year and the accounts were presented and carried. The following extracts from this report are of interest as indicating the class of work being done:

"Although it has only been in existence two years, the formation of the association is fully justified by the various schemes inaugurated and carried out, as well as by the large accession of members consequent upon the progress thus shown. At the end of the 12 months now under review the roll of membership had increased from 34 to 57. Taking into account that for various reasons a loss of six members had to be recorded, it shows that 29 new names have been added during the year.

"Since the exhaustive report made to you at the last general meeting with respect to this association, numerous further meetings between your own committee and that of the China Furniture Manufacturers' Association have taken place, especially one at Birmingham at which three members of your committee attended. The negotiations, which at the time seemed hopeful, have since come to an impasse, and your committee, seeing the futility of coming to an understanding with the other side, deemed it advisable to force the situation by putting an ultimatum to the China Association; the net result of this being that the China Association, so far as concerns the electrical manufacturers, is to-day non-existent, and that the few firms who formerly dictated in that association are now eagerly competing with each other to the benefit of the members of our association, who are no longer restricted by the various clauses which were in force under the old arrangement.

"During the year the names of 55 traders who had had their accounts with our members placed in the hands of solicitors were circulated to the members, and a general caution was also circulated in regard to 28 additional names.

"The negotiations which were carried on up to the beginning of the year with the view of bringing the Plant and Cable Associations into line with our own association and the Contractors respectively have, notwithstanding the exertions on both sides, proved abortive. Your committee therefore decided to leave the Plant and Cable Associations alone and to try to come to terms with the Contractors' Association only, which scheme has, as previously notified, happily been accomplished. It is to be hoped that the result of the mutual understanding between the associations will be of as amiable and beneficial a character as the negotiations were pleasant and conciliatory. A joint committee under that agreement has been appointed, consisting of four members of the Contractors' Association and four of our own. This joint committee has had two meetings, and your committee has pleasure in informing you that at the request of the Contractors' Association representative our own secretary, Mr. Davenport, has been appointed secretary to the joint committee. To this committee will, of course, be referred any questions or disputes which may arise between the members of the two associations, and its members will discuss and bring before the committees of their respective associations recommendations on any questions affecting the trade generally.

"In order to fix a time for due settlement of accounts where unsatisfactory terms were then existing, and so that definite dates should be fixed for the preferential discounts, terms as per circular already sent to the members were arranged. From the report to be placed before you, it will be seen that after paying all liabilities for the year, the association has a credit balance of £83. 19s at the bank.

"The committee would point out that the work of the association has very largely increased since its inception, and the number of points constantly being referred to the secretary and the committee shows how great was the need for such an organisation in connection with the industry. The correspondence seems to grow each week, and, naturally, a very great demand is entailed on the time of the secretary and the committee. They, however, do not begrudge the time thus spent if the interests of the members are being advanced, and they would strongly press upon the latter the desirability of communicating to the secretary any points coming within their cognisance affecting the interests of the trade as a whole. The committee feel that united action would be most advantageous in the event of a liquidation or bankruptcy where it may be felt that everything is not as it ought to be. The committee are of opinion that the association has already justified its existence. They have done everything in their power to make it a success, and they feel it rests with the members themselves to confirm and extend the usefulness of the organisation by the interest they take in its affairs and the assistance they give to its objects."

At the meeting Messrs. Lundberg, Nalder, and Paterson, who had been elected by the committee to fill vacancies, were confirmed in their appointments; and Messrs. H. Oppenheimer, C. S. Northcote, and D. Smith, who retired by rotation, were re-elected.

Mr. M. Byng referred to the protection needed in the case of small limited liability companies, in which the debentures were large and the ordinary share capital small. Such companies were frequently in the hands of one man, and offered no security to creditors. It was decided that the standing of such companies should be investigated by the association on request.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Feb. 25 the following were the candidates balloted for:

*Members.*—J. H. Cawthra, Electricity Works, South Shields; A. B. Maclean, Craig Park Works, Glasgow.

*Associate Members.*—P. T. Blissett, Messrs. A. Guinness, Son, and Co., Dublin; R. W. Fletcher, Box 623, Cape Town; W. N. Kernot, B.C.E., Working Men's College, Melbourne; T. Holme, 74, Bath-road, Southsea; L. J. Le Clair, Engineer's Department, St. James's Gate Brewery, Dublin; J. A. Panton, 28, Molyneux-road, Waterloo, Liverpool; E. S. Rayner, Langlands, Mumbles, R.S.O., Glam.; J. Skerritt, 3, Brighton-road, Addlestone, Surrey; P. H. Stewart, Messrs. A. Guinness, Son, and Co., Dublin; J. Williams, 48, Walter-street, Rotherham, Yorkshire; C. W. Zoephel, jun., 73, Maryon-road, Old Charlton, Kent.

*Associates.*—H. H. Arthur, Urban District Council Electricity Works, Ilford; C. W. Bloomfield, 204, Eglinton-road, Plumstead, Kent; C. E. Clayton, City of London Asylum, Dartford, Kent; M. E. J. Gheury, 12, Cressy-road, Hampstead, N.W.; S. Harris, 63, Lovaine-place, Newcastle-on-Tyne; J. H. Heywood, 231, Drake-street, Rochdale, Lancs.; E. A. Lambert, Ivy Tree Farm, Hadleigh, Suffolk; A. Loving, care of Mr. Loving, 16, Castlebar-road, Ealing, W.; S. C. Manchester, Winmarleigh, Lostock-park, Bolton, Lancs.; G. R. Pepper, Faraday House, Charing Cross-road, W.C.; F. H. Rudd, Electricity Works, Rochdale, Lancs.; S. J. W. Scott, 37, Ronalds-road, Highbury, N.; O. S. Spokes, Municipal Science School, Londonderry; H. A. Stewart, B.Sc., 85, Commercial-road, Lambeth, S.E.; G. Sykes, Electricity Works, Kingston-upon-Hull; U. Willan, 56, Angell-road, Brixton, S.W.

*Students.*—W. E. C. Adye, 51, Cadogan-street, S.W.; H. A. Arbuthnot, J. Auckland, and L. W. Ballard, Faraday House, Charing Cross-road, W.C.; J. R. Barr, 208, Morningside-road, Edinburgh; A. M. Beale, 9, Trafalgar-square, Chelsea, S.W.; T. W. Chalmers, 729, Great Western-road, Glasgow; H. B. Cresswell, Faraday House, Charing Cross-road, W.C.; H. G. Y. Crowder, East Oakley House, Oakley, Basingstoke; H. W. Curling, 27, Swallowfield-road, Charlton, S.E.; W. Dancer, 1, Great Cheetham-street, Broughton, Salford; E. Davies, 35, Peacock-street, Newington-butts; L. H. Dermer, Faraday House, Charing Cross-road, W.C.; J. M. d'Horschel, 8, Princess May-road, Stoke Newington; J. Dobson, Holme Rook, Birch-lane, Longsight, Manchester; L. C. Downman and A. C. Dufort, Faraday House, Charing Cross-road, W.C.; H. N. Dutton, Highmeadow, Read ley, Burnley, Lancs.; A. G. Edgar, Faraday House, Charing Cross-road, W.C.; W. N. Ellery, 7, Ford's-market, Canning Town; H. C. Flower and G. I. Gifford, Faraday House, Charing Cross-road, W.C.; W. A. Gosse, 198, Portland-road, Newcastle-on-Tyne; F. C. Grund, 14 Burne-grove, Tottenham, N.; H. D. Harris, 165, Mackenzie-road, Beckenham; F. De Betham Hart, S. B. Haslam, H. S. Hayden, and R. B. Holmes, Faraday House, Charing Cross-road, W.C.; L. L. Howard, 19 Kimberley-road, Rugby; K. Itu, Hawthorn, Denmark-road, Ealing; H. R. Hudson, 34, Rochester-road, Camden-road, N.W.; D. C. M. Hume, Seaforth, Bournemouth; H. Irle, 20, Hugh-street, Eccleston-square, S.W.; P. H. H. Jantzen, 6, The Avenue, Hornsey Park, N.; L. Lamb, 36, Graham-mansions, Hackney, N.E.; E. J. Martin, Electricity Works, Kirkcaldy; J. G. Murray and R. B. Murray, 24, Church-street, Lenton, Nottingham; F. A. G. Noel, Faraday House, Charing Cross-road, W.C.; G. S. Payne, Dunedin, Cambridge-park, Wanstead, E.; J. S. Percy, A. C. Pesterre, and H. S. Phillips, Faraday House, Charing Cross-road, W.C.; H. W. Pink, Catherington, Hillborough-crescent, Southsea; E. A. Powell and G. V. Pullen, Faraday House, Charing Cross-road, W.C.; W. A. Ritchie, 26, Binfield-road, Stockwell; J. Robinson, 23, Nelson-street, Charlton-on-Mersey, Manchester; W. A. Scotter, 20, Eversley-place, Heaton; A. Slaughter, 1, Great Cheetham-street, Broughton, Salford; A. K. T. Smith, The Woodlands, Dulwich Common, S.E.; A. Stanton, 13, Hyde-street, King's-road, Southsea; F. W. Strickland, 68, Canfield-gardens, West Hampstead; M. H. Tate, 8, Burnfoot-terrace, Whitley Bay, Northumberland; J. W. Taylor, Faraday House, Charing Cross-road, W.C.; E. F. Thornton, Farnley-hill, Corbridge-on-Tyne, Northumberland; A. L. Trickett, 65, Breakspear's-road, Brockley, S.E.; A. E. Turpin, 6, Peel-street, Nottingham; F. R.

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Unwin, 2, Gladstone-villas, Bridge-road, Chelmsford; A. Vipan, 126, Earlsfield-road, Wandsworth. S.W.; H. E. Webb, Faraday House, Charing Cross-road, W.C.; S. W. Webb, 2, Palmerston-villas, Rathmines, Dublin; H. A. Wootton, 21, Portland-road, Finsbury Park, N.; G. E. Worthington, Faraday House, Charing Cross-road, W.C.; A. Zoller, 8, Bishop's-road, Croydon.

## PERSONAL.

Mr. T. Tyson, electrical engineer, Great Grimsby Tramways Company, who has resigned his position with the Cleethorpes tramways, was last week presented by Mr. Samuel E. Barnes, A.I.E.E., shift engineer, on behalf of the employés, with a handsome electro-plated silver tea and coffee service and a suitably inscribed oak tray.

Mr. C. Jennings, who has for the last two or three years been local manager for the National Telephone Company, Limited, at Margate, on leaving the company's service to take up an important appointment with the Port Elizabeth Corporation, was on Saturday last, at a dinner at which the district manager, Mr. E. E. Stokens, presided, presented by the staff of the East Kent district with a handsome dressing-bag and cigarette holder.

We are informed that Mr. F. G. Bell, who has been for so many years closely connected with the telephone department of the General Electric Company, has resigned his position with that firm, and has joined the senior staff of the Berliner Telephone Manufacturing Company, 200, Upper Thames-street.

The Charing Cross and Strand Electricity Supply Corporation, Limited, held a Bohemian concert at the Freemasons' Tavern, Great Queen-street, W.C., on Tuesday last. An excellent programme was submitted and much appreciated by a large audience, the concert being a great success.

Mr. Wm. Burr, A.I.E.E., of Reading, has been appointed chief assistant electrical engineer at Croydon.

The Salford Corporation tramways employés' annual dinner was held last Saturday. About 120 sat down, among those present being Alderman Linsley, J.P., Councillor Jackson, J.P., Messrs. C. H. Chesters (traffic superintendent), H. Bolton, E. Eadson, and J. Griffin, (branch secretary). The proceedings were very successful, and reflected great credit upon the organisers of the gathering. A number of the members of the Salford Corporation tramways employés' band played selections of music during the dinner, and the following artistes contributed to the harmony: Messrs. H. Hughes, F. Wild, F. Royal, W. H. Jones, A. Turner, and T. Carlisle. Mr. G. W. Holford presided at the commencement of the proceedings.

The tramway employés of the Nottingham Corporation, at their second annual dinner last week, produced from within their ranks quite a number of elocutionists, vocalists, and low comedians of more than average ability. There are about 300 employés engaged on the service, but only a third of that number were present. The second and third sections took their turns on the two following days. The duties of the men were so arranged as to enable each one to enjoy the committee's hospitality without interfering with the convenience of the tram-travelling public.

Mr. O. J. Kirby, borough surveyor of Batley, has been awarded £50 for his services in connection with the laying of the tramways.

Mr. John Anderson, C.E., of the burgh surveyor's office, has obtained a responsible position on the engineering staff of Messrs. J. G. White and Co., Limited, engineering and tramway contractors, of London. Mr. Anderson has had considerable experience in the many public works carried out recently by the Aberdeen burgh surveyor for the Town Council, but more particularly in the work of reconstructing the city tramway system for electric traction during the past two years.

Mr. Lucas has been appointed secretary and traffic manager to the Leicester Corporation tramways at a salary of £350; and Mr. T. R. Smith resident electrical engineer at £250, increasing by £25 a year up to £350.

The annual social meeting and dance of the Ayr Corporation tramway employés was held in the Council Chambers on Friday last. The proceedings opened at 9.15 with a supper, at which Mr. Fred Coutts, the tramway manager, presided, and amongst those present were Councillor J. S. Hunter, convener of the Tramway Committee; Provost Allan, Dean of Guild Fraser, Bailie Grant, Bailie Wallace Allan, Bailie Thomas Allan, Councillors Robert Millar and Hugh Hunter, Mr. John Young (burgh surveyor), and Mr. Robert Adam (sanitary inspector).

A successful and enjoyable evening concert in aid of the funds of the Brighton Corporation Tramways Provident Society was held in the Great Hall, York-place Schools, last week, when the tramways manager and engineer, Mr. T. Holliday, presided over a crowded attendance. The society, which was inaugurated on Jan. 2 last, already numbers 157 members, and bids fair to be a very prosperous and valuable adjunct to Corporation tramways. The society is an entirely self-supporting one, and it is, therefore, a matter of much congratulation that the initial venture on its behalf should have proved so successful.

The Hon. Sydney George Holland has been elected a director of the Underground Electric Railways Company of London, Limited.

Mr. H. Lawes Webb has opened offices as consulting engineer at 35, Old Queen-street, Westminster, S.W. He will specialise in telephone work.

Mr. E. N. Greaves, construction engineer under the Bradford Corporation, who is about to take up a similar appointment with the Council of the city of Birmingham, was on Friday last presented by the staff of the electricity department with a handsome dressing-case and a silver match-box. The presentation took place in the presence of a numerous gathering at the generating station, and it was made on behalf of the subscribers by the engineering superintendent, Mr. William Jones, the chair being occupied by Mr. A. S. Blackman, the city electrical engineer and manager. Mr. Jones, who testified to the ability and qualifications of the recipient, also spoke of the courteous and unassuming manner which Mr. Greaves had shown to all those with whom he had come in contact in the discharge of his duties. Mr. Blackman said that although he had been at Bradford but a short time, Mr. Greaves had won his esteem and regard; and amongst other speakers who also testified to the esteem which Mr. Greaves had gained were Mr. C. B. Holdsworth, chief clerk and accountant, and Mr. Brown, assistant superintendent. The gifts were suitably acknowledged.

## LEGAL INTELLIGENCE.

### METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED, v. METROPOLITAN BOROUGH OF MARYLEBONE.

In the Chancery Division of the High Court, before Mr. Justice Buckley, the motion by the defendants for an extension of the time for completion of their contract to take over a portion of the undertaking of the plaintiffs was heard.

**Mr. Buckmaster, K.C.**, for the defendants, briefly stated what had transpired since judgment was given against the defendants on Aug. 7, 1903, for specific performance of the contract under Act of Parliament for purchasing a portion of the plaintiffs' undertaking, in respect of which purchase-money amounting to over a million was payable on Dec. 31. The Borough Council were unable to raise the money by loan. The alternative was to raise the money by a heavy rate, which was practically impossible, or to go to Parliament for borrowing powers. To present a Bill for that purpose it was necessary to obtain the consent of the ratepayers, and on Dec. 11 steps were being taken to get the sanction of the ratepayers. It was pointed out to the Court then that this could be done by about the end of January, and the time for completion was accordingly extended until Feb. 29. The sanctions to the Bill by the ratepayers and the Council had been obtained early in February, and the Bill had now been read a second time in the House of Commons. It would have to be dealt with in committee, and the Council now asked that the time for completion might be extended until Aug. 31, by which time in all probability the Royal assent could be obtained to the Bill.

A discussion then took place as to certain difficulties which had arisen as to the terms on which the former orders for extension of time were made, especially with reference to the repayments to the plaintiffs of capital expenditure on the undertaking.

**Mr. Justice Buckley**, in summing up, asked what were fair terms on which a further extension of time ought to be granted? There was an undertaking on which it was necessary to make further capital expenditure. Through the default of the purchasers the undertaking was left under the control of the vendors, but although it was now the purchasers' undertaking, the vendors were bound to go on with it and to pay money in respect of it. Why should this burden be thrown on the vendors? Further moneys must be provided by the purchasers, who were in default. What was a fair figure for them to pay as a term of their having a further extension of the time to complete? He (Justice Buckley) would name a figure and then appeal to the plaintiffs to take less, as he did not wish to press hardly on the ratepayers. Having regard to the evidence as to expenditure, he found the sum to be £20 000, but he asked the plaintiffs to accept £15,000.

**Mr. Cripps, K.C.**, for the plaintiff, said that after what had fallen from his Lordship his clients were willing to accept the £15,000.

**Mr. Justice Buckley** said he would extend the time for completion until April 30 on the term that the defendants would on or before March 31 pay the plaintiffs £15,000 in respect of expenditure on the undertaking.

### TOO LITTLE WORK.

Concerning a recent hearing in Mr. Justice Darling's court of a complaint raised by an apprentice, Alfred Marshall, against his master, the jury, in giving a verdict for the plaintiff, upheld that gentleman's contention that an insufficiency of work had been meted out to him.

The result is that his father receives £70 from Mr. Lock, engineer, of Bouverie-street, Fleet-street, being part of the money paid as premium for teaching the apprentice electrical engineering and also part of a sum which was to be returned to the youth as pocket money at the rate of 30s. a week.

**Mr. J. H. Lock**, the defendant, said he had had 27 years' experience as an engineer, and had been superintendent of the Crystal Palace School for Engineering. At his Bouverie-street premises no orders for work were taken, the whole place being utilised for the teaching of engineering. Young Marshall did not come in as an apprentice at all—he had finished his apprenticeship.

**Mr. McCall, K.C.** (in cross-examination): Do you think it was fair to describe this academy in Bouverie-street as a well-known London works?—**Defendant**: I was agent for introducing pupils to larger works elsewhere. It was a combined advertisement.

### AUTOMATIC TELEPHONE COMPANY.

Mr. Justice Byrne on Monday heard the petition of H. Le Blanc Smith and others for winding-up the Automatic Telephone Company (1903), Limited.

**Mr. Henry Terrell, K.C.**, said the petitioners for whom he appeared were holders of 11 000 shares, and they were supported by holders of 118,000 shares. They were opposed by Mr. Max Margowski, who was managing director, and who purported, with members of his family, to

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hold 191,000 shares. The Automatic Telephone Company, Limited, was formed in 1897 to take over the business of the Apostoloff Automatic Telephone Parent Syndicate, Limited, which was of Margowski's creation. The company came to grief and reconstruction was proposed, the result being the formation of the present company.

**Mr. Eve, K.C.**, said he was perfectly ready to meet the charge of fraud made against his client, Mr. Margowski, but he had not had time to read the affidavits presented on the petitioners' behalf, and he asked for an adjournment.

After some discussion this was agreed to, his **Lordship** directing the petition to stand for a week, and ordering Mr. Margowski to attend then.

## OVERCROWDING TRAMCARS AT BRADFORD.

Three summonses, involving questions of general interest to tramway managers, were dealt with by the Bradford stipendiary magistrate (Mr. Charles Skidmore) and others on the 1st inst. The points raised were the result of the action of Lieut.-Colonel Henry D. Sichel, who on Jan. 18 refused to pay a penny tram fare on the ground that the car on which he travelled was overcrowded.

The first charge dealt with was a summons taken out by the Bradford Corporation against Colonel Sichel for refusing to pay his tram fare; the second was a summons taken out by Colonel Sichel against Edward Dove, a tram conductor, for failing to warn intending passengers that the car was full; whilst the third was again laid by the colonel against the Corporation for failing to place in a conspicuous position in a tramcar notices giving the number of persons the car was licensed to carry.

**Mr. H. D. Wardle** (deputy town clerk) said in relation to the first case the issue was simply a question as to whether defendant had broken a Corporation by-law. There was no question of law involved, and the facts were admitted.

**Conductor Dove**, in cross-examination by Mr. A. Neill, who represented the defendant, said he was allowed to carry inside the car 22 passengers sitting and 10 standing, but there was no by-law to this effect. He did not warn the defendant not to get on the car. It was a wet morning, and people were standing inside instead of going on the top.

**Mr. Neill** said he should not contest the legality of the fare. His client had come into court in order that something might be done to prevent the systematic overcrowding of cars, which was alike injurious to health and comfort. Proceeding with the other summonses, he said the by-laws of the Corporation were evidently drawn up with the preconceived idea of evading responsibility. He contended that it was the duty of a conductor to warn passengers not to enter a full car, inasmuch as would-be passengers could not judge for themselves whether there was accommodation.

**Mr. Wardle** combated this statement, and urged that there was no onus thrown on a conductor in the manner alleged by Mr. Neill, nor was there any onus thrown on the Corporation to provide notices of the number that the cars were licensed to carry.

The **Stipendiary** intimated that he should fine the Colonel for refusing to pay his fare, and fix the penalty when he gave judgment on the other two questions, which would be on Thursday, March 10.

## THEFT OF ELECTRIC CABLE AT NEW CROSS.

At Newington Sessions on Thursday last week, Robert Tiffen, a fitter, and Herbert Ellis, clerk, pleaded guilty to stealing, and Alfred Toms, marine store dealer, was convicted of receiving, a large quantity of electric cable, used as high-tension trunk mains for the New Cross electric trams, being the property of Messrs. Siemens Bros. and Co., Limited. The cable was valued at £70 a ton, and Toms bought it for a few pence per pound, and having separated the copper wire from the leaden casing, sold both metals to Mr. Joseph Ames, a metal merchant of Kingsland-road. That these dealings were extensive was shown by the fact that within five months Mr. Ames paid Toms £390. It was stated that Toms was now serving a term of six months for receiving cable in December last. Sentences: Toms, penal servitude for three years; Ellis, 18 months' hard labour; and Tiffen, one month in the second division.

# COMPANIES' MEETINGS AND REPORTS

## OXFORD ELECTRIC.

The following report of the directors is to be submitted to the shareholders at the general meeting to-day:

The directors beg to submit their report and accounts for the year ended Dec. 31, 1903. The revenue account shows a profit (including £276. 3s. 1d. brought forward from last year) of £10,546. 3s. 1d. After providing £2 040. 17s. 2d. for debenture and other interest, and writing off £623. 15s. 3d. on account of hire purchase installations, the balance available for dividend is £7 880 10s. 8d., which your directors propose to appropriate as follows: in payment of a dividend at the rate of 6½ per cent. per annum on the share capital, ranking for dividend (whereof 2½ per cent. was paid in September last) £4,550, and in adding £2,500 to the reserve and renewal of plant account, which will then amount to £7,000, the balance of £830. 10s. 8d. to be carried forward to next year's account. It is estimated that at Dec. 31 last there was the equivalent of over 55 000 8-c.p. lamps connected to the mains. The number of Board of Trade units sold during 1903 was 12 per cent. larger than in the previous years. The capacity of the generating plant has been increased by 375 kw., and additional sub-stations have been installed at Christ Church, Merton College, and New-road. Extensive additions to the mains have been made in Banbury, Woodstock, New Mansfield, and Oakthorpe roads; also in St. Ebbe's, Brewer, Merton, Becket, and New Inn Hall streets.

## CHELSEA ELECTRIC SUPPLY.

The report to be submitted at the meeting on the 11th inst. shows a profit for the year of £33,055, which, with £311 brought forward, makes a total of £33 366. After deducting interest on debenture stock £6 750, interim dividend 6 per cent. on the preference shares and on ordinary shares at the rate of 4 per cent. per annum, balance of interest £65 and written off suspense account £1,607, there remains a balance of £19,600. The directors recommend that a sum of £9,724 be placed to credit of renewals and depreciation fund, a final dividend paid on the ordinary shares at the rate of 7 per cent. per annum, making 5½ per cent. for the year, leaving to be carried to next account £1,200. A further expenditure, amounting to £3,026, has been incurred during the year in connection with changing the system of supply from 100 volts pressure to 200 volts. This amount has been added to the suspense account, from which £1,607 has been written off, leaving that account at £3,213. The number of lamps connected on Dec. 31, 1903, was 195,235, an addition of 19,233 during the year, and the improvement in the units sold per lamp continues. The total number of units sold in 1903 was 2,739,352, being 481,793 more than the previous year.

## SCARBOROUGH ELECTRIC SUPPLY.

The annual report of this Company states that the number of consumers show an increase upon the previous year from 785 to 830, and that the total revenue had been £11,232, against £10,273. The balance on revenue was £5,337. 15s. 1d., and after the deduction of £1,775 absorbed by an interim dividend at the rate of 2½ per cent. paid in August, the directors recommend payment of a further dividend for the year of 4½ per cent., and the carrying forward of £57. 17s. 2d. An agreement had been entered into with the Scarborough Electric Tramways Company on lines satisfactory to both parties.

At the annual general meeting last week, Mr. J. E. Ellis, M.P., presiding, the report was adopted; and Messrs. G. Alderson Smith, G. Lord Beeforth, and J. W. Woodall were re-elected directors, and Messrs. C. E. Bradley and Co. were appointed auditors at an increased fee of 25 guineas.

## GREAT YARMOUTH AND GORLESTON TRAMWAYS.

The total revenue for the year 1903 amounted to £7,791 and the expenditure (including £296 for debenture and other interest) to £5,793, leaving a net profit of £1,997, which added to the amount of £142 brought forward from the last account, makes an available balance of £2,140. The directors place to depreciation and reserve fund £500, and pay a dividend at the rate of 7 per cent. for the year, leaving a balance to be carried forward of £240. The directors are glad to be able to report that considerable savings have been effected in the general running expenses in spite of the unfavourable weather. The traffic receipts have been well maintained. The rolling-stock and permanent way have been kept in repair and the stud is in good condition.

## HART ACCUMULATOR.

The fifth ordinary general meeting of the Hart Accumulator Company, Limited, was held on Wednesday, Mr. G. W. Kidd (chairman of the Company) presiding.

The report of the directors stated that the profit for the year is £5,860. 5s. 2d. and the balance brought forward from last year £4,877. 5s. 6d., amounting together to £10 737. 10s. 8d. The directors recommend the payment of a dividend of 12½ per cent. per annum on the ordinary share capital, which will absorb £5,000, leaving £5,737. 10s 8d. to be carried forward. The Company's buildings, plant, tools, etc., have been augmented by £1,790. 7s. 3d., which has been charged to capital, and due depreciation on same has been made. The maintenance of the works, plant, etc., has been well kept up at a cost of £724. 5s. 8d., which has been paid for out of revenue.

The **Chairman** said that although they had had a very successful year they were not paying so large a dividend as for the previous period, but the business done would have allowed them to pay with ease 15 per cent., as they did a year ago.

The report and balance-sheet were adopted, and the payment of a dividend of 12½ per cent., less income tax, on the issued capital of the Company was agreed to.

**Mr. Leslie W. Spratt**, in seconding the motion, agreed with the chairman that they had every reason to congratulate themselves on the success attained during the past year.

Messrs. G. W. Kidd and G. Hay, the retiring directors, were re-elected. The auditors, Messrs. Thomas S. Wederell and Co., were reappointed for the ensuing year.

The **Chairman** proposed a hearty vote of thanks to the manager, secretary, and staff, to which **Mr. Edward J. Clark** and **Mr. John H. Poulton** replied.

A vote of thanks to the chairman closed the meeting, after which an extraordinary general meeting was held for the purpose of increasing the capital of the Company. The following resolutions were carried: (1) "That the capital of the Company be increased from £40,000 to £60 000 by the creation of 20,000 new shares of £1 each. (2) That the new shares be called preference shares, and that the holders thereof be entitled to a cumulative preferential dividend of 6 per cent. per annum on the amount paid up thereon, but to no further

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share in the profits of the Company. (3) That in the event of the Company being wound up, the holders of the said shares shall be entitled to have the surplus assets of the Company applied, in the first place, in repaying to them the amount paid up on the preference shares held by them respectively. (4) That the said shares shall be offered for subscription to the members of the Company, in accordance with article 8 of the articles of association—namely, in proportion to the existing shares held by them. (5) That the interest on the new shares be paid half-yearly—namely, to the end of March and end of September, the first payment being made in October next; and (6) that the subscriptions for the new shares be payable as follows: for each £1 share, 5s. on application, 5s. on allotment, 5s. three months after allotment (if required), 5s. six months after allotment (if required)."

## NEWCASTLE ELECTRIC SUPPLY.

The annual meeting of the shareholders of the Newcastle-upon-Tyne Electric Supply Company was held in the Station Hotel, Newcastle, last week, Dr. J. T. Merz, chairman of the Company, presiding.

The directors report total receipts for the year amounting to £76,617. 14s. 2d., and a total expenditure of £34,050. 10s. 2d., there being thus a gross profit of £45,567. 4s.

The **Chairman** said the units sold last year amounted to 9,033,625, as against 5,537,500, showing an increase of 3,496,125. There was a considerable difference in the way these units were sold and distributed to consumers. In the year before, more than half the units were sold wholesale. Last year they took over the business of Walker and Wallsend Gas Company, and became not only sellers but also distributors of these units. They had also to bear the cost of distribution as well as manufacturing. This was considerable. This difference of proportion between wholesale units and units distributed by them had had the effect of putting up the cost of unit delivered, but if they rectified the figures and added on the rentals the price came out really the same as the year before. The gross profit of the Company for the year was £42,567. 4s., against £26,522 the year before. In former years they had to report considerable increase in the length of cables and wires. This year he had to report a very small addition to that. This was significant. The reason of the small increase was that they had now entered into a different stage of their business. Whereas two years before they had very much increased, last year they had increased very little, but they had begun really to do more profitable work—that was, to fill up the line and get as many customers as they could. The Company had now acquired an interest in the Priestman Power Company, Limited. The fact that a considerable source of power existed in the form of waste heat of gases at the coke ovens gave an opportunity for considering the propriety of utilising these for electric purposes, and the owners of the Priestman Company being shareholders, an understanding was come to to join hands, they giving heat and gas, and the Company, on the other hand, supplying electrical knowledge, connections, and facilities in order to utilise these. They would all be aware that the Corporation of Newcastle had brought in a Bill for the extension of their tramways in the districts outside the borough. These districts, or some of them, were in the area of this Company, in which the Company had a kind of monopoly for the supply of electricity. They would also remember the Company were not able to maintain what they considered their right with the Corporation when the Corporation started their tramways. The Company then thought they had a right to supply electricity for all purposes within the borough, but as tramways were not mentioned, and as nobody thought then of working tramways by electricity, it was then decided the Corporation had the right, in spite of their provisional order, to supply from their own house, and the supply of power was taken away from the Company. If the Corporation got this Bill for extending their tramways into the areas in which the Company had these rights, they would be in a similar position again. Therefore, in order to guard their rights and protect them, the directors had thought it necessary to lodge a petition against this Bill.

The report was adopted, and a dividend of 5 per cent. on the preference and 8 per cent. on the ordinary shares declared.

## TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The fortieth ordinary general meeting was held on Tuesday at the offices, 38, Old Broad-street, Sir Robert G. W. Herbert presiding.

In their fortieth annual report the directors stated that the accounts for the year show a net profit of £108,738. 2s. 4d. after charging the interest on the debentures. To this sum must be added £101,385. 14s. 11d. brought forward from last year, making a total of £210,123. 17s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 14, 1903, amounting to £22,410, leaving £187,713. 17s. 3d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, together with a bonus of 12s. per share, absorbing £67,230, being at the rate of 15 per cent., and making with the amount already paid a total dividend and bonus for the year of £2. 8s. per share, or 20 per cent. free of income tax, leaving £120,483. 17s. 3d. to be carried forward to the next account. The Company's factories at East Greenwich and Wharf-road have been actively engaged during the year in the manufacture of submarine telegraph cables and of insulated wire for land lines. The Company's steamships have been employed in cable-laying operations, as well as in the carrying out of repairs of submarine cables. The Company's factories and steamships have been efficiently maintained, and are in excellent order and repair.

The **Chairman** said the period under review had been a successful and industrious year for the Company. Last July they completed the laying of the second great Pacific cable which they had been concerned in—that between Honolulu and Manila. It was a large undertaking—upwards of 5,000 knots—and their vessels had returned from carrying out the work in very good order. He paid a compliment to the Company's chief electrical engineer (Mr. Lucas) and to the captains of their ships for overcoming exceptional difficulties during the execution of this work. During the recent test matches in Australia there had been a competition between two of their cables as to which should transmit the messages most promptly. The results obtained in either case had been nearly equal, but a record in rapid transmission had been established by means of this Company's work, with the exception of the Atlantic portion of one of the cables. Being a manufacturing company, it was not desirable to publish details of all their business transactions, but the Board were again able to state that the Company's factories were in fine order and doing good work, that their ships were also in excellent condition, and that everything connected with the Company was on a thoroughly sound and satisfactory footing. The pension fund item of £67,085 would disappear in future, as arrangements had now been made for vesting the money in trustees for the purpose of forming a permanent fund for the pensioning and granting of annuities to the Company's employes.

The report was adopted, and the payment of a dividend and bonus, making the total distribution for the year equal to 20 per cent., free of income tax, was sanctioned.

The **Chairman**, in reply to a question, said that they felt that no progress had been made in the Marconi operations which at all indicated any danger to this Company's particular province of submarine cable work. He was aware that very useful work had been done, and no doubt would be done in the future, by wireless telegraphy for short distances—in enabling communication to be established between ships out 100 or even 200 miles from the shore—but the directors had seen nothing to make them believe that important commercial and political messages could be transmitted from one side of the world to the other by that system with rapidity, security, and secrecy.

A resolution was afterwards passed approving a form of trust deed constituting a pension fund for the benefit of the Company's staff and their dependents, and sanctioning the payment to the trustees, to be appointed under the deed, of the sum of £67,085 appearing in the balance-sheet, and set aside for that purpose.

## CARLISLE TRAMWAYS.

The annual meeting of the Carlisle Electric Tramways Company was held on Monday in the Company's offices, Warwick-road, Mr. Lingard presiding. The report and balance-sheet (which have been published) were adopted.

The **Chairman** said the Company were gradually succeeding, as was shown by the more satisfactory figures they had been able to lay before them, and by the fact that during last year upwards of 2,800,000 passengers had used their cars against 2,200,000 in 1902. In considering the results which were laid before them, the meeting must not take the £879, which was the excess of receipts over those in 1903, as representing the real advance that they had made; for they must bear in mind that in 1902 the circumstances were rather exceptional, as there had been the Royal Show and the festivities in connection with his Majesty's coronation, events which brought in a sum of about £320, and to get at the increase of receipts for last year that sum should be added to the £879. He regretted the Corporation had not seen their way to meet the directors in reducing the price for current. The revenue account showed a surplus of £3,112, as against £3,039 in 1902 and £2,458 in 1901. The increase was slight as against 1902, but he had to remind them that, with the exceptional circumstances of 1902, the figures were really better than they appeared to be. They proposed to carry £500 of the surplus to the fund to meet depreciation, raising it to £2,533, to pay a dividend of 2 per cent. on the shares, and to carry forward £341. It was after very careful consideration that the directors decided to recommend the payment of even that small dividend; but they felt that their shareholders had borne the heat and burden of the day with great patience, and that at all events on this occasion it was fair that they should participate, even if it was not very largely, in the profits of the Company. Their car mileage had increased to the extent of 14 264 miles, and they had carried over half a million more passengers than in 1902, and their receipts had increased £879. The total receipts per car mile run had again risen. In 1901 they were 6·46d.; in 1902, 7·05d.; and in 1903, 7·38d. The expenses in 1901 amounted to 71·71 per cent. of the receipts; in 1902, 67·68 per cent.; and in 1903, 69·71 per cent., the latter being equal to 5·15d. per car mile. Taking into consideration again the special circumstances of 1902, he did not think there was much to complain of in those expenses, especially as he believed he was right in saying they compared very favourably with expenses of similar undertakings.

An honorarium of £125 was voted to the directors in recognition of their services during the past year, and the usual votes of thanks concluded the meeting.

## LIVERPOOL TRAMWAYS BENEFIT SOCIETY.

At the recent third annual meeting of the benefit society formed in connection with the Liverpool Corporation tramways service, Alderman E. Burns, chairman of the Committee of Management, presided. The society has now been in existence a little over three years, having been formed on Sept. 1, 1900, and the first subscriptions deducted on Oct. 8 of that year, the Corporation agreeing to contribute one-third of the total contributions. The number of members on the roll of the society on Dec. 31, 1900, was 1,340, and on Dec. 31, 1903, 1,697. The income of the society for the 12 months ended Dec. 31, 1902, was £3,274. 16s. 10½d., and for the year ended Dec. 31, 1903, this amount was increased to £3,341. 13s. 1½d. During the year sick allowance was granted for varying periods to 735 members, the average amount paid to each member for sick allowance being £2. 1s. Since the formation of the society 49 death claims had been paid, of which 33 were members and 16 members' wives. On Dec. 31, 1902, the amount standing to the credit of the

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society was £2,189. 5s. 4d., and this sum had now been increased to £3,363. 3s. 10d., £3,000 of which has been invested in Liverpool Corporation bonds. From March 1, 1902, the sick allowance under Rule 33 was increased from 12s. 6d. to 15s. per week for Classes 1 and 3, and from 6s. to 7s. 6d. per week for Class 2, and this increased allowance had been thoroughly appreciated by the members of the society. One of the objects of the society was to extend the benefits as early as possible to include a superannuation fund, and this matter is about to be finally reported upon. The Lord Mayor was elected hon. president of the society, and Mr. Richard Barrow was reappointed hon. auditor.

## BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT.

The ordinary general meeting was held on Wednesday at Winchester House. Sir John A. Willox, M.P., presided.

The directors' report for the year ended Dec. 31, 1903, stated that the revenue account shows a credit balance of £11,041. 1s. 10d., which, with £2,909. 14s. 5d., the balance brought forward from the previous year, makes a total of £13,950. 16s. 3d. After deducting £4,855. 17s. 2d. for interest on debenture stock paid and accrued, and for other interest, and £1,093. 15s. for interim dividend paid on 7 per cent. cumulative preference shares, there remains a net balance of £8,001. 4s. 1d., which the directors recommend should be dealt with as follows: to payment of dividend up to Dec. 31, 1903, upon the amounts paid up on the 7 per cent. cumulative preference shares, £1,531. 5s.; to credit of depreciation account, £1,250; and that the balance of £5,219. 19s. 1d. be carried forward to the next account. A profit of £1,185. 8s. 6d. was earned under contract for works carried out for the Lewisham Company, which has been applied in reduction of the account for preliminary and issue expenses. The business of the Company continues to show steady progress, the number of consumers being now 1,734 and the number of 8-c.p. (35-watt lamps) connected 60,540. The Company's Bill in Parliament received the Royal assent on Aug. 11 last, and the undertaking of the Lewisham and District Electric Supply Company, Limited, was accordingly transferred to this Company as from Sept. 30. The directors, with the sanction of Parliament, have entered into a provisional agreement (a copy of which can be inspected by the shareholders at the registered offices of the Company between the hours of 11 a.m. and 3 p.m. on 24th and 25th inst.) for the purchase of the undertaking of the Crystal Palace District Electric Supply Company, Limited, whose area of supply connects the separated areas in Lewisham and Penge acquired from the Lewisham Company. The managing director has made careful inspections of the Crystal Palace Company's generating station, sub-stations, and area generally, and is satisfied that the undertaking can be economically worked by this Company, and the directors confidently believe that the purchase will be advantageous and profitable.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation and distribution of electricity | 5,235 | 5 | 6 |
| Rents, rates, and taxes | 892 | 2 | 2 |
| Management expenses—salaries, etc. | 2,188 | 0 | 0 |
| Special charges—insurance, etc. | 93 | 12 | 4 |
| | 8,409 | 0 | 0 |
| Balance carried to net revenue account | 11,041 | 1 | 10 |
| | £19,450 | 1 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sales of current per meter, less rebates | 18,620 | 7 | 8 |
| Rental of meters | 721 | 11 | 3 |
| Transfer fees | 16 | 2 | 6 |
| Sundry receipts | 63 | 8 | 5 |
| Rents receivable | 28 | 12 | 0 |
| | £19,450 | 1 | 10 |

Abstract of Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 253,690 | 0 | 0 |
| Due from sundry tradesmen and others | 12,090 | 18 | 5 |
| Sundry creditors on open accounts | 1,852 | 12 | 0 |
| Bills payable | 9,153 | 14 | 6 |
| Debenture stockholders for interest accrued | 1,125 | 0 | 0 |
| Parr's Bank, Limited, overdraft | 7,000 | 0 | 0 |
| Balance from net revenue account | 6,751 | 4 | 1 |
| | £291,663 | 9 | 0 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 273,303 | 8 | 1 |
| Stores on hand | 885 | 17 | 10 |
| Cost to date of change-over system of supply | 759 | 19 | 2 |
| Preliminary expenses, and cost of subscription of stock, etc. | 6,696 | 11 | 10 |
| Suspense account | 900 | 0 | 0 |
| Sundry debtors for current supplied, etc. | 7,935 | 14 | 2 |
| Cash at bank and in hand | 1,181 | 17 | 11 |
| | £291,663 | 9 | 0 |

The **Chairman** said the Board proposed to ask the debenture holders to agree to a modification of their rights, either by converting their present stock into preference shares at once or by accepting an equivalent amount in a new debenture issue at 4½ per cent. per annum without any future right to convert into preference shares. The report and accounts were adopted.

An extraordinary meeting was held subsequently, at which resolutions were passed confirming the purchase agreement with the Crystal Palace Company and empowering the Board to arrange terms of settlement with the debenture holders.

## NORTHALLERTON ELECTRIC LIGHT AND POWER.

The annual general meeting of the above Company was held on the 24th ult. Mr. John Hutton, M.P., presided.

The annual report, which was adopted, showed a profit of £262. 12s. 7d., as compared with £152. 4s. last year. The directors had authorised the issue of 5 000 non-cumulative preference shares of £1 each, and of these 563 have been already issued; £1,100 ordinary shares had been issued during the year.

The **Chairman** said they had sold 7,749 units of light more as compared with the previous year, of which 3,974 went to private consumers, and they had received the sum of £126. 16s. 4d. more for their current than in the previous year. He therefore hoped they were satisfied with such progress. The working expenses had decreased very considerably—viz., to £51. 11s. 2d.—and they had saved on maintenance and repairs £47. 17s. 9d.

## CAMBRIDGE ELECTRIC LIGHT.

The annual meeting of the shareholders was held on the 24th ult., Mr. D. Munsey presiding. The directors' report, already noted by us, was adopted, and their remuneration increased to 300 guineas. Messrs. Simpson and Parsons, the retiring directors, were reappointed to office. The thanks of the Company were accorded the manager, secretary, and staff, and a vote of thanks to the chairman concluded the meeting.

## NEW COMPANIES REGISTERED.

**Rhodes Electrical Manufacturing Company, Limited.**—Capital, £60,000. Object: to acquire the business of electrical manufacturing engineers carried on at Bradford and London as the Rhodes Electrical Manufacturing Company, to adopt an agreement with A. L. Rhodes, S. H. Fielden, J. A. Halford, and H. H. Hopkins, trading as the Rhodes Electrical Manufacturing Company, and to carry on the business of electricians, electrical, mechanical, and general engineers, makers of electrical tramcars, electric light cables, telegraph and other wires and accessories, dynamos, motors, telephones, bells, electroliers, arc and other lamps, etc. Registered office: 70, Bishopsgate-street Within, E.C.

**Rhodes Electrical (Parent) Syndicate, Limited.**—Capital, £5,000. Object: to carry on the business of electricians, electrical and general engineers, electric tramcar and motorcar manufacturers, manufacturers of electric cables, wires, accessories, and fittings, etc. Registered office: 70, Bishopsgate-street Within, E.C.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Retz (Lower Austria).**—The Municipality require tenders for the installation, etc., of an electric light works. Tenders by March 20.

**Seville (Spain).**—The Department of Commerce, etc., at Madrid require tenders for installation and working of tramways at Seville by March 21.

**Plasencia (Spain).**—The Municipality require tenders for installing and working an electric lighting undertaking concession. Tenders by March 28.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Wrexham.**—The Town Council invite tenders for stores, including various electrical fittings. Particulars from the Borough Electrical Engineer. Tenders by March 12.

**Manchester.**—The Tramways Committee invite tenders for general stores. Particulars of Mr. J. M. McElroy, general manager, 55, Piccadilly, Manchester. Tenders by 10 a.m. on March 7. See advertisement in last issue.

**Kilmarnock.**—The Corporation invite tenders for the various plant in connection with electric lighting and tramways for the burgh. Particulars from the Town Clerk. Tenders by March 14.

**Belfast.**—The Corporation invite tenders for electric motors, insulating cables, stoneware conduits, troughs, etc. Specifications, etc., from the City Electrical Engineer. Tenders by 11th inst.

**Canary Islands.**—The Department of Commerce, etc., invite tenders for installation and working of tramways from San-Cristobal de la Laguna to Tacoronte (Canaries). Tenders by March 23.

**Tiverton.**—The Town Council invite tenders for the erection of buildings for electricity works. Specifications, etc., may be obtained from Mr. J. Siddalls, Town Hall, Tiverton. Tenders by 12th inst.

**Slough.**—The Urban District Council invite tenders for the supply of gas or other material for lighting, etc., of the public lamps within the district. Tenders to Council Office, Mackenzie-street, Slough, by 4 p.m. on March 10.

**Manchester.**—The Electricity Committee invite tenders for the supply of 5,000 yards of 1in. feeder cable. Specifications, etc., may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall. Tenders by March 10.

**Hackney.**—The Guardians invite tenders for providing and fixing electric light fittings. Specifications, etc., from Mr Frank R. Coles, Clerk's Office, Sidney-road, Homerton, N.E. Tenders by March 9. See advertisement in last issue.

**Caerphilly (Wales).**—The Urban District Council invite tenders for free wiring in connection with the proposed provisional order for

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electrical supply in the district which they are now applying for. Tenders by 12 noon on March 7.

**Rugby.**—The Urban District Council invite tenders for the construction and erection of a refuse destructor. Specifications, etc., may be obtained at the office of Mr. D. G. Macdonald, A.M.I.C.E., surveyor to the Council. Tenders by March 28.

**Sunderland.**—The Corporation invite tenders for the supply of indiarubber-covered cables from April 1, 1904, to March 31, 1905. Specifications, etc, can be obtained from the Borough Electrical Engineer. Tenders by March 31. See advertisement.

**Gainsborough.**—The Urban District Council invite tenders for telephone instruments, fire alarms, and connecting overhead wires. Specification from Mr. R. W. Fraser, electrical engineer to the Council. Tenders by March 16. See advertisement in former issue

**Italy.**—The Government Railway Department require tenders for a signalling apparatus on the Siemens and Halske system, estimated at £2,720, for the section from Rimini to Ancona. Particulars may be obtained from Inspection générale des chemins de fer, Rome.

**Dartford.**—The Urban District Council invite tenders for the construction and working for a term of years of electric railways. Specifications, etc., may be obtained from Mr. W. Kay, Council Offices, Dartford, Kent. Tenders by March 26. See advertisement.

**London, E.C.**—The Metropolitan Asylums Board invite tenders for installations of fire alarms and telephones at their asylum, Caterham, Surrey. Specifications, etc, can be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on March 8.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Wallasey.**—The Urban District Council invite tenders for the supply and delivery of alternating-current transformers required during the next two years. Specifications may be obtained from Mr. J. A. Crowther, Sea View-road, Liscard. Tenders by March 16.

**Aston Manor.**—The Corporation invite tenders for two water-tube boilers, superheater, and mechanical stoker. Specifications from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 ncon on March 14. See advertisement in last issue.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr. J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Wiring.**—The May-Oatway Fire Appliances, Limited, invite tenders for wiring installations for direct connection with the fire brigades at Edinburgh and Aberdeen. Tenders by 9th inst. Particulars from Managing Director, 49, Queen-street, Glasgow. See advertisement.

**Warrington.**—The Electricity Committee invite tenders for 12 months' supply of electric motors. Specifications, etc., can be obtained on application to Mr. F. V. L. Mathias, A.M.I.E.E., borough electrical engineer, Howley, Warrington. Tenders by 12 noon on 14th inst. See advertisement.

**Ballinasloe (Ireland).**—Tenders are invited for two electric motors, to be driven from the existing plant, for the Joint Committee of Management of the District Lunatic Asylum, Ballinasloe. Specifications may be seen at the office of Mr. J. Smith, M.I.C.E. Tenders by 2 p.m. on March 12.

**Londonderry.**—The Corporation invite tenders for various supplies, including engine-room stores, carbons, electric meters and demand indicators, for Foylehill Hospital. Specifications, etc., can be obtained at the Town Clerk's Office. Tenders to the Committee Room, Guildhall, by 3 p.m. on March 8.

**Warrington.**—The Electricity Committee invite tenders for 12 months' supply of paper-insulated cables. Specifications, etc., can be obtained on application to Mr. F. V. L. Mathias, A.M.I.E.E., borough electrical engineer, Howley, Warrington. Tenders by 12 noon on 14th inst. See advertisement.

**Kettering.**—The Urban District Council invite tenders for the wiring of the arc and incandescent lighting circuits and fittings at their generating station. Specifications, etc., may be obtained from Mr. John Bond, Council Offices, Market-street, Kettering. Tenders by 16th inst. See advertisement.

**Manchester.**—The Electricity Committee invite tenders for the substitution of high-voltage fittings for low-voltage fittings on consumers' premises in the south-eastern district of the city. Specifications may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall. Tenders by March 10.

**Lincoln.**—The Corporation invite tenders for one marine-type water-tube boiler and one high-speed engine coupled to a continuous-current dynamo. Specifications, etc., may be obtained from Mr. Stanley Clegg, Electricity Works, Brayford Side North, Lincoln. Tenders by 21st inst. See advertisement.

**Leek.**—The Urban District Council invite tenders for electricity meters. Specifications can be obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Council, 14, Old Queen-street, Westminster, S.W., on and after March 7. Tenders by 12 noon on March 14. See advertisement.

**Newport (Mon.).**—The Corporation invite tenders for boosters, balancers, etc., switchboards, tramway poles and brackets, overhead materials, section pillars, cables, and trolley wire. Specifications may be obtained from Mr H. Collings Bishop, M.I.E E., Town Hall. Tenders before March 21. See advertisement.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated) during the 12 months ending March 31, 1905. Specifications, etc., may be obtained from Mr. E G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by 19 h inst. See advertisement.

**Norwich.**—The City Council invite tenders for underground cables, rubber-covered wires and accessories, incandescent lamps, continuous-current meters, and motor for 10-ton travelling crane. Specifications, etc., may be obtained from the City Electrical Engineer, Corporation Electricity Works. Tenders by 10 a.m. on March 14. See advertisement.

**Poplar.**—The Borough Council invite tenders for two 1 000-kw. turbo-driven three-phase alternating-current generators and condensing plant. Specifications, etc., may be obtained at the offices of the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 9 a.m. on March 12. See advertisement.

**Ilford.**—The Urban District Council invite tenders for the supply of various stores required during year ending March 31, 1905, including electricity meters and demand indicators, arc lamp carbons, etc. Specifications, etc., from the Chief Electrical Engineer, Electricity Works, Ilford. Tenders by 4 p.m. on March 8. See advertisement in last issue.

**Birmingham Tame and Rea District Drainage Board.**—Tenders are invited for buildings and works comprised in the erection of electric power station, refuse destructor house, boiler-house, weight office, two cottages, inclined approach road, etc. Bills of quantities, etc., may be obtained after Feb. 26 from Mr. J. D. Watson, engineer to the Board. Tenders by 9 a.m. on March 7.

**Govan.**—The Corporation invite tenders for the purchase of three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery, and balancer, also for three-wire booster by the British Thomson-Houston Company, Limited. Particulars may be obtained from the Burgh Electrical Engineer, Helen-street, Govan. Tenders by March 29. See advertisement.

**Londonderry.**—Tenders are invited for carrying out the following works at the District Lunatic Asylum: (Section A) steam set boiler, pipework, switchboard, etc.; (B 1) wiring and cables to villa; (B 2) wiring and cables to new block. Specifications, etc., may be obtained at the office of Mr. R. V. Macrory, consulting engineer, Strand, Londonderry. Tenders before 12 noon on March 17.

**Shoreditch.**—The Council invite tenders for various articles and works during year from April 1 to March 31, 1905, including electric cables and sundries, gas pipe and fittings, and engineers' stores. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender may be obtained from Mr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, Old-street, E.C. Tenders by March 8.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Stepney.**—The Electrical Committee invite tenders for the supply and erection of one 1,000-kw. steam-turbine-driven double-current generator; and four water-tube Babcock and Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump, and accessories. Specifications may be obtained at 27, Osborn-street, Whitechapel. Tenders by March 14. See advertisement in last issue.

**Wimbledon.**—The Urban District Council invite tenders for the supply of engine-room stores, cables, joint boxes and jointing material, transformers, meters, lubricating oils, and incandescent lamps and carbons to the electricity department during the year ending March 31, 1905. Specifications may be obtained from the Chief Electrical Engineer, Electric Light Works, Durnford-road, Wimbledon. Tenders by March 18. See advertisement in former issue.

**Ilford.**—The Urban District Council invite tenders for the supply and erection of the following plant: one 1,000-kw. steam dynamo, comprising vertical engine coupled direct to multipolar dynamo; extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, motor-driven pumps, water-cooling tower, and pipework; water-purifying plant; pipework; feeder and pilot cables, feeder pillar, and joint-boxes. Specifications, etc., may be obtained from Mr. John W. Fenton, Town Hall, Ilford, Essex. Tenders by March 22. See advertisement in last issue.

## RESULTS OF TENDERS.

**Exeter.**—The Council have accepted the tender of Messrs. H. A. Willey and Co., at £440, for replacing existing motors and arc lamps.

**Bedford.**—The Electrical Committee have accepted the tender of the British Thomson-Houston Company, Limited, at £1,278, for high-tension switchboard.

**Kingston.**—The Guardians have accepted the tender of Messrs. C. Oldridge and Sons, London-road, Kingston, at £2,074. 10s., for electric lighting the infirmary.

**Leeds.**—The tender of Wallis and Watson, Trinity-street, Leeds, at £95, has been accepted for wiring for electric lighting the branch library, Wesley-road, Armley.

**Prestwich.**—Messrs. Browett, Lindley, and Co. have received the order from Messrs. Mather and Platt, Limited, for the 250-kw. engine for coupling to their dynamo for the asylum.

**Battersea.**—The tender of Messrs. C. A. Parsons and Co. to supply and fix a steam turbine-dynamo at the central generating station for £4,890 has been accepted by the Borough Council.

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**Manchester.**—The British Westinghouse Electric and Manufacturing Company, Limited, has secured a contract from the Corporation for the supply of the complete electrical equipments of 100 tramcars.

**Leeds and Wakefield District Tramways.**—Messrs. Dick, Kerr, and Co., Limited, have given the contract for the supply, laying, and jointing of the extra high-tension feeders, etc., in connection with the above scheme to W. T. Glover and Co., Limited, Trafford Park.

**Derby.**—The tender of Mr. H. White, at £54, has been accepted for the supply of 120 incandescent lamp brackets on tramway poles. The committee have also accepted the tender of Messrs. J. G. White and Co., Limited, at £1,359. 18s. 2d., for the lay-outs in connection with the new car sheds.

**Lowestoft.**—The Town Council have received the following tenders for the erection of the sub-station at the Cross: Messrs. Godwin and Brassington, £202. 5s. 10d.; Messrs. Freeman and Jones, £199. 19s. 9d.; and Messrs. J. Byard and Son, £186. 18s. 9d. (recommended for acceptance).

**Colchester.**—The Town Council have accepted the tender of Messrs. Davey, Paxman, and Co., Limited, at £840 (less a discount of 12½ per cent. for cash on completion of test) to supply and fix a boiler 9ft. 9in. by 14ft. 6in., capable of evaporating 10,000lb. of water per hour, with a pressure of 180lb. to the square inch.

**Rowley Regis.**—The Town Council have accepted the tender of the Birmingham and Midland Tramway Company, New-street, Birmingham, for the construction and electrical equipment of tramways included in the total sum for construction of tramways 10, 11, and 12 under Birmingham and Midland Tramway Act, 1902.

**Swindon.**—The Corporation have accepted the following tenders for complete traction switchboard and for the supply and laying within the borough of tramway feeder-cables, pilot wires, arc lamp services, etc.: British Westinghouse Electric Manufacturing Company, Norfolk-street, Strand, W.C., switchboard, £750; British Insulated and Helsby Cables, Limited, Prescot, Lancs., tramway feeders, £1,190. 9s.

**Wiring.**—The May-Oatway Fire Appliances, Limited, have accepted the following tenders for wiring installations for direct connection with the fire brigades: T. C. and E. C. Jack, Wm. Douglas, Limited; S. Henderson and Sons, Wm. Douglas, Limited; the Edinburgh Laundry Company, Wm. Douglas, Limited; D. M. Brown, James Maxwell and Son; Great North of Scotland Railway, Pratt and Keith.

**London County Council.**—The Council have been recommended to accept the tender of Messrs. J. G. White and Co., Limited, at £95,005. 7s. 4d., for the execution of the roadwork and plate-laying in connection with (1) the reconstruction for the underground conduit system of electrical traction of the existing cable tramways between Kennington and Streatham, and (2) the construction for the same system of traction of short portions of tramways in Tooting High-street and Defoe-road, authorised by the London County Council (Tramways and Improvements) Act, 1901; that the solicitor do prepare and obtain the execution of a contract to give effect to the tender, and that the seal of the Council be affixed to such contract when ready. The Council have also been recommended that Messrs. J. G. White and Co., Limited, be allowed to sublet the following portions of the work to the undermentioned firms or to such other firm or firms as may be approved by the engineer under the contract—namely: (1) to the Hadfield Steelfoundry Company, Limited, of Sheffield, the manufacture of the special work (consisting of points and crossings); (2) to the Anderston Foundry Company, Limited, of Middlesbrough, the manufacture of cast-iron yokes, road boxes and covers; (3) to the Associated Portland Cement Manufacturers, Limited, of London, the supply of cement; and (4) to Messrs. Bullers, Limited, of London, the manufacture of the porcelain insulators.

# BUSINESS NOTES.

## TRACTION.

**Pemberton.**—The District Council have received sanction to borrow £16,155 for tramway purposes.

**Finchley.**—Messrs. Griffiths are proceeding with track work on Cherry Tree-hill, Stag-hill, and Cemetery-hill.

**Bromley.**—We understand that the Tramways Committee are corresponding with Mr. W. Ivey in regard to another tramways scheme proposed by him.

**Bradford.**—It is understood terms have been arrived at with regard to the proposed purchase of the Shipley section of the Mid-Yorkshire Tramways by the Corporation.

**Tokyo.**—In order to cope with the increased demand for electricity, the Tokyo Street Railway Company has placed an order for a large dynamo with an American firm.—*Anglo-Japanese Gazette.*

**Beckenham.**—The British Electric Traction Company have offered a security for the due performance of their contract, which the Urban District Council have referred to the Tramways Committee.

**Derby.**—The receipts of the Corporation tramways during the four weeks ended Feb. 20, 1904, were £1,218. 11s. 9d., being an increase of £81. 5s. 11d. as compared with the corresponding period last year.

**West London Tramways.**—The last few days the tramcar service on the Shepherd's Bush and Hounslow line suffered interruptions owing to water filling an excavation made by the telegraph company.

**Campbeltown.**—The Town Council and Kintire District Committee have given a general approval to the preliminary arrangements for laying a light or electric railway between Campbeltown and Machrihanish.

**Leeds.**—The Tramways Committee have resolved to proceed with the construction of the whole of the Hyde Park-road and Belle Vue-road tramways.

**Ipswich.**—The obstacle which has arisen to the complete opening of the Felixstowe-road section of the Ipswich electric tramways has now been settled, a parish meeting having decided to allow the Corporation a right-of-way.

**Cheadle.**—The work of laying the metals between Cheadle and Gatley continues to progress rapidly, and the time cannot be far distant when this portion of the route will be completed and the electric cars doing good service.

**Exeter.**—Negotiations are proceeding for the acquisition of a site of the new car-sheds. The returns from the existing tramways for the last three weeks were £97. 12s. 6d. The average number of fares per day has been 1,116.

**Japan.**—A scheme to construct an electric railway between Kyoto and Otsu (Japan) has been approved, and a syndicate has been formed in the United States to carry the enterprise through. The length of the road is about 30 miles.—*Railway Times.*

**Wigan and Ashton.**—The tramway which is being constructed by the Wigan Corporation has been laid from the Mechanics' Arms, Warrington-road, Goose Green, to the boundary of Park-lane, and work is being proceeded with to Worsley Mesnes.

**Rye.**—The proposed scheme for the extension of the Rye and Camber tramway right up to the Camber sands was again discussed at the last meeting of the directors. It appears doubtful whether circumstances will admit of the adoption of the scheme, at any rate for the present.

**Nottingham.**—At a recent joint meeting of the Improvement, Tramways, and Finance Committees of the City Council a proposal to construct a tramway from St. Ann's Well-road, along Bath-street, to Sneinton Hermitage, was considered, and instructions were given for a key plan of the district to be prepared.

**Middlesex.**—Three light railways, with a total mileage of 11½ miles, are under construction by the County Council, 26 miles are also authorised, and further extensions are under consideration. The Council has obtained an Act constituting it a tramway authority; this gives the Council a *locus standi* in opposing Tramways Bills.

**Glasgow.**—Mr. John Young, general manager of the Corporation tramways, in a report forwarded by the Tramways Committee to the Joint Bridge Committee on the congestion of vehicular traffic in the centre of the city, suggests as a measure of relief the erection of a new bridge over the Clyde on the line at Oswald-street and Commerce-street.

**Poynton.**—The Parish Council last week, after discussing the local tramway schemes, agreed that the mid-Cheshire scheme be carefully watched in the interests of the Council, but that no action be taken at present. The Chairman said he thought it best to leave the matter in the hands of the Stockport Corporation and the Hazel Grove Council.

**Leith.**—The conference between representatives of the Edinburgh and Leith Corporations and of the Edinburgh and District Tramways Company was held on Wednesday. The discussion was mainly upon the question of through traffic. A new committee was appointed on Wednesday from those opposed to the introduction of cable tramways into any part of Leith.

**Beddgelert.**—The proposal to construct an electric tramway from Beddgelert *via* Pen-y-Gwryd and Capel Curig to Bettws-y-Coed provokes a protest from Prof. W. P. Ker, who says: "The road, one of the most beautiful in the kingdom, is visited yearly by thousands of people, who are drawn there by something not compatible with overhead electric railways, and who will hear of this project with something like dismay."

**West Ham.**—The first section of the electric tramways system was formally opened on Saturday. The mayor and Corporation drove in a decorated car at the head of a procession from Stratford to the Balaam-street end of Barking-road at Canning Town. The Board of Trade certificate was not issued until about noon, and as soon as the document was in the hands of Mr. H. E. Blain, the tramway manager, the line was open to the public.

**Newcastle-Stoke Tramway.**—The newest extension of the Potteries Electric Traction Company's system of electric tramways was inaugurated on Tuesday, when the public service was commenced on the Newcastle-Stoke line, *via* Hartshill. The line has been passed by the inspector of the Board of Trade. The service is at present a nine-minute one, and the fare between the two towns is 2d., the 1d. stage being opposite Hartshill Church.

**West Bromwich.**—The difficulty which has prevented the completion of the branch line of the tramways connecting West Bromwich with Oldbury having been removed, through communication has now been opened. The chief obstacle was the passage of cars under the bridge in Bromford-lane near Oldbury Station, but the matter has been arranged satisfactorily, and on Tuesday a trial trip in a special car was made the whole length of the section.

**Shoeburyness.**—The Urban District Council have decided that, in consequence of the unnecessary delay which had occurred in the carrying out of the scheme for a seashore tramway, to write to the Board of Trade and ask them that the order in respect of the Shoeburyness-Southend light railway should be drawn up forthwith, and that such order should contain provisions requiring the Southend Corporation either to proceed with the light railways forthwith or to abandon the project.

**Holborn.**—At the next meeting of the Borough Council, preference is to be given to the question of the tramways laid down in Theobalds-road, Clerkenwell-road, Gray's-inn-road (from Holborn to Clerkenwell-road), and those sanctioned by the London County Tramways Act,

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1900, proposed to be laid down from the existing tramway in Clerkenwell-road near its junction with Gray's-inn-road, along Rosebery-avenue to its junction with St. John-street-road, Clerkenwell, of an underground system of electric traction.

**Aberdeen.**—On Saturday at a meeting of a Gas and Electric Sub-Committee a deputation from the Suburban Tramways Company was received for the purpose of finally adjusting the terms under which a supply of driving energy should be given to the company by the electric department. After discussion it was agreed that the Corporation should supply the company with current for their lines outside the city boundary at 2¼d. per unit, subject to a maximum demand by the company of 150,000 units per annum.

**Deptford and Greenwich Tramways.**—Mr. Graham Harris (as arbitrator) is investigating a claim made by the London, Deptford, and Greenwich Tramways Company against the London County Council in respect of the transfer of its lines to the Council. Under the notice given the London County Council were to purchase the whole of the lines, together with all the equipment and the depôt. Exclusive of materials for permanent way, stable utensils, unexpired licenses, and other small items, the total claim was £138 287.

**Kirkcaldy.**—A deputation from the Town Council have interviewed the manager of the North British Railway Company with regard to the company's opposition to the Tramway and Harbour Bill. In the tramway section of the Bill a clause has been inserted giving power to the Corporation to carry merchandise and minerals. This clause the Corporation have now agreed to withdraw, retaining power only for the carrying of parcels up to 112lb. The hope is entertained that the railway company's opposition may be withdrawn.

**Cardiff.**—The Public Works Committee have received complaints from shopkeepers on Cowbridge-road as to gangs of men being continually employed on the tramway pulling up and putting down setts. The borough engineer says that the road is very troublesome because the old foundations of the tramway has been utilised on the score of economy, and double traffic has to go over a single line. It is understood that the negotiations with property owners were nearly complete whereby the road could be widened and a double track laid down.

**Swansea.**—In a recent action brought by the Corporation for a declaration of their rights against the Swansea Tramways Company, it has been decided that under the various Acts of Parliament the Corporation can only purchase the tramways in four sections—the first section in 1906, when it has to grant the company a lease for 21 years, and the second section not until the lease has expired, when it has again to grant a lease for 21 years, and so on through all four sections. It will thus be nearly the end of the century before the whole of the tramways can be taken over by the Corporation.

**The Berlin Electric Railway.**—The Berlin Overhead and Underground Electric Railway is to be extended as far as the Grunewald. Steps have been taken by the municipal authorities for the prevention of a similar catastrophe as in Paris in the Berlin Electric Railway tunnels. Each carriage is now furnished with a fire hose, and in every tunnel spots are clearly indicated by coloured lamps where fire appliances are kept. Should any accident suddenly interrupt the electric current, light in the tunnels will be provided by a separate independent supply of current. Emergency exits are also being bored between the stopping places in the tunnels.

**St. Marylebone.**—A request was submitted at last night's meeting, signed by 10 members of the Borough Council, asking them to rescind or vary the resolution of the Council of Nov. 12, 1903, adopting a recommendation of the Legal and Parliamentary Committee, contained in their report of Sept. 30, 1903, that to inform the London County Council and Messrs. Hicks, Davis, and Hunt that the Council adhere to their previous resolution against the construction of a surface tramway along Edgware-road; and that, in lieu thereof, the Council resolve to give all necessary consents to the London County Council's proposals to construct surface tramways along Edgware-road, Maida-vale, and Tottenham Court-road.

**Newcastle.**—A correspondent to the *Newcastle Chronicle* suggests that it would be an excellent thing if a tramway were laid down to the Fish Quay at North Shields and carriages adapted for the carriage of goods as well as passengers run on that section. He considers that as it is slightly more than a quarter of a mile from the top of the bank to the widest part of the Quayside, about £2,000 would suffice for its complete instalment. He says if the matter be too speculative for the tramways company to inaugurate, the Corporation, for the benefit of the ratepayers, should do it and charge a wayleave rent to the tram company. When the "Low-street"—*i.e.*, from Bell-street to the new quay—is widened, the tramway could be extended to the ferry.

**London County Council Tramways.**—The two new tramway routes which have been opened in South London by the London County Council, each give improved access to the City from the south-eastern district. The lines through the Borough and along the Marshalsea-road to the end of Southwark Bridge are now completed, and tramcars run from the Lord Wellington to the bridge, *via* the Old Kent-road, Great Dover-street, and St. George's Church. The completion of the new spur line along the eastern side of Southwark-street and of the junction at the corners of Southwark-street and Southwark Bridge-road has also enabled the County Council to commence running a service of cars from Camberwell-green to the Hop Exchange, the terminus of the East Hill horse tramways, close to London Bridge.

**Tram v. Omnibus.**—Discussing the effect of the London County Council electric trams on the omnibus traffic, Mr. W. A. Perry, chairman of the Star Omnibus Company, says the *Daily Telegraph*, declared that it was a grievous injustice that the County Council should carry passengers for less money than they could possibly afford to do. He felt that if this were generally known the ratepayers would object to such a procedure. The company made no complaint of the Council carrying passengers at a fair rate, which they did when they were not running over a route covered by omnibuses. With reference to the proposal made at a meeting last week of another omnibus company to place motor 'buses on the road, the chairman said the Star Company were anxious to obtain, if possible, a cheap mode of carrying the traffic, but at the present time they had not found one which would achieve that object.

**Hull.**—At Monday's special meeting of the City Council the report of the Finance Committee as to the estimates and rates for the ensuing year was adopted. Alderman Larard defended the action of the Tramway Committee in reducing their contribution towards the reduction of the rates from £14,500 to £11,500. He said that during the five years the electric trams had been running they had paid out of revenue £37,183 for interest and £33,749 for sinking fund, and had contributed £62,000 towards the reduction of the rates. He insisted upon the need for substantial reserves. Although the traffic receipts had been continually increasing (this year the increase was £9,000), the expenditure had also largely increased, and it was impossible to prevent it. But there had been a decrease in the net revenue, and this might be attributed to the old town route and the Hedon-road route, which were not so profitable as the others.

**Brighouse.**—The Tramways Committee having found it possible to inaugurate a service of cars to Brighouse without waiting for the completion of the transformer station at Hipperholme, an official opening of the line took place last Thursday week. A 15 minutes' service to and from Halifax was instituted, which was on Monday reduced to half-hourly. Representatives of the Halifax Corporation, including the Mayor, Alderman J. Wade, and the chairman of the Tramways Committee (Alderman T. Hey), travelled to Hove Edge in a special tram. Here they were met by members of the Brighouse Corporation, Alderman Stocks (the deputy-mayor) taking the place of the Mayor (Alderman W. Smith), who, on account of ill-health, is abroad Alderman Stocks drove the car from Hove Edge to the Brighouse terminus, where a large concourse of townspeople had gathered. A number of speeches were made from the top of the trams.

**Portsmouth.**—Trials are being made with a tramway car having a covered top. The cover is bolted down securely to the car proper, is glazed on all sides, and the side windows, similar in size to those below, can be opened from the end of the car by the conductor by a ratchet arrangement worked with a handle. According to the weather the sashes can be lowered as desired, and the doors, which are on the gangway at the end of each car, opened. The trolley, now in the centre of the top deck, is taken away entirely, and fixed to the top of the cover. The cost of the cover is only £65, an insignificant amount compared to the cost of the car itself—over £600—and is supplied by Milnes, Voss, and Co., of Birkenhead. Another improvement has been made at the North End depôt, where a splendid system of machine shops for the repair of the cars is nearing completion. Room has been found for the erection of dining and recreation rooms, both specially set apart for the comfort of the tramway men when off duty.

**Natal.**—Installations of light railway plant are apparently becoming very popular in Natal Colony. One of the largest and most complete of these is the 2ft. gauge line which has been constructed on his estate by Mr. W. Pearce, of Lower Illovo. The line is nearly eight miles long, and traverses the entire estate, connecting the mill with the Illovo River railway station, and circumscribing, by means of branches, the whole of the 3,000 or 4 000 acres which is under sugar cultivation all the year round. Considerable enterprise and skill were exhibited in this undertaking. For instance, an iron bridge was carried across the Illovo. The bridge is 540ft. long, and is built to carry a 10-ton locomotive and 12 five-ton cars. It cost £1,654, making the total cost of the railway £5,056, the average cost per mile working out at £501, without the bridge, and £817 including that item. It is an interesting fact that in not one detail of the construction of the bridge, except in the purchase of the material, had Mr. Pearce to engage outside help. The whole of the work was carried out under the superintendence of Mr. E. J. Young, the resident engineer.—*South African Exports.*

**Wood Green.**—The special committee appointed by the District Council to deal with cases of emergency in connection with the electric tramways have presented a report, in which the surveyor reported that the company, without giving notice to the Council, and in defiance of the Council's protest, had broken up the road from opposite the Home and Colonial College to Granville-road, and had laid their cables for that length. The recommendation of the committee was that the Council agree to the proposal of the company as to the laying of their cables, subject to the diversions suggested by the surveyor and to the surface of the road being made good. They further recommended that the attention of the company be directed to the serious illegality in breaking up the road without notifying the Council. With reference to the arbitration question the surveyor reported that the arbitrator had inspected Lordship-lane and had intimated his intention of making a preliminary award as to the works necessary at once to be executed to enable the road to be reopened for ordinary traffic, reserving his decision as to who is to bear the cost of the execution of such works. The County Council had verbally offered to make up the margins of the road with granite macadam.

**Aston.**—The Public Works Committee, in a report to be presented to the Aston Town Council on Wednesday, express regret that the makers of the tramway points and crossings are unable to deliver the special castings in reference to the temporary track required in connection with the maintenance of the tramway traffic between Aston Cross and the city boundary for a period of one month from Feb. 19. While regretting the delay, the committee point out, however, that it would have been most unwise to execute concrete work during such weather as had been experienced during the last few weeks. The work necessitated by the alteration of Witton-lane depôt had been commenced. The committee have applied to the Board of Trade for formal consent to the construction of a double line of tram-

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way in Park-road and in Witton-lane, and for the reconstruction of the lines in Witton-road, Bevington-road, and Trinity-road, and in order to save the inconvenience to the public generally associated with the working of the tramway service upon a temporary track, it has been arranged to stop the traffic entirely in the Witton-lane and Park-road during its reconstruction, and to work the traffic along another route, for which purpose five crossing places will have to be constructed.

**Derby Rail Contract.**—In proposing the adoption of the report of the Tramways Committee at Wednesday's meeting, Alderman Duesbury said it would be in the memory of the Council that there was a considerable amount of talk about a contract for Belgian rails being entered into, and the committee were blamed for this. As a matter of fact, the committee never had a contract for Belgian rails. They entered into a contract with Messrs. J. G. White and Co. for a certain specification, and a very stiff test was imposed, while a tester was engaged to see the rails came up to the specification. Messrs. White had found considerable difficulty in getting the rails to come up to the test, and they had, moreover, been unable to get the contractors to supply them as agreed in proper time. As a consequence this contract with the Belgian railmakers had been broken by Messrs. White, and they had entered into a contract with the North-Eastern Steel Company, Middlesbrough, to supply the whole of the rails with the exception of 230 tons, which had been placed down. The contract had not only been entered into with the North-Eastern Steel Company for these rails, but 300 tons had been made and tested, and would be in Derby this week. The whole of the rails, he hoped, would be in Derby before the Council met again. This would not entail any extra cost either to the Tram Committee or the ratepayers, as the rails would be supplied at the same terms as the foreign rails would have been. He considered they had got out of a very difficult position in a very satisfactory manner.

**Reading.**—The Council have determined to withdraw the Reading Corporation Bill, 1904, which has been deposited in Parliament. The following report of the tramways engineer and manager has been adopted: "Since the opening of the electric system in July, 1903, the car services have been gradually improved and the traffic has increased, and will increase considerably as the summer approaches. The whole of our cars are in use at certain times every week, and in order to provide still better services to meet the summer traffic, and also to allow the car equipments to be overhauled regularly, and kept in proper repair, which with the present arrangements is only done with difficulty, we shall require eight more cars, and I suggest that as soon as the specification for the cars can be drafted that tenders be invited. The present office accommodation at Mill-lane is insufficient to carry on the work of the department. The offices now in use are required entirely for clerical work, and are much in need of accommodation for a drawing office. This can be arranged without difficulty by extending the first floor of the present offices to the repair shop, and as the work of the department is becoming seriously hindered for want of more room, I shall be glad if you will sanction the proposed extension." The tramways engineer and manager has now been asked to prepare the drawings and specification for the supply of six additional electric tramcars with bogie wheels, having seating capacity for about 70 passengers, and tenders will be invited for the supply thereof. The offices of the tramway depôt in Mill-lane is to be extended as suggested, according to plans, specification, and estimate prepared by the borough surveyor.

**Lancaster.**—The County Council have decided to petition against the following Bills: (1) to incorporate the Preston and Blackburn Tramways Company, and to empower that company to make and maintain a tramway and other works, and for other purposes—that the expenses of opposing such Bill be charged upon the county fund, and that the seal of the Council be attached to the said petition; (2) to incorporate the Preston and Lytham Tramways and Tramroad Company, and to empower that company to make and maintain tramways, a tramroad, and other works, and for other purposes; (3) to empower the Corporation of Barrow-in-Furness to construct an opening bridge across Walney Channel, to make certain street works, to lay down additional tramways, and to execute works in connection with their water undertaking, and for other purposes; (4) to empower the Urban District Council of Stretford to construct additional tramways and other works within their district, and to make further and better provision for the good government of the said urban district; (5) to authorise the Preston, Chorley, and Horwich Tramways Company to abandon a portion of their authorised tramways, and to construct other works in lieu thereof, and other purposes; (6) for authorising the construction of dock works and tramroads at Trafford Park, in the county of Lancaster, and for transferring the powers of the West Manchester Light Railways Company, and for providing for the repair and regulation of industrial roads in Trafford Park, and for other purposes; (7) to authorise the Corporation of Manchester to construct tramways and street widenings within and beyond the city, and to confer further powers upon the Corporation and neighbouring authorities with respect to the exercise of powers relating to tramway works and electricity within and beyond the city, and for other purposes.

**Liverpool.**—At the meeting of the City Council on Wednesday the Tramways Committee recommended that an application be made to Parliament or the Board of Trade in the next session for powers to construct the following tramways: a line commencing by a junction with the existing tramways in Prescot-street, opposite Low-hill, passing along Hall-lane, Edge-lane, and St. Oswald-street, and terminating by a junction with the existing tramways in Prescot-road at the Old Swan. The proposed tramway will be laid as a double line throughout if provision can be made for the widening of Edge-lane from a minimum width of 40ft. to 60ft., and for the widening of St. Oswald-street in accordance with the prescribed line from 38ft. to 60ft. The length of street is about 2 miles 500 yards. The Electric Lighting and Power Committee of the Corporation have received from Mr. A. Bromley Holmes, the consulting engineer, a report recommending that the price for electrical energy charged to the Tramways Committee should be increased from 1·05d. to 1·12d. per unit, subject to the existing sliding scale to meet variations in the cost of coal. The report stated: "The margin between the price received from users of electrical energy for lighting and power and the cost of producing such energy is considerably greater than is required to meet the anticipated increase in capital charges and rates for the current year. Under these circumstances it would be an unwise policy to check the development of the business by raising prices. The sale of electrical energy for lighting purposes is the most profitable portion of the business of the electric supply department, and with the view of facilitating the adoption of the electric light in houses of small rentals, the electrical engineer recommends the trial of prepayment meters under certain conditions, as to which he will shortly be in a position to report further." The matter will be the subject of a conference between the two committees.

**Keighley.**—The Town Council have adopted a minute recommending that the tramways be equipped for electric traction on the overhead trolley system. The estimated cost of laying down the overhead trolley system was given by Mr. Waterhouse as follows: Ingrow section, £6,579. 3s.; Utley section, £10,612. 17s. 9d.; Stockbridge section, £8,751. 3s. 6d.; erection of a tram-shed, £1,160; overhead equipment, £6,036; eight cars, £4,800; the altering of gas and water mains, £482. 12s. 6d.; cables from the power station £2,170; new switchboard at power station, £819; and with £1,379. 3s. 3d. allowed for contingencies, these items made a total of £42,790. The intention of the committee was to run a 10 minutes' service, and that would necessitate about six cars, leaving two cars for emergencies. The cars along the Ingrow and Utley route would run about 100 miles a day, and those along the Stockbridge route about 90 miles. The horse trams last year made about 8 4d. per mile, and it was estimated that the new cars would realise 8¾d. per mile. The Electricity Committee, however, were proposing to charge them 2d. per unit, but if they were to be charged on the same scale as the ordinary consumers, that amount would be reduced by an eighth, or a saving of about £200. If a 20 minutes' service were adopted, there might be a saving of £1,400. He never believed, however, that the scheme would pay, but would need assisting from the rates. The most serious drawback was the loss of the old cars, amounting to £9,000 or £10,000, while the Council would have still to meet interest and sinking fund amounting to £755 yearly; but they had against those figures certain lands worth about £8,000 or £9,000, and some 30 horses, which might sell for £500 or £600. He thought they would require 2d., or not more than 3d., from the rates to assist the undertaking. The route from Ingrow to Utley will be taken in hand first, and be extended to the bottom of Cavendish-street. The Council have decided to carry out as much of the work as possible under their own direction, and to apply to the Board of Trade to borrow the amount mentioned in the specification.

**Perth.**—In the course of an interview on the subject of tramways, reported in the *Perth Courier*, ex-Bailie Wright, the energetic electric light convener, said: "Notwithstanding the debt, there are many things that might be urged in favour of the reconstruction of the tramways and their adaptation to electrical power. When the old tramway company was formed they based their calculations on a very small income, and within two or three years of the starting of the tramways the revenue had been more than doubled. More than that, a curious coincidence occurs in the working of the existing tramways and the estimate of revenue framed by the engineers—viz., that during last year the average drawings per car mile was 10d. exactly—the figure assumed by Messrs. Kincaid, Manville, and Dawson as the receipts to be earned by the electrically equipped cars. The sum of £70,000 certainly looks a big figure, but it must be understood that this money is not to be spent on works which are only to be started in the future. It is to be spent on substitution of electricity for horse haulage. Were the same number of cars to be run with horse haulage which it is proposed to run with electricity, it would mean more than doubling the expenditure on horse traction. At present something like £1,800 a year is spent on the horse traction, and doubling the number of cars would run up to £3,600, while by substituting electricity the cost of the current and interest and sinking fund on overhead equipment, along with maintenance, will not amount to more than £2,000 a year. It is plain, therefore, that by adapting the cars to electric traction, double the number of cars can be run at little more than half the cost of horse traction." The suggestion that there were a good number of hours every day just now when the cars were running half empty did not daunt the bailie, who responded, "Against this it might be said that during the summer months with greater facilities more than double the number of passengers could and would be carried than what has been accomplished during the past summer seasons. It is not necessary to run a regular number of cars all the year round, but when the traffic is such as to necessitate additional cars, these can be put on when required without being under the necessity of keeping a number of horses eating their heads off to be ready for the extra traffic. There should be no difficulty during the months of June, July, August, and September in having an average income over the existing track of not less than £1,000 a month, possibly on some of these months a much larger proportion. The dead weight, however, on the tramway undertaking is the large sum which has been paid to the old tramway company, and the only way to help to reduce the loss under this head will be by extensions into districts at present not supplied but where there are large and growing populous places. It is estimated that the extension of the tramway to Dunkeld-road would cost £4,500. When the interest and sinking fund necessary to that sum is provided for, and the work extensions met with, the revenue that might fairly be expected to come from a growing district such as that should provide a substantial surplus—a surplus of not less than from £400 to £500 to help the deficiency on the other routes. Barnhill is now beginning to show signs of development, and with the tramway running out in this direction a fairly good revenue might be expected to start with, and it may be the means of furthering building developments there; while the loop line should be

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carried from the end of Victoria Bridge to join the existing line at the end of Perth Bridge. With the prospect of additional works in the harbour district, a large increase of population might very reasonably be expected to take place in the Edinburgh-road district, and here again extension within a short space of time might be carried out with advantage. While there may be a pretty large debt resting upon the city meantime, the debt is not beyond the reach of the ratepayers to meet, and it can safely be said that at no period in the history of Perth during the last 75 years has there been more care and economy practised than there is by the Town Council. It will never do to allow the city to stand still, and it is just about as bad to tinker with or only half carry out improvements or public works, as has been proved by the recent large expenditure of money. The largest expenditures which have taken place are the schemes that to-day are showing the best results."

## LIGHTING AND GENERAL.

**Glasgow.**—The Corporation require £50,000 for telephone extensions.

**Poynton and Worth (Cheshire).**—It is proposed to adopt the Lighting Act for the lighting of Poynton.

**Cleckheaton.**—Application is to be made for sanction to borrow a further sum of £4,000 for electric lighting purposes.

**Anglesey.**—The County Council will oppose the Bill promoted in Parliament by the North Wales Power and Traction Company.

**Todmorden.**—The Council have decided to apply for borrowing powers to the amount of £20,000 in respect of electricity works.

**Weardale.**—The Durham County Council are obtaining local information with a view to adopting a county scheme of electricity supply.

**Darwen.**—An enquiry has been held into the application of the Corporation for sanction to borrow £6,500 for the puposes of electric lighting.

**Golcar.**—The Board of Trade has sanctioned the order applied for by the Huddersfield Corporation for the lighting of Golcar with electricity.

**Topsham.**—The local electric light company have purchased a plant for 2 000 lights, and the promoters expect to have the light installed by the end of May.

**Middlesbrough.**—A recommendation for the electric lighting of the town hall is before the Corporation Streets Committee. The cost is estimated at £300.

**Commercial Cable Co.**—The directors have declared a quarterly dividend of 2 per cent. The transfer books will be closed on the 30th inst. and reopened on the 5th prox.

**Mullion.**—Signor Marconi is at Poldhu, and preparations are being made to erect poles 50ft. high on the top of the present towers, which will then be 264ft. above the sea-level.

**Stoke-upon-Trent.**—The Town Council have received sanction to the borrowing of £17,840 for electric lighting purposes, and £12,800 for the provision of a refuse destructor.

**Rotherham.**—The enquiry into the Corporation's application for sanction to borrow £14,670 for additional electric lighting plant, already referred to by us, has now been held.

**Change of Address.**—The central station and tramway department of the Electrical Company, Limited, has been removed from 25, Victoria-street S.W., to 121, Charing Cross-road, W.C.

**Finchley.**—The electrical engineer's last report shows that the number of applications to date was 117, equal to 6,040 8-c.p. lamps; 203 street lamps have been converted from gas to electric lighting.

**Wood Green.**—The time limit of the District Council's provisional order expires in July next, and application is now to be made for laying the mains in the compulsory area at once, and for sanction to the borrowing of £7,600.

**Malvern.**—A trial of the new electricity plant has been made with highly satisfactory results, and Mr. Maybury, who has resigned, having been appointed county road surveyor for Kent, hopes to start the public supply in the course of a few days.

**In Japan.**—The Tokyo Electric Light Company has decided to increase its capital by 3,500,000 yen to 7,000 000 yen in order to extend the business, and either to issue debentures or raise loans to the maximum amount of 1,000,000 yen.—*Anglo Japanese Gazette.*

**W. T. Henley's Telegraph Works Co.**—Subject to audit, the directors have decided to recommend a dividend on the ordinary shares of 15 per cent. (less income tax) for the past year, including the interim dividend of 6 per cent. paid Sept. 1 last, payable March 12.

**Aberystwyth.**—The agreement between the Corporation and the electric supply company has been adopted. The town clerk, the surveyor, and the chairman have been instructed to draw out a specification and invite tenders for lighting the new promenade by gas and electricity.

**Colchester.**—The borough electrical engineer has reported as follows: output of electricity in units during January, 1904, 55,781 (1903, 39 342; 1902, 28 184); number of consumers connected at end of January, 414 (334, 263); total number of 8-c.p. lamps connected, 25 174 (20,613, 14,795).

**Redditch.**—Upon the reading of the Electric Supply Committee's report on Wednesday the chairman of the committee (Mr. F. Dolphin) said the cost of production of the current, unit for unit, was undoubtedly greater with the temporary steam plant now in use than it was with the gas plant.

**Metropolitan Electric Supply Co.**—The directors recommend a final dividend of 9s. 6d. per share, being at the rate of 9½ per cent. per annum, making a total distribution of 17s. 6d. per share, or 8¾ per cent. for the past year; £18,000 is placed to depreciation and reserve fund and £2,485 carried forward.

**Fulham.**—In the event of the Prudential Assurance Company declining to lend the Council the sum of £25,000 in connection with its electric lighting undertaking at interest at the rate of £3. 12s. 6d. per cent., the amount is to borrowed from the London County Council at interest at the rate of £3. 15s. per cent.

**Southwark.**—An enquiry has been held by Mr. J. W. Thompson, an assistant commissioner under the London Government Act, 1899, into the application of the Southwark Borough Council for a scheme providing that the expenses of the Newington electric lighting undertaking should be chargeable on the whole borough.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Electric Construction Company's further issue of £12,500 4 per cent. perpetual first mortgage debenture stock, and Isle of Wight Electric Light and Power Company's £50,000 4½ per cent. debenture stock.

**Cable-Laying.**—We have received from the Callender Cable and Construction Company two framed photographs of work in progress at Pangbourne. One shows the method employed when attaching the cables to the railway bridge over the Thames. The firm's collection of photographs of cable-laying forms quite an history of the art.

**Londonderry.**—The electrical engineer in his last report says that the boilers and mountings are ready for test, the switchboard will be delivered at an early date, and the steam sets will soon be under test in Bedford. The original system of providing condensing water direct from the river is to be retained, and the original system of exhaust to atmosphere.

**Exeter.**—At last week's meeting of the City Council Alderman Reed, in moving the adoption of the Electric Light Committee's report, said the work of the Westinghouse Company had been largely completed. It was gratifying to know that the tests had been very satisfactory. The committee would shortly meet to consider a proposal to reduce the price of current.

**Swansea.**—The electrical engineer (Mr. Prusmann) in his last report on the question of lighting the Strand and Llangyfelach-road, advises an installation of either 13 or 18 arc lamps, the former at an installation cost of £890, and the latter at £1,109. He suggested, if the lighting were decided upon, the matter be got in hand at once. The matter is before the Sub-Lighting Committee.

**York.**—In the minutes of the Electric Lighting Committee to be presented to the next meeting of the City Council, it is stated that the electrical engineer presented a preliminary report upon the question of lighting the Fulford-road district, practically the whole of Walmgate Ward, with electricity, and it was referred back for further details before a report is submitted to the Lighting Committee.

**New Cable to Japan.**—The U.S.A. Government has decided to sanction the laying of the new telegraph cable between the Japanese coast and Guam (Philippines) to connect with the Pacific cable, on the ground that the use of commercial facilities does not constitute a breach of neutrality. The object of the projected cable is to prevent the isolation of Japan in the event of Russia's cutting both existing cables between Japan and Shanghai.

**Leeds.**—The Corporation Lighting Committee propose to substitute electricity for gas in the illuminating of all tramway routes within a radius of one mile from the junction of Boar-lane and Briggate, opalescent and clear globes to be used for such lighting at the discretion of the superintendent. The Tramways Committee have given permission for the using of tramway poles in connection with this extension of electric lighting.

**Dorking.**—The Council have agreed to a list of mains which Messrs. Edmundson's asked the consent of the Council to proceed with as early as possible, the estimated cost being £2,177. 9s. 7d. A special committee has been requested to report (*a*) the roads included in the original loan of £20,000; (*b*) the roads covered by the proposed supplementary loan of nearly £2,200; (*c*) the roads included in the provisional order, but not provided for above.

**Ovingdean.**—At the last meeting of the Newhaven Rural District Council a resolution passed at a parish meeting at Ovingdean in reference to the introduction of electric light by the Brighton Corporation in the parish was read. "In view of future contingencies," the resolution stated, "the consent of the District Council to the proposal ought to be withheld." It was agreed to forward the resolution to Mr. Cowney, the member for the parish, before taking any definite steps.

**Kelso.**—Extensive improvements are in course of being carried out at Floors Castle, the seat of the Duke of Roxburghe, chief among which is the installation of electric lighting throughout the castle and contiguous stables. In connection therewith there will be two 50 h.p. oil engines, with dynamos and accumulators. The contractors for this work are Messrs. Leo Sunderland and Co., Victoria-street, Westminster. About 100 men are at present employed in carrying out the undertaking.

**Patent Litigation.**—It is well known that patent litigation is expensive to both litigants, whichever may be successful. We are informed, however, that in the case of the recent actions *re* steam traps, which have been decided in the High Court of Chancery and in the Appeal Court in Mr. Geipel's favour, the result has been a flood of orders which has more than filled the works, and Messrs. Geipel and Lange have found it necessary to extend their arrangements for the manufacture of the Geipel traps in consequence.

**Bo'ness.**—The Town Council are negotiating with the Secretary for Scotland with a view to obtaining sanction to borrow a sum not exceeding £25,000 for the installation of the electric lighting of the burgh. The Board of Trade having decided to withdraw any objections to the agreement with the Electric Construction Company provided the Council state that the "contractors are to collect the revenue as agents for and on behalf of the Council" at the end of Clause 13, it has been decided that these details be altered accordingly.

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**Worcester.**—The annual report upon the municipal electric light undertaking shows a greatly improved state of affairs. The profit on the year's working amounts to £1,693, the largest yet recorded, and this result has been achieved in spite of the payment of an additional £1,280 in interest and sinking fund in connection with the provision of the new station, and a contribution of £200 towards the salaries of Corporation officials. The gross profits represent 6½ per cent. on the capital outlay of £120,640, and the net profit is equal to more than a 2d. rate.

**Paris.**—A central station is being erected at Saint-Ouen, near Paris, by a syndicate who announce that they will sell current at 5d. per unit—a very low price compared with those ruling in Paris. They have the Metropolitan Railway to fall back on, which they are said to control, even if they do not succeed in getting customers for lighting. The *Revue Industrielle* considers that anyhow a reduction of 50 to 60 per cent. might be expected in the price of current, and presumes that even then customers will complain that they are being fearfully exploited by the electric lighting companies.

**May-Oatway Fire Appliances.**—We are informed by the May-Oatway Fire Appliances Company, Limited, that they have a very formidable list of installations in hand, including installations for the Midland Railway Company, passenger station, goods sheds, etc., Heysham; London County Council, Colney Hatch Asylum; Lyceum Theatre and Theatre Royal, Edinburgh (first theatres in the United Kingdom automatically connected with a fire brigade); Brown and Polson's works, Paisley; Jas. Templeton and Co., various warehouses and mills; J. and B. Stevenson, bakeries; and 18 other warehouses and bonded stores.

**Bedford.**—The last report of the Electricity and Street-Lighting Committee states that the electrical engineer has submitted a scheme for lighting Midland-road and Silver-street with arc lamps, and dispensing with the 22 existing incandescent lamps, at an estimated cost of £628. 10s. The engineer estimates that if this scheme is carried out the annual increase in the cost for lighting these streets would be £162. 4s. 7d., but the area would be provided with 10 times the present illumination. The committee recommended that such scheme be carried out, and also a number of extensions of mains. Both recommendations have been adopted.

**Watford.**—The Rural District Council last week received a letter from Mr. Stanley J. Attenborough, who is acting as solicitor for the Council in opposing the Watford Urban District Council's application for a provisional order to extend their electric light area, stating that the Urban District Council had asked the Board of Trade to dispense with the consent of the Rural District Council to the order. He suggested the form of a reply, and asked the Council's instructions. The Council decided to strongly object to the Board of Trade dispensing with their consent, and directed Mr. Attenborough to represent their objections to the Board accordingly.

**Wrexham.**—An application from the National Telephone Company in reference to their application to lay underground pipes and cables in certain streets is before the General Purposes Committee of the Town Council. The borough accountant's last statement as to the cost of the generation of electricity shows that from July 1 to Dec. 31, 1903 (six months), the income was £2,146, and the cost of working £1,454. Gross profit, £692; interest on loans, £473; net profit, £219; repayment of loans, £412; excess of repayment over net profit, £193. From Sept. 30 next a uniform charge is to be made to private consumers for lighting current at 5d. per unit, with ½d. per unit discount if paid by the end of the month following the close of each quarter.

**London Telephones.**—In the House of Commons on the 26th, Lord Stanley, replying to Mr. John Campbell, said the expenditure on the London telephone exchange system was £1,495,602 on Dec. 31 last. The system was not complete. Its extension was dependent on the provision of further funds by Parliament, and he hoped shortly to move a resolution for leave to introduce a Bill to provide additional capital for this purpose. It had been necessary to restrict the expenditure on telephone works in London and to reduce the number of workmen employed, in order to avoid exceeding the expenditure authorised by Parliament. If further expenditure was authorised at an early date, the works would be pressed forward as rapidly as possible.

**Rangoon.**—*Indian Engineering* says, in view of the Brush Company's alleged inability to carry out their Shanghai concession, the Rangoon Municipal Committee have adopted a resolution to ask the Brush Company, by cable, firstly, what guarantee they are prepared to give the Rangoon Municipality for carrying out their electric lighting and traction tender if they are granted a license. Secondly, as it has been ascertained that Government is not competent to grant a license for more than 42 years, are the Brush Company willing to accept the concession for that period? Thirdly, whether the Brush Company are willing to pay any excess which might be fixed by the arbitrators over and above four lakhs of rupees, which is the price the company agreed to pay for taking over the existing tramways?

**London Gazette.**—A first and final dividend of 4½d. in the £ has been declared in the estate of Edwin Ward, plumber and electrician, 38, Osborne-road, lately trading there and at 108, Bevoir-valley and 47, Lodge-road, Southampton; payable March 4 at Official Receiver's Office, Midland Bank-chambers, High-street, Southampton. The first meeting in the estate of Samuel Henry and James Edgar Thompson (trading as Thompson Bros. and Co.), electricians, East-street, will be held at 11 a.m. on March 8 at 6, Athenæum-terrace, Plymouth. A petition for the winding up of the Electric Timber-Seasoning and Preservation Company, Limited, will be heard at the Royal Courts of Justice, Strand, on March 8. Any person who intends to appear must send notice to Foss, Ledsam, and Blount, 5, Fenchurch-street, London, E.C., before 6 p.m. on March 7.

**Ealing.**—The trading account for the nine months ended December, 1903, shows a total output for the nine months of nearly 684,000 units, an increase of about 17 per cent. over the previous nine months, while the revenue had advanced £1.878, being £14,172 for the nine months. A substantial profit has been made on the nine months' working, although abnormal expenditure under two or three heads has somewhat diminished the percentage yield of profit to the capital employed, the cost of the various improvements—the benefit of which has not yet been fully felt—having been charged against the revenue. The borough electrical engineer's report on the question of new engines required for next winter's load having been further considered, the Electricity Supply Committee recommended the Council to instal a new 750-kw. engine set. The electrical engineer was instructed to prepare the necessary specifications and to advertise for tenders. The report was adopted at the last Council meeting. The cost of the set, with its foundations, condenser, piping, switchboard, etc., is estimated at about £10,000.

**Croydon.**—The committee have adopted the following report of the borough electrical engineer upon the lighting of the Mitcham-road tramways extension: "I beg to report that the cost of supplying 36 arc lamps in Mitcham-road and eight lamps in Tamworth-road amounts to £2,450. The revenue obtained from these lamps would be £792 per annum. The present cost of the gas lamps amounts to £112. 10s. per annum. If this work were carried out simultaneously with the tramway construction, the saving in excavation would practically pay for the cost of a three-way duct from the central station along Mitcham-road. The additional cost of laying a three-way duct, if not put in at the same time as the tramway track is put down, would amount to £500. Summary—Cost of arc lighting, £792 per annum; present cost of gas lighting, £112. 10s.; additional cost of arc lighting, £679. 10s." The committee recommend that this extension of the tramways be lighted by arc lamps (the whole of the existing tramway routes are now so lighted); that the works be carried out simultaneously with the tramway construction, and that application be made for sanction to borrow the sum of £2,450, the estimated cost of the work.

**Lincolnshire and Yorkshire Power Bill.**—The Bill to incorporate the Lincolnshire and Yorkshire Electric Power Company will meet with formidable opposition when it comes for consideration before a Select Committee of the House of Commons. The area proposed to be covered by this company's operations comprises the whole of Lincolnshire, the whole of the East Riding, the whole of the North Riding (with the exception of the Middlesbrough Union and certain parishes in the Guisborough Union of the Stokesley Union), and so much of the West Riding as lies within the area bounded on the south and west by the River Wharfe. From this area no fewer than 33 petitioners have, within the time allowed by the Standing Orders, lodged petitions praying to be heard against the proposals of the company. The petitioners are the County Councils of the North and East Ridings of Yorkshire, the County Councils of Lindsey and Kesteven; the Corporations of Hull, Grimsby, Lincoln, Bridlington, Ripon, York, Scarborough, Richmond, Beverley, and Harrogate; the Urban District Councils of Spalding, Scunthorpe, Gainsborough, Cleethorpes-with-Thurnscoe, Barton-upon-Humber, Brigg, Brumby and Frodingham, and Hessle; and the Rural District Councils of Grimsby, Glanford, and Gainsborough. Other opponents are the Great Grimsby Gas Company, the Great Grimsby Waterworks Company, the Scarborough Electric Supply Company, Yorkshire Electric Power Company, Derbyshire and Nottinghamshire Electric Power Company, Lincolnshire Ironmasters' Association, Humber Conservancy Commissioners, Sir Hickman Beckett Bacon, and Mr. Albert Herbert Fryer.

**Melksham.**—The Urban District Council are considering a letter from the Southern District Electric Corporation, stating the provisional terms upon which they would be prepared to equip and run an electric supply station. The terms are as follows: "(1) We (the company) will completely equip an electric supply station, lay mains, and carry out all required work to the satisfaction of the Council for a sum agreed upon, and to run and maintain the works, and do all things needful as undertakers under an order for a period of 30 years. The sum required for the work to be obtained by a loan on a 30 years' repayment basis; the interest and sinking fund thereon to be paid by us. (2) The charges to be made by us for the supply of electricity to be agreed upon between your Council and ourselves. (3) During the currency of the arrangement extensions to be carried out as required by the joint approval of the Council and ourselves. (4) We would adopt the 'free wire' system, and ourselves provide the capital required for the same. (5) We, as undertakers, to maintain the works in a proper and efficient state of repair, and the Council or their officer appointed for the purpose to have the right, at all reasonable times, to inspect the works. Any dispute as to maintenance or efficiency to be referred to the Board of Trade. (6) The Council to have access, at all reasonable times, to the books of the undertaking. (7) The Council to have the right to terminate the arrangement at any time up to 14 years by giving six months' notice, and upon payment of any loss which might have been incurred in running the works up to the time of the termination of the arrangement, and interest thereon at 4 per cent. After an existence of 14 years the Council to have the right to terminate the arrangement at any time by giving six months' notice after payment of compensation."

**Islington.**—At to-night's meeting it will be proposed that application be made to the London County Council to borrow £170 for mains extensions and £488 for the conversion of two supplies from a two-wire 100-volt to a three-wire 100-volt system. The latter step has been taken owing to the receipt of complaints from consumers in High-street to the effect that the pressure of supply is below the standard, and investigation has shown that there is some ground for the statements made so far as regards that portion of High-street between the Grand Theatre and the corner opposite The Angel. Owing to the traffic along the frontage and to the congested state of the subsoil below the

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footway, it has been found inadvisable to attempt to place additional boxes or apparatus in connection with electric lighting in the ground, except at the ends of the section—namely, Torrens-street, City-road, and Duncan-street. Also in Northampton-park, owing to the increase of motor load, the pressure at the ends of the distributing mains laid from Essex-road is considerably below the declared value. The special committee *re* wages, overtime, etc., at the electric lighting station will recommend that the resolutions of the Council of Aug. 7, 1903, in so far as they relate to the payment of "dirty money," the supply of overalls, and to the wages, hours, and conditions of labour of carpenters, bricklayers, and labourers engaged at the electric lighting station be rescinded; that one hour per day be allowed to men employed in cleaning flues, boilers, heaters, etc., when working out of daylight and in a cramped position; that one suit of overalls and one additional pair of trousers be allowed annually to men continuously employed as above; that carpenters and bricklayers in the electric lighting department be engaged at the rates of pay as agreed to by the employers' associations and trade unions or as in practice obtain, and that the hours be 52½ per week, as is now the case, which hours we are informed have been agreed to by the trades unions concerned.

**Portadown.**—Electric lighting is at present engaging the attention of the Town Council, and a committee has been appointed to consider an offer from Mr. R. Carson, Waring-street, Belfast, which contains the following: "I will be in Portadown shortly to lay before you a scheme for lighting the town by electric light, and also to provide power for mills and factories much cheaper than present cost. We will erect power station, lay cables, erect lamps, and do all the lighting required, put the light into shops and private houses free of cost to the town or owner, and only charge a rent or interest on the sums. We will find all the capital and guarantee capital interest and sinking fund, while we would arrange to pay off the amount in 25 years, when the town would be absolute owners of the plant. We would ask your Council to obtain a provisional order, but we will pay all the cost, so that the town will be at no expense in the matter. The cost of lighting will equal about 3s. 3d. per 1,000ft. of gas, and better light. Your Council jointly with my firm will control all the business. The Council will have the option of taking over the entire plant at such time as they may arrange. The profits, after providing for interest on capital and sinking fund, to be divided between the Council and my company, or as may be arranged. The charge for electric light to private consumers not to exceed 6d. per unit, and for power purposes 3d. per unit for first hour and 1½d. per unit afterwards. We would erect plant capable of supplying power for all the mills and factories about town. Millowners would have their power much cheaper than present cost. We would also put in motors and charge rent for them, which would pay off the cost of motors in a number of years, if millowners so desire, or we will sell them the motors. By this scheme the town provides or secures electric light at no cost to the town, and when sinking fund is closed the town becomes absolute owner of the plant, and the income from the lighting and power charges goes to the credit of the town, and reduce the rates, and my company will be discharged from further liability. As soon as I get map and other particulars we will make out estimate and specification. My company have at present three town jobs for about £400,000 now on hands on similar terms."

**Poplar.**—The Borough Council have received a report from Mr. Hooper, the newly-appointed electrical engineer, stating that on the whole the plant and mains as they exist are in a satisfactory state. Two of the sets, however, are very small, and necessarily inefficient, and it is proposed to take action with regard to these at once. It is a fact well known to the Council that the plant was run at some risk during last winter. The engineer suggests that to meet the difficulty the two sets should be disestablished, and in their place there should be substituted two generators, each of 1,000 kw. capacity. By this arrangement the present plant would be increased by 1,800 kw., and either of the two generators be available during next winter—that is to say, the present boiler power will be sufficient to drive one of the two new engines, the other affording a very necessary reserve should any of the other sets break down. It is proposed that one of the two machines be fixed upon a permanent basis and the other placed temporarily, with the prospect of removal to another site if an extension of the present building in which the engines are housed be hereafter decided upon. The high-tension alternating-current three-phase system is intended to be adopted in connection with the new machinery, and the scheme, as a whole, will involve a capital expenditure of £66,500, the following being particulars—viz.: generating station, £20,000; mains and south district, £25,500; north district, £14,000; dock crossing subways, £6,000—total, £65,500. For the present, however, it is only necessary to provide for supply of the two generators, with foundations, condensing plant, and switchgear, at an estimated cost of £16,000, and having regard to the time requisite for manufacture of the plant proposed to be acquired, it is necessary, in order that the same may be provided and in operation by the ensuing winter, that the two generators should be obtained as soon as possible. The committee recommended that the Council agree with the proposition to substitute for the two existing 100 sets two 1,000-kw. generators, and that advertisements be forthwith issued inviting tenders for their supply, with the necessary foundations, condensing plant, and switchgear, at an estimated cost of £16,000. This was agreed to.

**Mansfield.**—The Council have adopted a report to the Electricity Committee, including a statement of the consulting engineers (Messrs. R. Hammond and Son) on the total capital expenditure on the electrical undertaking and refuse destructor works, giving the total expenditure to date, together with provision for the further expenditure required to provide generating plant and feeder main for the tramway. Details are as follows: Buildings—J. Greenwood, £15,240. 14s. 11d.; Custodis Chimney Construction Company, Limited, £917. 1s.; Mansfield Engineering Company (wiring), £303. 14s. 2d.—total, £16,461. 10s. 1d. Machinery—Musgrave, £3,006. 5s.; Thos. Parker (including tramway set), £6,180; Johnson and Phillips, £685. 16s.; Carrick and Ritchie, £311. 1s. 10d.; Britannia Company, £336. 9s. 1d.; Crompton and Co., £2,450—total, £12,969. 11s. 11d. Accumulators—Tudor Company, £2,997. 12s. Mains—Western Electric Company, £10,100; local expenditure, horse services, wages, and materials, £55. 5s. 10d.—total, £10.155. 5s. 10d. Meters and demand indicators—Chamberlain and Hookham, £768. 15s.; Reason Manufacturing Company, £438. 2s. 6d.—total, £1,206. 17s. 6d Switchboard and electrical instruments—Bertram Thomas, £1,600; sundry tools and instruments, £18. 14s. 4d.—total, £1.618. 14s. 4d. Public lighting — Gilbert Arc Lamp Company, £878. 0s. 6d. Refuse destructor—Heenan and Froude, £5 000. Preliminary expenses—expenses of deputation, £27. 4s.; costs of electricity order, £262. 9s. 10d.; town clerk, £60—total, £349. 13s. 10d. Miscellaneous expenses: clerk of works, £443. 6s. 1d.; travelling expenses, £200; boiler tests, £21; treasurer, £5; stamps and sundries, £34. 3s. 3d.; National Telephone Company, £8. 11s.; printing and stationery, £242. 13s. 4d.; auditors' fees, £2. 2s.; books, £21 6s. 6d.; preliminary running expenses, coal, water, and wages, £130. 14s. 9d.—total, £1.108. 16s. 11d. Office furniture—furniture and general, £161. 18s. 3d.; Globe Wernicke Company (card record), £26. 18s. 11d.—total, £188. 17s. 2d. Engineering fees, £2,570. Land—purchase of land, £3,694. 8s. 10d.; compensation, £60; tithe redemption, £7. 12s. 7d.; approach roads, £702. 2s. 6d.—total, £4,464. 3s. 11d. Contingencies, £30. 16s. Grand total, £60,000. The expenses in connection with the Act of Parliament are not included in the total, as they are repayable over five years. The share debitable to the electricity and refuse destructor undertakings amounts to £504. 6s. 7d. The engineers draw attention to the fact that the accounts under all the contracts are not yet finally closed. Except in the case of the mains contract, in which payment is made upon measurements of the completed work, it is possible to arrive at the figure which will be payable nearly exactly, so that the ultimate capital commitments will not differ from the figures given above to any extent, if at all. In the case of the mains contract, they have included a sum which, to the best of their belief, will not be exceeded unless further extensions are put in hand.

**London County Council.**—The Parliamentary Committee reported as follows: "The Council on Jan. 26, 1904, approved the action taken by us in lodging a memorial against the London United Tramways (Railways) Bill on the ground of non-compliance with the Standing Orders relating to tramways and tramroads. The matter came before the Examiner of Bills on Feb. 15, who decided that the works described in the Bill constituted, so far as they were proposed to be laid on public roads, tramways. Accordingly, the petition for leave to introduce the Bill was endorsed as not complying with Standing Orders, and referred to the Standing Orders Committee of the House, who have now reported that the Standing Orders should not be dispensed with. It is probable, therefore, that the Bill may not be proceeded with. The object of the proposed 'railway' was to link up by a line partly in tunnel under the Thames, and for a short distance at each end on the surface of public streets, the London United Tramways Company's systems north and south of the river, and also to establish a direct communication between these tramways and the Metropolitan District Railway at Hammersmith Broadway. It has been hinted on behalf of the promoters that the objection taken by the Council to this particular Bill was based upon technical grounds alone, and that a scheme which would have proved of great advantage to the travelling public has thus been hindered. In answer to this, we believe the Council will share our view that, however desirable the linking-up of the existing lines of communication may be, its duty is to endeavour to prevent promoters of schemes from evading the Standing Orders of Parliament by calling a tramway proposed to be constructed partly along a public thoroughfare a 'railway,' and so seeking to dispense with the consent of the local and road authorities concerned to the introduction of the Bill to authorise the construction of such tramway. The Shoreditch Metropolitan Borough Council have applied for the Council's consent required by the Board of Trade regulations for ensuring a proper and sufficient supply of electrical energy in the area scheduled to the Shoreditch Electric Lighting Order, 1892, to an alteration of the standard pressure of supply in the area of supply under the order. The Borough Council has hitherto supplied current at a pressure of 150 volts, and now desires to increase the pressure to a standard one of 240 volts and 480 volts on the outer conductors. The Borough Council have given public notice, by newspaper advertisements, of its application to the Council, but no objections have been received from consumers in consequence of the notice. Consent has been given subject to the usual conditions. The following notices under Electric Lighting Acts and Orders were agreed to: from the Blackheath and Greenwich District Electric Light Company of intention to lay high and low tension mains along portions of Rushey-green and Sangley-road, and to fix a transformer box at the junction of Sangley-road and Rushey-green, and to lay high and low tension mains along portions of Berlin-road, Bromley-road, and the lane leading to Messrs. Robertson and Sons, and to build transformer boxes in Bromley-road; also to lay high-tension mains along a portion of Sydenham-road and low-tension mains across Newstead-road and St. Mildred's-road, and along a portion of Birch-grove; from the County of London and Brush Provincial Electric Lighting Company, to lay high and low tension mains along Sternhall-lane; from the Crystal Palace District Electric Supply Company to lay high-tension mains along London-road, Eliot-bank, Sydenham-hill, Sydenham-hill-road, Kirkdale, Wells-road, and Springfield-road, and to build transformer boxes in London-road and Sydenham-hill; from the Metropolitan Electric Supply Company, to lay low-tension mains along a portion of Seymour-mews and high-tension mains along Circus-street and a portion of Marylebone-road. Notice under an order was received from the Hampstead Metropolitan Borough Council of intention to lay mains along portions of Akenside-road, Eastheath-road, Albion-road, Fordwych-road, Mortimer-road, Elsworthy-road, and High-road, Kilburn.

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The Borough Council is the undertaker under the order, and the Council have no power of approval or disapproval of the works.

**St. Marylebone.**—At the meeting last night the Finance Committee reported that they had resolved to make a formal application to the London County Council to advance, immediately upon the passing of the Borough Council's Bill, the amounts authorised in it, or so much of them as may be required within the year. The Council will, of course, not be bound to take up the loan, even if promised, so that any negotiations, whether with the Metropolitan Electric or any other company, will be in no way prejudiced. The following report of Electric Supply Committee was also submitted: "The Electric Lighting Bill—(*a*) We have to report that the St. Marylebone Electric Lighting Bill has been read a first and second time in the House of Commons. Mr. Horner, M.P., blocked the Bill on two occasions, but withdrew his opposition on the 23rd inst. Petitions have been presented against the Bill by the London County Council, the Metropolitan Electric Supply Company, Mr. Horner, M.P., the Regent's Canal Company, the Great Central Railway Company, and the Harrow School Estate. We (in conjunction with the parliamentary agents) are conferring with the clerk and principal officers of the London County Council with a view to the removal of their objections to the Bill. We are objecting to the Electric Supply Company's *locus*. We have not been able to comply with Mr. Horner's requirements. The parliamentary agents are in correspondence with the other petitioners. Mr. Goddard, M.P., has given notice of his intention to move an instruction to the committee to whom the Bill will be referred, and we consider that the instruction, slightly modified, might be accepted. The parliamentary agents are conferring with Mr. Goddard. The Gaslight and Coke Company (for whom Messrs. Dyson and Co. are acting) have asked for a suspension of Standing Orders to enable them to present a late petition, alleging that they had not discovered until a recent date, when the time for petitioning had expired, that the Bill might materially and prejudicially affect their interests. We are resisting the gas company's application for a suspension of the Standing Orders. Lord Portman has not petitioned against the Bill, but he has stated his objections, and we are considering as to how far they can be met. It will be seen from our report that important matters connected with the Bill will arise from day to day until the measure is passed or rejected, and we believe it will be clear to the Council that it is expedient that the committee, to whom so many powers have been delegated in connection with the undertaking generally, and the preparation of the Bill in particular, should have all necessary powers connected with the employment and instructing of counsel, and the sanctioning of minor alterations and amendments to the Bill, and, therefore, we recommend the Council to authorise the town clerk, subject to the directions of the Electric Supply Committee, and in conjunction with the parliamentary agents, to take all necessary steps in the promotion of the St. Marylebone Electric Lighting Bill, and the instructing of agents, counsel, and witnesses that the committee may deem necessary, and that the said committee be authorised to act in all matters for and on behalf of the Council during the progress of the Bill through Parliament, and that they be required to report regularly to the Council on any action taken. Proposals to lease the undertaking to companies, or to enter into working agreements—(*b*) We have considered the negotiations which are pending as to the leasing of the undertaking to the Metropolitan Electric Supply Company or some other company, or the entering into a 'working agreement' such as is sometimes sanctioned; and although we have nothing definite to report at present, we think it very desirable that the Council should at once take the necessary steps to amend the Bill by an enabling clause, giving the Council full power to lease the undertaking for a period, or to enter into a working agreement with a company so as to be guaranteed against loss. Such a clause has been prepared, and is under our consideration. We recommend the Council to authorise us to take all necessary steps to secure such an amendment of the St. Marylebone Electric Lighting Bill, 1904, as shall confer power upon the Council (should the Council desire to do so) to enter into an agreement with a company to carry on the undertaking either temporarily or permanently, and that the common seal of the Council be affixed to the necessary petition to the House of Commons.—ERNEST R. DEBENHAM, Chairman."

## PROVISIONAL PATENTS, 1904.

FEB. 22.

**4353. Improvements in and connected with electric vibrating apparatus for massage purposes.** Paul Hoffmann, 33, Cannon-street, London. (Complete specification.)

**4357. Improvements in electrical transformers.** John Sedgwick Peck, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 28, 1903, being date of application in United States.) (Complete specification.)

**4376. Improvements in electricity meters.** John Mesny Tourtel and the Tourtel Manufacturing Company, Limited, 146A, Queen Victoria-street, London.

**4378. Improvements in electrical switches.** Walter Sandell Mappin and George Stanley Mappin, 55, Pagoda-avenue, Richmond.

**4396. Improvements in means or apparatus for controlling incandescence electric lamps.** Russell Forrester Ferguson, 46, Lincoln's-inn-fields, London.

**4395. Improvements in gripping appliances suitable for screwing lamp-shade clamp-rings on and off electric incandescent lamp-holders.** Russell Forrester Ferguson, 46, Lincoln's-inn-fields, London.

**4372. Improvements in and relating to the electrolytic manufacture of chlorates and perchlorates.** Paul Corbin, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 31 1903, being date of application in France.) (Complete specification.)

FEB. 23.

**4443. Improvements in collectors or trolley-arm heads for electric traction systems.** Henry Peace, 24, Temple-row, Birmingham.

**4448. Thermal cut-outs for electric circuits.** Wallace Fairweather, 65, Chancery-lane, London. (American Electric Telephone Company, United States.) (Complete specification.)

**4449. Thermal cut-out for electric circuits.** Wallace Fairweather, 65, Chancery-lane, London. (American Electric Telephone Company, United States.) (Complete specification.)

**4450. Thermal cut-out for electric circuits.** Wallace Fairweather, 65, Chancery-lane, London. (American Electric Telephone Company, United States.) (Complete specification.)

**4451. Improvements in and relating to electrical switches.** George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham. (Complete specification.)

**4461. Improvements in electric traction systems.** Ernest Francis Moy and Percy Henry Bastie, 3, Greenland-place, Camden Town, London.

**4472. Improvement in and connected with audiphones, telephones, and like instruments employed for the transmission of sound.** Hermann George Pape and Edward John Higgins, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**4473. Improvements in and connected with audiphones, telephones, and like instruments employed for the transmission of sound.** Hermann George Pape and Edward John Higgins, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**4487. Improved process and apparatus for the manufacture of sulphate of copper and caustic alkalies by the electrolysis of alkaline chlorides.** Henri Michel Granier, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 6, 1903, being date of application in France.) (Complete specification.)

**4502. Improvements in and relating to ploughs or similar devices for collecting current from conduit conductors for electric traction.** Charles Palmer Grew, 1, Queen Victoria-street, London.

**4507. Improvements in electric controllers.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Complete specification.)

**4512. Improvements in generating electricity by the use of moist chemicals which are mechanically pressed upon zinc.** Henry Nehmer, 36, Clifton-street, Finsbury-square, London.

**4519. Improvements in electric mercury vapour lamps.** Godfrey Bamberg, 173, Fleet-street, London.

FEB. 24.

**4579. Improvements in electric arc lamps.** Samuel Barnes Griffith and Frank Biliotti, 8, St. John-street, Adelphi, Strand, London.

**4587. Improved construction of electric switch.** George Smith, 173, Fleet-street, London.

**4590. An improved telephone annunciator or indicator switchboard.** August Eckstein and Francis George Bell, Peel Works, Adelphi, Salford, Manchester. (Complete specification.)

**4592. Improvements in electro or other magnets.** Ernest Shouls and Samuel Bridgwater, 43, Gibson-square, London.

**4594. New system of operation of make-and-break devices for electric circuits and apparatus therefor.** Frank Seary and John Lenderyou, 22, Southampton-buildings, Chancery-lane, London.

**4600. Improvements in electric fuses.** William Richard Macdonald, 322, High Holborn, London.

**4609. Improvements in indicators operated electrically from a distance.** Barthélemy Becker, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London.

FEB. 25.

**4629. An improved electric arc lamp.** George Charles Shankster, 26, Lee-street, Holderness-road, Hull.

**4646. Improvements in or in connection with metallic circuit intercommunication telephones.** M. W. Franz Petmeky, 3, Brown-street, Market-street, Manchester. (Complete specification.)

**4647. Improved trolley for electric tramcars.** William Campbell, 65, Chancery-lane, London.

**4660. Improvements in electric contact breakers or tremblers for ignition coils.** Samuel Raphael Cohen and Barnett Raphael Cohen, 33, Chancery-lane, London.

**4663. Improved means for rupturing electric circuits.** Percy Holbrook Thomas, Westinghouse Patent Bureau, Westinghouse-buildings, Norfolk-street, Strand, London. (Complete specification.)

**4676. Improvements in or connected with insulators for the conductors of electric railways.** Frank Dietrich Ward and Harry Crampton Furniss, 4, South-street, Finsbury, London.

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FEB. 26.

**4721. An improved auto-condensation plate for use with electric currents of high potential and frequency for therapeutic purposes.** Ernest Brown, 100, Wellington-street, Glasgow.

**4731. Improvements in or applicable to pendant incandescent electric lamps.** George Hamer Scholes, 70, Deansgate, Manchester.

**4769. Improvements in alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**4770. Improvements in automatic regulators for alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**4771. Improvements in alternating-current motor control.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**4772. Improvements in controlling alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**4773. Improvements in controlling alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**4783. A new or improved electric heating device.** José Padris, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

**4785. Improvements relating to reproduction of sound by means of phonographic and electrical apparatus.** Henri Félicien Léon Hantz, 18, Buckingham-street, Strand, London.

FEB. 27.

**4866. Improvements in electric transformer furnaces.** Otto Frick, 55, Chancery-lane, London. (Complete specification.)

**4869. Improvements in wireless telegraphy.** Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901 Oct. 13, 1903, being date of application in United States.) (Complete specification.)

**4874. Improvements relating to trolley poles for cars electrically propelled on the overhead system.** Washington Harry Kilbourn and Archibald Dick Flower, Fife House, Kingston-on-Thames.

**4875. Improved construction of electric switch.** Gustav Markt, 173, Fleet-street, London.

**4891. Improvements in apparatus for the electrical ignition of internal-combustion engines.** Stanley Brotherhood and Charles William Bryant, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 17, 1904.*

1902.

**25435. Electric telegraphy.** O'Neil.

1903.

**3939. Fixture studs for electric lamps and other electrical appliances.** Brookes. (Betts and Thomas.)

**4077. Construction of armatures for alternating-current electric motors.** Mavor, Grafton, and Mavor and Coulson, Limited.

**4275. Electric regulating switches.** Henry William Wartnaby, Dix, and John Sandford.

**4413. Method and device for collecting and putting to practical use the electricity from the interplanetary ether.** Whitney.

**4704. Telephone receivers.** Heys. (Hutchison Acoustic Company.)

**5011. Electric switch for motor cycles and vehicles.** Mason and Brown.

**5537. Mouthpieces of transmitters and receivers of telephones and speaking tubes.** Latham and Boyes.

**5744. Electrical measuring instruments.** Fisher.

**5918. Switch for use in charging storage or secondary batteries.** Heys. (Hutchison Acoustic Company.)

**6466. Electrically-operated means for controlling the pump discharge and the supply of water to water-closets and the like.** Stewart and Shanks.

**6483. Electric controllers.** Carolan. (General Electric Company.)

**6485. Electric reactance coils.** Carolan. (General Electric Company.)

**6491. Alternating electric current motors.** Carolan. (General Electric Company.)

**6493. Electric metering systems.** Carolan. (General Electric Company.)

**6954. Forming lead peroxide on plates of electric accumulators.** Diamant.

**7415. Two-way electrical switch.** Lewis.

**7527. Ceiling roses, cut-outs, and the like, for electric lighting purposes.** Grocott.

**7612. Conduits for underground electric conductors.** Pocklington and Simplified Underground Conductor Company, Limited.

**8676. Plates or electrodes for electrical accumulators.** Cance.

**9264. Electrically-heated hand tools or implements.** Haynes.

**11442. Arc light electrodes.** Vogel.

**14563. Electric switches.** Ball.

**22087. Apparatus for establishing electrical correspondence selectively.** Despradels.

**24500. Rectifying and obtaining light from alternating electric currents.** Weintraub. (Date applied for under International Convention, March 23, 1903.)

**24501. Rectifying alternating electric currents.** Weintraub. (Date applied for under International Convention, March 23, 1903.)

**24502. Rectifying and obtaining light from alternating electric currents.** Weintraub. (Date applied for under International Convention, May 9, 1903.)

**27585. Casings for electric wires and lamp holders, wall-plugs, and the like for use therewith.** Walker.

**28055. Arc lamps.** Société Française d'Incandescence par le Gaz (Système Auer.) (Date applied for under International Convention, Dec. 22, 1902.)

**28057. Solutions for use in the cells of galvanic batteries** Wheatley. (Atwood Electric Company.)

**28232. Coin-freed apparatus for electric supply.** Sabat.

1904.

**1847. Manufacture of electric cables and the like.** Stratton and Claremont.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ¼-⅜ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6½ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 xd |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | ⅞-4½ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ¾-1½ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1½-1⅝ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10½-11½ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5½-5⅝ |
| Crompton and Co. ..... | 3 | .. | 1⅞-2½ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ½-1½ |
| —— 5 per cent. Debentures..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1½-1⅝ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9½-9¾ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 12-13 |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5½ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-110 xd |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18-19 |
| —— 4 per cent. Debentures..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14½-15½ |
| Telegraph Construction and Maintenance..... | 12 | .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 115-118 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12½-13½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9½-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10½-11½ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10-10½ |
| —— 7 per cent. Preference ..... | 5 | .. | 9⅞-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14½ |
| —— ,, ,, £10 Ord. .... | 6 | .. | 10⅝ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7½-8 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5½ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅞-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 102-104 |
| Chelsea Electricity Supply ..... | 5 | .. | 5½-6 |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary..... | 10 | .. | 10½-11½ |
| —— 6 per cent. Cumulative Pref..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 7½-8½ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11½-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5⅜-6½ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5⅜-6½ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 5 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3-4 |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 82-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5⅜-6½ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7½-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 10½-11½ |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 103-106 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary | 5 | – | 1⅞-2 |
| —— 6 per cent. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | – | 17½-18½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | .. | 98-102 |
| Oxford Electric, Ordinary, 1-96 and 1-14,510 | 5 | .. | 5½-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 97-100 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | – | 95-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 3-3½ xd |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| South London, Ordinary | | – | 3¼-4 |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 |
| —— 3½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4⅜-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4⅞-5⅛ |
| Westminster, Ordinary | 5 | – | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6½ |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 92-95 |
| —— 4 per cent. Pref. | 100 | – | 97-100 |
| —— " " deferred | 100 | – | 86-89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-115 |
| City and South London, Consolidated Ordinary | 100 | – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 123-126 |
| —— " " " '96 | 100 | – | 119-123 |
| —— " " " '01 | 100 | – | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | – | – | 13-13½ |
| —— Ordinary, 1-50,000 | – | – | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 102-104 |
| Waterloo and City, Ordinary | 100 | – | 83-92 xd |

## Electric Tramways.—

| | | | |
|---|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | – | 4⅝-4⅞ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 82-85 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10-10½ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9-10 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10½-11½ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 120-125 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-3 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5½-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 104-107 |
| —— Prov. Cert., all paid | 100 | – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | – | 1⅜-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— Debentures | 100 | – | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | – | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | – | 113-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | – | 3¼-4 xd |
| —— 4 per cent. Debenture Stock | 100 | – | 80-83 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11½-11⅞ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | – | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | – | ¾-1⅛ |
| New General Traction, Ordinary | 5 | – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 10½-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | – | 11½-12½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | – | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8½-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,152 6 per cent. Preference | 1 | – | 1 |
| —— £526,083 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 99-101 xd |
| —— Deferred Stock | 100 | – | 74-77 xd |
| —— 6 per cent. Cum. First Pref. | 10 | – | 13-14 xd |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 13½-14½ xd |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5-5½ xd |
| —— 3½ per cent. Deb. Stock, Red. | 100 | – | 96-97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| Oriental Telephone and Electric Company | 1 | – | ¾-1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | Receipts per | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 27 | 1,066 | 822 | + 244 | + 9,301*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 20 | 159 | 160 | – 1 | + 180 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 27 | 306 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 26 | 734 | 641 | + 93 | + 2,021 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 25 | 290 | 317 | – 27 | – 294 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 27 | 163 | 206 | – 43 | – 81 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 28 | 1,547 | 1,503 | + 44 | + 8,377 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 24 | 863 | 837 | + 25 | +34,037 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 28 | 3,332 | 3,229 | + 103 | +19,792 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 28 | 672 | 701 | – 29 | + 2,600*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 26 | 4,353 | 4,334 | + 24 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 27 | 861 | 666 | + 195 | — | — | — | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 28 | 275 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 27 | 1,779 | 1,590 | + 188 | +22,960 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 27 | 161 | 148 | + 17 | + 223 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 27 | 7,138 | 7,054 | + 74 | + 480*h* | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 28 | 3,127 | 3,097 | + 30 | – 587*h* | 6⅜ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 25 | 367 | 385 | – 19 | – 2 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 26 | 200 | 216 | – 16 | – 230 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 27 | 154 | 168 | – 14 | + 72 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 28 | 84 | 60 | + 24 | + 61*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 26 | 3,490 | 3,501 | – 11 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 26 | 654 | 628 | + 26 | | | | | | | | | | | |
| Dundee City Tramways | ,, 24 | 759 | 770 | – 11 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 27 | 588 | 493 | + 105 | + 8,578 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 27 | 12,997 | 12,174 | + 823 | +53,350*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 24 | 2,113 | 2,142 | – 29 | + 6,275 | 31¾ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 20 | 1,118 | 998 | + 200 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 27 | 1,895 | 1,702 | + 193 | + 7,279 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 24 | 122 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 24 | 247 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 27 | 4,763 | 4,900 | – 137 | +15,532 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 20 | 9,257 | 9,114 | + 143 | + 2,885 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 28 | 1,477 | 1,479 | – 2 | + 356*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 20 | 9,653 | 8,305 | +1,348 | +83,327 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 132 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 20 | 75 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 27 | 3,323 | 3,073 | + 250 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 27 | 1,302 | 1,193 | + 109 | +82,004 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 29 | 95 | 103 | – 8 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 25 | 396 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | Jan. 18 | 3,443 | 2,628 | + 815 | +45,490 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | Feb. 28 | 4,091 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 25 | 819 | 803 | + 16 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 23 | 1,024 | 924 | + 40 | + 2,747 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 27 | 550 | 503 | + 47 | + 3,887 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Erratum.**—In an article on "Electrical Furnaces," which appeared in a recent issue, we gave a description of an interesting lecture which was delivered at Birmingham. Unfortunately, the lecturer's name was incorrectly spelt as "Slansbie." It should have been Mr. J. H. Stansbie. The lecture and demonstrations were so much appreciated that it is likely to be repeated at an early date.

**Corporation Tramway Accidents.**—The recent case against the London County Council for damage caused through a tramway accident was dismissed under the Public Authorities Protection Act, but it was not clear from the report of the action that the real cause for the dismissal of the case was that the proceedings were not taken within the statutory period of six months. If this is done, municipal authorities are just as liable as companies for damage arising from accidents on their tramway system.

**The Japan-Philippine Cable.**—The construction of the proposed submarine cable between Japan and Guam, in the Philippines, is being held over owing to the war. We hear that President Roosevelt thinks it undesirable to sanction the undertaking at the present time. The Commercial Cable Company is pressing forward the scheme, however, and is acting largely on behalf of the Japanese Government. The feeling in America is that, should the cable be constructed in the future, it should be laid and operated under the immediate control of the United States Government.

**Electric Traction on Ordinary Railways.**—The note in our last week's issue on the experiments being carried out by the Oerlikon Company before the delegates of the Swiss Government Commission explained the collection of high-voltage current on the single-phase system. Further details of the equipment on the train itself are not yet to hand, but we understand there is a motor-generator on the locomotive which converts the single-phase current received from the line into direct current, which is delivered to the motors driving the locomotive.

**The McMillan Memorial Fund.**—We learn from the Institution of Electrical Engineers that the subscriptions received up to the 9th inst. for the above fund amounted to £991. This is not quite one-half the amount which the President fairly expects to raise. We note from the list of subscriptions sent to us that there are a very large number of members and associates who have not yet forwarded their quota. This we trust they will do promptly and so testify to their appreciation of the invaluable services rendered by the late Mr. W. G. McMillan. Our readers who have not yet contributed will kindly take this note as a personal reminder.

**St. Marylebone Electric Lighting.**—The Court of Referees in the House of Commons has decided that the Metropolitan Electric Supply Company have not the right to be heard as opponents to the Bill promoted by the Borough Council of St. Marylebone. It appeared from the arguments of Mr. Balfour-Browne, as counsel for the company, that they wished only to ensure that they should have the first charge on the moneys raised if the Bill were passed. We are pleased to see that the Borough Council have thrown out a number of frivolous motions which have stood on their agenda for months, and that they are amending their Bill on business lines at a private meeting.

**Siberian Critics.**—An interesting example of the way the Russian press censorship is worked is given in a recent number of our contemporary the *Electrical Review* of New York. In its issue of Dec. 12, 1903, our contemporary gave a description of the central station at Thomsk, Siberia, which was illustrated. It appeared that the illustration of the vertical engines used in the station offended the Russian censor, and consequently it was obliterated before the papers were allowed to circulate in Siberia. It is a curious thing that the illustration should give offence when the description accompanying the same was allowed to pass. While the incident is a laughable one, it shows the hindrance to the circulation of technical literature in Russia and Siberia.

**Brighton Telephones.**—With respect to the description of the Brighton telephone exchange, which appeared in our last issue, we omitted to mention that the whole of the woodwork in the switchroom and throughout the building, including the roof, has been rendered non-inflammable in order to reduce the fire risk. In consequence of this, should a fire be accidentally caused in any part of the exchange it would have considerable difficulty in spreading. We would also like to emphasise the fact that while the Ericsson-Bell Telephone Company manufactured and supplied the switchboard, the system of switching is entirely due to Mr. A. R. Bennett, the consulting engineer. The system is one he has devoted much time to develop, and the switchboard was made strictly to his specification.

**Wireless Telegraphy.**—The Belgian postal authorities have decided that after the 15th inst. public service shall be given from the Belgian wireless telegraphy stations to the Channel boats. The charge of 2d. per word will be made in addition to the ordinary telegraph rates. The United States Army Department has organised a wireless telegraph between Fort Wright, Fisher's Island, and Fort Schuyler, N.Y., a distance of 97 miles. Messages of 1,000 words each have been exchanged and read distinctly at a speed of 30 words a minute. The line established is intended for use between St. Michaels and Nome, Alaska, where it has been impossible to establish ground lines because during the winter the cables are wrenched away by the ice. Over £70,000 has been expended on attempts to establish a land telegraph line, but without success.

**Photography.**—It is an indication of the large staffs now employed in electricity undertakings that at Glasgow there is a photographic society, all the members of which are employed in the Corporation electricity department. The first exhibition of this society was opened in the St. Andrew's Cross works last week by Mr. Chamen. Formed in the spring of last year, there are now 27 members on the roll. The exhibits, which numbered 116, were divided into four classes, and the following were the winners of medals: Class A—bronze medal, "Canal at Cadder," by W. Fethney. Class B—silver medal, "A Lake Scene," by H. Laing; bronze medal, "Above the Lynne," by W. H. M'Kenzie. Class D—silver medal, "Gathering Storm," by W. Fethney. The society is also evidence of the fact that members of the staffs of electricity undertakings are no longer working 16 hours out of 24, as in the earlier days of electric lighting.

**Long-Distance Telegraphy.**—The Indo-European Telegraph Company within the past few days have arranged for the sending and receiving of telegrams between Teheran and Manchester without a single break. This, roughly speaking, represents a distance of 4,000 miles. Of course, it has long been possible to send direct messages over such an area of country, but where the Indo-European Company now save is in the matter of time. With the establishment of mechanical repeaters at 11 stations they are able to speak to Teheran with the ease and readiness with which one wires to London. This was demonstrated this week by the receipt at Manchester of a message containing 149

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words from the Persian capital in the short space of eight minutes. As an indication of the greatness of the world's business it may be mentioned that on an average 1,000 messages go from London to Teheran, thence to be distributed all over India and beyond, every day.

**London Tramways.**—An interesting petition was brought before the Borough Council of Camberwell on Wednesday last with respect to the conversion for electric traction of the Camberwell and Dulwich tramways. It will be remembered that the London County Council have recently decided not to purchase these lines at the present time, and that in consequence there is likely to be at least a seven-year interval before the matter is again brought up. The company have accordingly applied to Parliament for powers to equip the line electrically. Out of the 1,347 householders along the lines of route no less than 1,135 are in favour of their so doing, whereas only 116 were opposed to the same. The petition accordingly requests the Council to give their consent to the Bill. They urge that an electrical service is required at once, and that those most interested are in favour of this Bill. The Council have, however, decided to oppose the Bill, and, of course, the London County Council are doing the same. Neither will provide the electric tramways, and both oppose private enterprise doing the work.

**Post Office Telephony.**—In the House of Commons last week Mr. John Campbell drew attention to the recent report of the National Telephone Company, in which the chairman stated that they are working in partnership with the Post Office. He asked for details of the arrangements. Lord Stanley replied that the statement made by the chairman of the National Telephone Company had reference, probably, to the arrangement made in 1901 for free intercommunication between the exchange systems of the Post Office and the company in London. This arrangement had proved to be a great convenience to the large body of telephone users in the London area. It would continue until the termination of the company's license. The company were bound at the expiration of the license to sell to the Post Office their plant in the London area at a valuation on what are known as "tramway" terms. As soon as funds have been provided under the Bill, which he hoped shortly to obtain leave to introduce, the development of the London telephone service by the Post Office would be expedited as much as possible.

**Maintenance Contracts.**—An interesting point was raised before the Local Government Board at Darwen last week with respect to an application for further loans for the electric lighting undertaking. A Mr. Duxbury asked the inspector to look into the question as to whether the contracts for new cables included items for maintenance. It seems that under the contract by which certain cables were obtained the contractors were made liable for the upkeep of the cables for 10 years, and Mr. Duxbury's conclusion was that by so doing maintenance charges were included in the contract sum and charged to capital. This is an interesting question, which the inspector ruled out of order on a technical point. It is obviously only fair to manufacturers and to the accounts that these long-term maintenance responsibilities should be accompanied by an annual charge, as is the case in accumulator work. We believe, however, that the demand that the cable contractors should be responsible for faults developed over as long a period as 10 years is most unusual, and that it will become more infrequent in the future.

**Berlin Tramways.**—The following information as to the Berlin tramways is of interest as a comparison with the work done in the large towns in this country which have effective tramway undertakings. Thus, last year the Berlin tramways consisted of 305 miles of track, and carried 312,410,000 passengers, of which a fair number were season-ticket holders. The total receipts were £1,476,050 and the expenditure £754,800, the ratio of the latter being 53·88 per cent. The cost of electric motive power was £172,550. The net profits, including the balance brought forward, amounted to £412,100, out of which, after payment of interest on debentures, a dividend of 8 per cent. is paid on the share capital of £4,289,250. This compares with a distribution of 7½ per cent. in 1902. As against these figures it may be mentioned that during the same year, 1903, the Glasgow tramways had 124 miles of track open and carried 177,179,549 passengers. The receipts from the Glasgow tramways were £656,572, from which it will be seen that at Glasgow they carried more people and also earned more money for a given length of line than did the Berlin company.

**Independent Telephony.**—The growth of independent telephony in the United States has during the past few years been remarkable. The need of inter-communication between various independent telephonic systems is, of course, great, and at first sight it would appear there would be a great gain if the various independent telephone companies were formed into a joint company in opposition to the Bell system. Such a course, however, is strongly opposed by the independent telephone companies, who at the same time wish to secure active co-operation for mutual benefits. At a recent congress the various independent telephone companies in Ohio have reorganised their association on strictly republican lines. They have arranged for an upper and lower council of delegates, on which every company will have a single representative. In the upper council this representative will have a single vote, whereas in the lower house his number of votes will be in proportion to the assessed value of the property he represents. It will be the lower council which will deal with taxes. The new organisation includes a registration court, joint action for patents, tolls, etc. It remains to be seen how far the scheme is practicable.

**Electrical Driving.**—Prof. F. G. Baily, M.I.E.E., of the Heriot-Watt College, delivered a lecture last week on "The Electric Motor and Electrical Driving," in the rooms of the Building Trades' Exchange, Edinburgh. Prof. Baily commenced his lecture by describing the general principles of the electric motor, showing the methods of speed regulation and the effect of load upon the speed. He spoke of the special properties of the "shunt" and the "series" types of motor, and, in comparing the two, referred to the action of the one as corresponding to that of a governed and to the action of the other as corresponding to that of an ungoverned steam-engine. Speaking of the various types of motors used for shop work, he pointed out the advantages of completely enclosed motors automatically controlled. He afterwards raised the question whether it was better to attach a motor to each machine or to have one large motor and to distribute the power by shafting, and stated that while one large motor was not so expensive as a number of small motors, in establishments where some of the machines were frequently idle it was more economical to use a motor for each machine. The advantages of electric cranes, and of distributing by electricity the power required in connection with building operations and in factories, were illustrated. In Edinburgh, the lecturer said, it was difficult for manufacturers to generate their own electricity cheaper than they could obtain it from the Corporation mains. In some very large works, however, the proprietors found it cheaper to have their own engines and boilers, and he instanced some cases of large firms generating electricity for their own use at from ½d. to ¾d. per horse-power hour.

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**Leeds Section Dinner.**—On Thursday last week Mr. H. Dickinson took the chair at the first annual dinner of the Leeds Local Section of the Institution of Electrical Engineers. This section, although only formed in the autumn of 1902, has now 191 members, and is doing good work. Mr. R. K. Gray attended the dinner as president of the parent Institution, and he proposed the toast of "The Leeds Local Section." In so doing he spoke in praise of the Corporation electricity works. Mr. Dickinson, in reply, referred to the work of the Institution, especially with regard to the training and education of engineers. This, he said, was a matter of the most vital importance to the country. Given proper facilities for it, he had no hesitation in saying that we had young men who were adopting engineering as a profession who would maintain the reputation which the country had always held for engineering method. He felt, however, that keen as was competition nowadays, it would be much more severe in another 10 years, and if our engineers were not as well equipped as those of foreign countries, they could not expect to hold their place. This was a question for the parent body. Mr. R. Hammond proposed the toast of "The Corporation and City of Leeds," and said that he knew no city in which municipal matters were taken in hand with such thoroughness as in Leeds, and where the leading citizens were so willing to take part in municipal affairs. He was very glad to know that in Leeds the chairmen and vice-chairmen of committees retained office from year to year. Mr. Herbert Brown, vice-chairman of the Lighting Committee, responded, and agreed that it was a great advantage that chairmen and vice-chairmen of committees should retain their positions year after year. The speeches were interspersed with an excellent musical programme.

**Electro-Chemistry.**—Mr. Bertram Blount commenced a series of three Cantor lectures on this subject at the Society of Arts on Monday last. He pointed out that while experiments were very interesting, they could not be shown to advantage in this part of his lecture, but later on he hoped to show visually what could be done by means of the electric furnace. The commercial interest in electro-chemistry depended solely upon the ability to use processes economically. If there were two processes, one electro-chemical having to compete with the other, it depended solely upon the cost which process succeeded and which failed. The most important electrolytic process was that of refining copper, of which 70 per cent. was thus refined, and how big a business it was could be realised from the fact that some 250,000 tons annually were produced in the States. The Anaconda works alone utilised 3,000 h.p., and deposited 100 tons per day in tanks which covered an area of three acres, and the labour costs were reduced to a minimum by using mechanical methods throughout the works. The lecturer mentioned the importance of a quick turnover. Copper costs from £40 to £60 a ton, and the sooner it was marketed the less capital lying idle. The aim of inventors was to deposit the copper quicker, but there seemed to be a limit to celerity, in that too great an amperage per square foot usually meant bad deposits, while, instead of a crystalline, a smooth deposit was wanted. Mr. Dolphin's improvement was described. This gentleman gets a circulation of the electrolyte and also an increase in the oxygen by carrying a stream of air by means of the moving electrolyte. It was, however, in the direction of improved methods of winning rather than in refining that the greatest economy was to be obtained. We cannot enter here into technical matters, but the lecturer discussed the probability of further extensions in electrolytic refining, coming to the conclusion that the process held the field as regards copper, and there might be some chance for nickel, but neither for zinc nor lead could it compete against the common processes.

**New Books.**—"Transactions of the Institution of Civil Engineers of London," vol. xxix. (Dublin: John Falconer).—"The Common Sense of Municipal Trading," by Bernard Shaw (Westminster: Archibald Constable and Co., Limited). 2s. 6d. The boast of the author of this work is that it contains no figures. He holds that figures are of no matter so far as settling the question whether municipal trading is sound in principle is concerned. A glance through the 120 pages serves to confirm this view to a certain extent, and we hope those interested in the subject who have been pelted from other quarters with figures more or less accurate and often confusing will be refreshed by a study of Mr. Shaw's excellent little book.—"Testing of Electro-magnetic Machinery," by Bernard V. Swenson and Budd Frankenfield," vol. i. (London: McMillan and Co.) 12s. 6d. This is a very concise treatise on the subject with which it deals, and is intended as a college text-book and also as a work of reference for engineers. The present volume deals with direct-current electromagnetic machinery and apparatus, and is almost exclusively confined to dynamo-electric machinery. The second volume, which will conclude the treatise, will deal with alternating-current machinery and apparatus.—We have received from the Gresham Publishing Company vol. ii. of "Modern Electric Practice," by Mr. Magnus Maclean. Our readers will remember that this book is edited by Mr. Maclean and that he is assisted by 34 experts, each of whom is responsible for some particular subject. Thus the present volume consists of five different sections contributed by authors as follows: "Alternating-Current Motors," by M. B. Field and G. G. Braid; "Static Transformers and Rotary Converters," by A. F. Berry; "Electric Storage Batteries," by J. T. Niblett; "Switches and Switchgear," by W. E. Warrilow; and "Electric Mains," by J. C. A. Ward.—We have also received a copy of the sixth edition of the "Motor Manual," a little book which is exceeding useful as a guide to the practical side of all that concerns users of motor-bicycles or medium power motorcars. The price of this book is 1s., and it is published by the Temple Press, Limited.

**Street-Lighting Tests.**—We have received from Mr. J. W. Bradley, the city engineer of Westminster, his sixth quarterly report on tests of street lamps within his district. These reports have been mentioned before in our columns, but the figures obtained become more valuable as time goes on, because Mr. Bradley in each case gives the total average cost per candle-power per annum for all the tests up to date. For instance, the figures in the present report include averages for from 35 to 40 tests on each source of light. The average total cost per candle-power per annum, which includes interest and sinking fund charges as well as the cost of maintenance, now stands as follows for the various types of lamps used in Westminster. For the electric arcs supplied by the Charing Cross and Strand Company, which are equipped with opalescent globes, the cost is 11·49d. For the arcs supplied by the St. James's and Pall Mall Company, which are equipped with Muranese globes, the cost is 15·1d. The lowest cost of all is obtained by the arc lamps supplied by the Westminster Electric Supply Corporation, each giving on the average 605 c.p., for which the charge is £22 per annum for 3,940 hours burning. In this case the average total cost per candle-power per annum for the last 18 months comes out at 8·7d. With gas the best figure for cost is obtained with the Sugg's high-pressure lamps in Parliament-street, and the average of 35 tests is 9·85d. The nearest approach to this with ordinary incandescent mantles is 18·18d. for the gas-lamps used on the Carlton House terrace. In a footnote at the

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end of his report Mr. Bradley explains that all the tests were carried out under exactly similar conditions with the same photometer, and that precautions are taken to guard against the effect of extraneous light, reflection from buildings, or obstruction by any opaque object such as glazing bars. The tests are only carried out on clear nights. Mr. Bradley also calls attention to the fact that with incandescent gas burners the light obtained various enormously with the condition of the mantle. It is this which accounts for the great difference between tests carried out on these gas mantles in the laboratory and those made under actual lighting conditions. In other words, it explains the difference between estimates of comparative cost of electric and gas lighting made by gas experts on paper and the actual facts.

**The Edison Medal.**—The annual dinner of the American Institute of Electrical Engineers was this year made the official celebration of the twenty-fifth anniversary of the commercial undertaking by Mr. Edison of the incandescent lamp. The whole of the details of the proceedings were exceedingly well organised, and did great credit to the American Institute. Mr. B. J. Arnold, the president, was in the chair, and had to read a large number of congratulatory telegrams from all parts of the world. The toast of the evening was proposed by Mr. T. C. Martin, and his words were reproduced as follows: "The American Institute of Electrical Engineers is proud to embrace in its membership to-day the foremost inventors of the age and the greatest captains of industry, and has placed upon its golden tablets many an auspicious discovery and art to celebrate. But it surely could find no worthier hero among them and no better gift to mankind to signalise than the man and the lamp around both of whom we twine to-night the laurel wreaths of our admiration and our love. There should be encouragement in the founding of this medal to-night for every struggling, ambitious youth in America. Let us and let our sons recall and applaud the cheery little newsboy at Detroit; the half-shod, half-frozen operator seeking bravely a job along the icy pikes of the Central States; the gaunt, untutored experimenter in Boston, taking eagerly needed fees for lectures he was too modest to deliver; the embryonic inventor in New York, grubstaked by a famous Wall-street man for his first stock ticker; the deaf investigator at Menlo Park who wreaked unique retaliation on his affliction by preserving human speech for ever with his phonograph; the prolific patentee who kept the pathway to the Patent Office hot with his footsteps for nearly 40 years; the genius, our comrade, who took this little crystal bulb in his Promethean hand and with it helped to give to the world a glorious new light which never was before on land or sea—Thomas Alva Edison." The deed of gift of the Edison medal provides that it shall be awarded only to a student who has graduated, or received a degree, during the year at some institution in the United States of America, or in the Dominion of Canada, at which instruction in electrical engineering is given. The student must be not more than 25 years old. The medal is to be awarded to the student who sends in the best thesis or record of research on theoretical or applied electricity or magnetism.

**The Generation of Power.**—Before the Edinburgh Association of Science and Art recently, Prof. Hudson Beare lectured on the subject of the generation of power. At the outset he pointed out that 150 years ago our ancestors were practically dependent upon water power. During the last century, however, water power had practically been driven out of the field by steam; now, strangely enough, owing to the fact that the electrical engineer has given us the means of transporting power over considerable distances with only comparatively trifling losses, water power had once more asserted its true position, and was displacing steam power in many directions. Some of the schemes, such as that for the utilisation of the Zambesi Falls for the power required on the scattered goldfields of Rhodesia, and others of a similar nature, were still only in process of discussion and development, but we had on all hands abundant proof of the rapid growth of water-power generation. The one which had most appealed to the general public had been the Niagara Falls scheme, but there were, as a matter of fact, many others, almost as important, actually in operation. At Niagara it was contemplated eventually to develop 5,000,000 h.p., and the author commented on the remarkable increase in the size of the generating unit, instancing the case of Niagara, where units of 5,000 h.p. each were in operation. Discussing the question of the displacement of the reciprocating engine by the steam-turbine, the lecturer described some of the principal types of steam-turbines, such as the Parsons, the Curtis, and the Laval, and gave some statistics as to their present utilisation and future prospects. In conclusion, he said that he claimed that the engineer, to whom all this extraordinary development was due, had to be as highly trained and as highly educated as a member of any of the other learned professions, and that he must be something more. His scientific training must be as thorough and complete as that of a first-class medical man; he must be as capable as a highly trained barrister or solicitor in weighing and sifting evidence, for he frequently upon such evidence had to come to decisions which were irrevocable, and the safety of thousands of lives might depend upon the correctness of the judgment he had formed. He had, in addition, to possess the power of organising and controlling great bodies, often almost armies of workmen, and at the same time he must not neglect the smallest detail in his many schemes. This was a gift which was commonly said to be the one thing necessary to make a general into a successful commander of world-wide reputation.

**Single-Phase Railways.**—In view of the attention now being given to single-phase motors for electric traction purposes, it is interesting to hear of some contracts just awarded in Indiana for single-phase third-rail roads. The first contract is for the equipment of the Fort Wayne, Decatur, and Springfield road, extending from Fort Wayne, Ind., to Springfield, Ohio. On this road the Westinghouse single-phase motor equipment, with induction control, has been adopted, as it was not necessary to use existing direct-current trolley lines in any of the cities which are entered. The Indianapolis and Cincinnati Traction Company, which is constructing a high-speed line between Indianapolis and Connersville, Ind., has given out a contract for the equipment of 53 miles of road with the Westinghouse single-phase alternating-current railway system. This is to be a high-speed line, largely on private right of way, going ultimately to Hamilton, Ohio, and thus making it possible to give high-speed electric service between Indianapolis and Cincinnati. On this latter line a third-rail system with direct current had been decided upon before the single-phase system had come to the front. The opportunity for saving in first cost and in operation induced the consulting engineers of the line to reconsider their plans. They had two 500-kw., three-phase, 23-cycle, 230-volt generators on order, and were going to distribute from these to rotary converter sub-stations. Under the new arrangements the power station equipment, as regards generating machinery, will remain unchanged. The step-up transformers, which will raise the voltage to 16,500 for transmission, will be connected on the Scott system, so as to give two-phase current on the high-tension line. There will be six static transformer sub-stations, one-

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half of which will be connected on one phase, and the other half on the other phase. The transformers in these sub-stations will give 3,300 volts on their secondary terminals, which will be the trolley line voltage. This voltage will be reduced by a transformer on each car. The first contract calls for 10 cars, each equipped with four 75-h p. motors, with gearing which will give a maximum speed on a level of 42 miles per hour. These cars are intended for local service. The sub-stations will be approximately 10 miles apart. The trolley wire will be No. 000 copper. There will be no feeders supplementary to the trolley wire. The consulting engineers estimate that in the equipment of the entire ultimate road of 93 miles from Indianapolis to Hamilton a saving over the former direct-current plans of £100,000 will be effected in first cost. In the event of the new system not being a success the bulk of the apparatus can still be used for a direct-current system. Even the motors are said to be suitable for both systems, and it would simply mean the addition of rotary converter plant and of additional low-tension feeders.

**Radium.**—The *Physical Review*, which is the organ of the American Physical Society, publishes in its issue of Feb. 2 interesting condensations of papers read by Prof. E Rutherford before the meeting of the society held on Dec. 30. The first deals with the question as to whether the radioactivity of radium depends upon its concentration. The author determined by the electrical method first the intensity of the radiation from a known quantity of radium in the form of pure solid radium bromide in a state of radioactive equilibrium, and, secondly, when dissolved in a solution as radium chloride of more than a thousand times the volume of the solid radium bromide. No appreciable difference in the intensity of the $\gamma$ rays was observed in the two cases, although the experiments were continued over a month's interval. Since the intensity of the $\gamma$ rays serves as a comparative measure of the radioactivity of radium, it may be concluded that, over the range examined, the radioactivity of radium is independent of its concentration. This result shows that the rate of disintegration of radium and its products is not appreciably altered by the bombardment of its own powerful radiations, and renders it probable that the radioactivity of radium is in all cases directly proportional to the amount of that element present. The other paper was on the heating effect of the radium emanation, and Mr. H. T. Barnes was associated with Prof. Rutherford in reading the same. The results of a considerable investigation show that the heat emission of radium is an accompaniment of the expulsion of $\alpha$ particles, and that the time variation of the heating effect of each of the different active products is the same as the time variation of the activity measured by the $\alpha$ rays. The heat emission of radium is probably due in part to the kinetic energy of the expelled $\alpha$ particles, and in part to the energy released consequent upon the rearrangement of the components of the systems left behind after the expulsion of the $\alpha$ particle. It was deduced that the emanation, released from 1 grm. of radium, gave out an amount of heat during its life corresponding to about 10,000 gramme-calories. It has been show that the volume of the emanation released from 1 grm. of radium probably lies between $6 \times 10^{-4}$ cubic centimetres and $6 \times 10^{-5}$ cubic centimetres at standard pressure and temperature. Assuming the density of the emanation to be about 100 times that of hydrogen, 1 grm. of the emanation would during its life radiate an amount of energy lying between $2 \times 10^{9}$ and $2 \times 10^{10}$ gramme-calories. One-pound weight of the emanation would initially radiate energy at the rate of $10^{4}$ to $10^{5}$ horse-power, and would emit during its life an amount of energy between $6 \times 10^{4}$ and $6 \times 10^{5}$ horse-power days. There can thus be no doubt that matter, under special conditions, is capable of emitting an amount of energy enormous compared with that released in the most intense chemical reactions. On the disintegration hypothesis this energy is derived from the energy latent in the radium atoms and is released during the successive stages of their disintegration.

**The London Traffic Commission.**—Since our last issue evidence has been given before the London Traffic Commission on the London traffic by Mr. Behr, the expert in mono-rail work. In the course of his evidence he gave figures as to the comparative cost of tubes and of mono-rail lines carried overhead. He put the capital outlay for the tubes in London at between £600,000 and £850,000 per mile, whereas the overhead mono-railways could be constructed for £100,000 per mile. Mr. Behr gave particulars of various lines he had designed in and round London, but with the exception of one from the Houses of Parliament to the Putney Bridge railway station, along the Chelsea Embankment, they were not in touch with the most congested areas. This latter line he considered could be built for £25,000 per mile, and that it would not spoil the appearance of the embankment. Mr. Francis Fox, the next witness, spoke in favour of shallow tunnels or subways under new or very wide streets, but he considered that the construction of them under the existing streets in the Metropolis would be fraught with very great danger to adjacent property, as they would be, generally speaking, in a bed of gravel and sand. At a subsequent meeting of the Commission Mr. J. F. S. Gooday, the general manager of the Great Eastern Railway, gave evidence as to the steps taken by his company to deal with increase in traffic. They had increased the width of their carriages so as to give 21 per cent. additional carrying capacity, and had now decided to lengthen the platforms so as to permit of 17-coach trains replacing those with 15 coaches. The seating capacity of their trains, which was now between 768 and 852, would be increased 15 per cent. by this latter alteration. Sir Henry Oakley, the chairman of the Central London Railway, gave figures as to the work done on that line. They carried last year between 120,000 and 130,000 passengers a day, with 338 trains in each direction. It would appear that the seating capacity of the trains was 350. In the year 1903 the traffic earnings per train mile amounted to 5 5d. and the expenses to 2 11d. per train mile. The experience of the Central London Railway showed an approximate regularity or continuance of the demand during the day, and was evidence of the convenience afforded by the railway to the workers in London. In his opinion, to relieve the congestion of the Strand, Piccadilly, etc., the completion of a circular railway without junctions was urgently necessary, and would enable a continuous service of trains, each train capable of seating about 350 passengers, to be run in each direction every two or three minutes, besides affording the best possible east and west service attainable. Exchange facilities could be provided at Liverpool-street, Broad-street, Mansion House, Ludgate-hill, Law Courts (with G.N. and Strand Station), Charing Cross, Piccadilly-circus, Hyde Park-corner (with proposed Marble Arch and Clapham Railway), High-street, Kensington, Addison-road, and Hammersmith Stations on the south side; and on the north side at Shepherd's Bush (with G.W. and L. and N.W. joint station at Uxbridge-road), Marble Arch (with proposed North-West London line), Oxford-circus (with Baker-street and Waterloo), Tottenham Court-road (with Charing Cross, Euston, and Hampstead), and British Museum (with G.N. and Strand) Stations. At the Bank, in addition to the present facilities, an exchange could probably be effected with the proposed Lothbury Station of the Great Northern and City line.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A M.I.C.E., ETC.

*(Continued from page 327.)*

### II.—Induction Systems.

Induction systems depend for their success on the fact that a current is induced in a coil or circuit when the current in a neighbouring coil or circuit is started, stopped, or varied. Faraday in 1831 discovered that currents are *induced* in a closed circuit by moving magnets near the circuit or by changing the strength of the current in another circuit near the first. Let the first be called the primary, and the latter the secondary circuit. Then a momentary inverse current is induced in the secondary, when the current in the primary is approaching, beginning, or increasing in strength; and a momentary *direct* current is induced in the secondary circuit whilst the current in primary is receding, ending, or decreasing in strength. In fact, a decrease in the number of imaginary lines of force passing through a circuit produces a *direct*, and increase in the number of lines of force produces an *inverse*, current in the circuit, the total E.M.F. induced being equal to the rate of change in the number of lines of force through the circuit. Faraday thus laid the foundation of all modern progress in dynamo construction and application.

Fig. 9.—Apparatus for Preventing Collisions at Sea, referred to at page 327.

Sir W. Preece made many experiments on signalling without connecting wires, taking advantage of these laws. He used apparatus differing but little in main features from the earlier systems, but with the following important additions and improvements. By means of a revolving contact breaker the current at the sending station was interrupted rapidly—thus a discontinuous current of high frequency was obtained. He used a telephone in the receiving circuit instead of a galvanometer or relay, and long and short "dot-and-dash" signals on the Morse code were transmitted. In this case probably leakage currents play an important part, but induction has, at any rate, *something* to do with the result. He also used a microphone, which in its elementary form consists of a pencil of carbon supported loosely between two blocks of carbon fixed on a sounding board of thin pine, the blocks being connected with the collecting wire or line and a telephone. The microphone serves to magnify very minute sounds, and is the invention of Prof. Hughes (1878). When the microphone was used, conversation was conducted over considerable distances. On one occasion at least insulated copper wires were laid in squares and used so as to preclude the use of earth currents, and signals were transmitted inductively over a distance of a quarter of a mile.

An elementary induction arrangement consists of two coils of insulated wire (Fig. 10), one with a battery, dynamo, or other source of current in it, also a contact breaker or interrupter if the current be continuous; the other coil may be at a considerable distance away, should be parallel to the first, and should contain a telephone or other suitable receiver. The interruptions or renewals of current in the first (or primary) coil will give rise to a varying magnetic field round that circuit, which will induce secondary currents in the second coil, these affecting the telephone or other receiver.

Sir Oliver Lodge, who has been the most persistent and successful English experimenter in connection with etheric and induction signalling, described in 1898 some of his work in connection with a system of electromagnetic induction telegraphy. Some of his patents of about that date are very suggestive, and well worth careful study.

In a transformer the alternating current in the primary circuit induces currents of higher E.M.F. in the secondary circuit. In this case the circuits are packed closely together. In telegraphy the two circuits are placed as far apart as possible. In one of Dr. Lodge's experiments he used a coil passing right round his college at Liverpool, having a controllable alternating current circulating in it. A similar coil was placed some distance off and connected to a magnifying telephone and to a condenser of such capacity as to make the period of the circuit synchronise with that of the transmitting circuit. In the magnifying telephone the coil was the moving part instead of an iron diaphragm as in the ordinary telephone, the coil being suspended over the telephone magnet on the end of a tuning fork, which was carefully

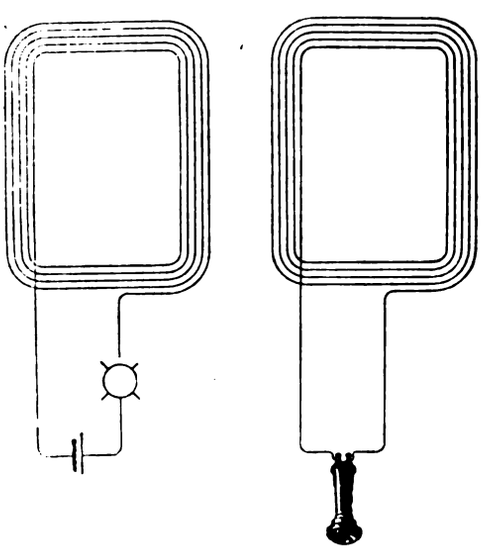

Fig. 10. An Elementary Induction System. This comprises two coils of insulated wire, one with a battery, and a circuit breaker, if the currents are not alternating.

tuned to the same period or frequency as the current. On one prong of the tuning fork a single-carbon microphone was attached, and this was connected to a second and exactly similar telephone with a battery in circuit. This again was connected to a third, and so on, the vibrations becoming stronger at each step. In this way very feeble vibrations, which would not excite the ordinary ear, were increased till they were audible at some distance. In using a system of this kind, or, indeed, any wireless system, a call bell or alarm actuated by the vibrations sent from the distant station is valuable. Mr. Evershed's call relay is an important auxiliary where telephones are employed, and will be described later.

*Dr. Lodge's Induction Experiments* (1898).*—In 1898 Dr. Lodge read a paper before the Institution of Electrical Engineers describing at length his "magnetic induction" method of signalling. The system depends on electric "resonance." It had already been shown that two similar Leyden jars in similar circuits may be "syntonised," or tuned, so that one responds to electric oscillations in the other, the lines of force of the one circuit crossing the other and by their fluctuations producing in the second an alternating E.M.F. The Leyden jar in the distant circuit may, for practical telegraphy, be replaced by a condenser of greater capacity, the circuit being in each case a large horizontal coil of wire; thus the frequency of the electric impulses may be reduced to that of sound. Instead of a coherer to detect the induced vibrations, an ordinary

* *Proc.* I.E.E., vol. xxvii. (Fig. 11), copied by permission of the Council of the Institution.

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telephone receiver may be used as a shunt to the condenser circuit. An alternating or intermittent current of considerable power may be employed—in fact, Dr. Lodge used a Pyke and Harris low-frequency alternator to give the current. The cable or horizontal coil used was about ¼ mile long, and enclosed a rectangular area of 150 × 30 square yards. When a condenser of 28 microfarads capacity was used with the thick wire of a hedgehog transformer in circuit the induced frequency was as low as 384, and gave rise to a pleasant note in the telephone. The sounds could be heard over 100 miles away, even in Cheshire towards the Dee, from Liverpool (the sending station) in the ordinary National Telephone Company's telephones. When, however, a condenser was employed, and the sending and receiving circuits were *properly tuned*, the signals were not audible to outsiders more than two miles away. The importance of *tuning* was thus forcibly shown, as well as the great possibilities of, and some of the difficulties connected with, induction telegraphy and telephony. Several of Dr. Lodge's arrangements of apparatus are shown on another page, and in passing something may be said as to the uses of the words "induction" and "conduction" in this connection. Experiment can answer, in some cases at least, the question as to the relative part played by induction and conduction in a given case. In one experiment Mr. Gavey stretched an insulated wire between two boats at sea, dipping the ends of the wire into the sea. Signals were sent from the land—from a similar wire—and could be heard distinctly in the wire when it was above water, but not when it was below water, showing that *induction* was the chief factor in this case. However, conduction probably plays some part in most of these experiments, where no special arrangement is made to

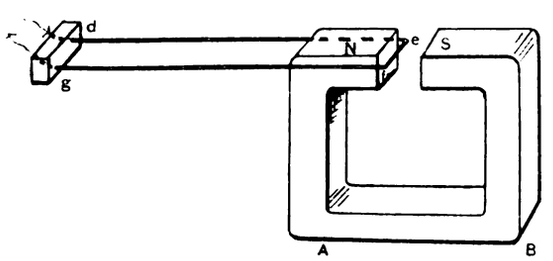


FIG. 11.—Evershed's Call Relay.

eliminate this part altogether. At the time of the reading of Dr. Lodge's paper signalling was regularly carried on by the Post Office authorities between Lavernock Point and Flat Holm, across 3·3 miles of water, Mr. Evershed's call relay being invented to get over the call difficulty.

*Mr. Evershed's Call Relay.*—Mr. Evershed found that an indicator working at a lower frequency than that necessary for telephonic receivers was a necessity. In principle his call apparatus (Fig. 11) illustrates what all vibratory indicators for minute alternating currents must more or less conform to. It consists of a rectangular loop of fine wire, *d*, *e*, *f*, *g*, fixed in an insulating block in such a position as to allow its end, *e*, *f*, to move freely in the air-gap between the poles, N, S, of a magnet, A, B. When the rectangle is traversed by an alternating electric current, the loop vibrates up and down about the fixed end, *g*, *d*, and if the rectangle be tuned so that its free period of vibration is the same as that of the current, it becomes a very sensitive alternate-current indicator or voltmeter, the amplitude of the vibrations being proportional to the impressed E.M F. at the terminals of the rectangle. In fact, it forms a simple alternate-current synchronous motor. A fixed contact screw may be placed adjacent to the free end of the rectangle, so that a local circuit may be closed whenever the vibrations become sufficiently great. Or a better method is to have *two* rectangles connected to separate secondary circuits in such a way that they oscillate in opposite phase. If the two rectangles be made the poles of a local circuit, they act as a relay in coming into contact with each other. Hence the term "relay" as applied to the instrument. Two instruments of this kind were made by Mr. Evershed and used in 1896. Later on (1898) they were used with perfect success by the Post Office authorities in the experiments between Lavernock and Flat Holm already referred to. They were used as relays for closing the call-bell circuit, the primary current being derived from a small alternator with a heavy flywheel, which was driven by hand to a speed above the synchronising frequency, the exciting current was switched on, and the alternator allowed to gradually come to rest, thus passing through the synchronising speed, so that the two rectangles of the distant relay had time to act. The rectangle (at 16 periods per second) gave a visible indication with about one five-hundredth of the power required for a telephone of frequency 400 per second.

*Telephonic Difficulties—Important Experiments.*—Induction systems have, however, special difficulties to contend with as the following experiment shows: An attempt was made by Mr. Preece some years ago to communicate, by induction mainly, between England and Ireland. A circuit was made up from Carlisle to Haverfordwest, in England, and another from Belfast to Wexford, in Ireland. The whole telegraphic system of the country was stopped from midnight to 2 a.m. on one Sunday morning in June, 1895. Attempts were made to signal, but it was impossible to distinguish the signals on account of the strange incessant babel of sounds which filled the telephone receiver. The hum of two or three alternate-current lighting stations was clearly distinguishable, but the strange medley of weird noises due, it may be, to electrical effects outside the earth prevented the experiment from succeeding. The difficulty is not confined to induction methods, for Dr. Lodge* has recently observed in experiments on wireless telegraphy, where a sensitive telephone receiver was connected in a low-resistance circuit, the ends of which dipped into the sea, and ordinary inductive influences were inoperative, that certain earth-current disturbances were strongly in evidence. These have been classified into noises like (*a*) uniform flowing or rushing water; (*b*) intermittent crackling; (*c*) bubbling and boiling water; (*d*) rocket-like disturbances; (*e*) high-frequency disturbances, not detectable by the telephone, but appreciable by the coherer. The rocket-like disturbances are like a shrill whistle dying away in pitch. They may be due to meteorites, which, rushing through the atmosphere, produce electrical disturbances which diminish in frequency as the velocity of the meteorite increases. They are observed more at night than during the day, not because meteorites are more plentiful at night, but because the highly ionised air in daytime screens the effect, by absorption, from the telephone receiver.

*(To be continued.)*

## TYPES OF DIRECT-CURRENT LOW-TENSION SWITCHGEARS.

BY W. E. WARRILOW

The instalment of continuous-current plant has been carried out to a wide extent in this country, and although there seems a prospect of the generation of electricity being confined to high-tension stations in the future, there will still be a need for the employment of direct current. It is interesting to note that while progression and improvement in the alternate-current field of electric supply has been very rapid, tending towards the production of almost perfect types of machinery, the advances in the direction of low-tension work have been less marked. This fact is chiefly traceable to the limits imposed on this particular system of supply, and the circumstance that only congested and comparatively small areas can be successfully dealt with by it. At the present time there are in operation a large number of generating plants delivering energy to tramway systems and tube railways, but it is highly probable that in the near future such stations will be replaced by power-houses equipped with polyphase plant. However, the production of direct current, whether by steam-engines or from rotary converters, demands much the same type of controlling apparatus. In considering the design of low-tension switchgears, a glance into the past indicates that many of the older forms were of a seemingly temporary character, the principles underlying the successful opening of circuits carrying heavy currents being little understood.

* *Proceedings* Royal Society, Jan. 22, 1903.

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As with alternating-current switchboards, so with their direct-current brethren, a wider experience, teaching ofttimes many severe lessons, has brought the engineer's attention to bear on the more efficient design of the controlling apparatus. This state of affairs is to be observed in the development of any commercial article, but the teaching of experiment has been found particularly essential in the evolution of many sections of the electrical industry.

Reverting now to the design of direct-current switchgear proper, the great majority of boards on the market are usually made up of a number of slate or marble slabs mounted in a light steel framework and fitted with the necessary switches, circuit breakers, and instruments. Such boards have an operating face, whereon all the parts requiring attention from the switchboard are mounted, and a back, allotted to the terminal studs, cable connections, and 'bus bars, for the distribution of the energy to the various sections of the gear. Although the framework of these gears is generally similar in design, the manner of assembly differs considerably, as does also the arrangement of the fittings making up the controlling apparatus. In fact, it is difficult to realise how, with such a form of construction, any standardisation could be possible. A similar divergence of opinion is to be found among manufacturers as to the connections of the boards, though one finds that in many cases they are more or less guided by the specifications issued from the offices of consulting engineers. This latter point is ofttimes a sore one, as consultants are apt to be very arbitrary in their demands, and do not in any way bring their views into line with those of the manufacturer, who naturally has to standardise wherever possible. The frictional difficulties thus occasioned will no doubt be settled as time goes on, but it would seem that the best solution of the problem would be found in the giving of *carte blanche* to the maker. In the present article it is, however, not intended to deal with the subject of the connections of the various types of direct-current boards, but rather to illustrate the different methods of assembly adopted by manufacturers of this class of apparatus.

Compared with a single-phase alternating-current gear, the connections of a direct-current board are much more complicated and require greater care in their arrangement, especially with boards in which all couplings are behind slate or marble slabs. When copper strip is employed for coupling the various fittings on the panels a much neater job can be made than with cable connections, but in both cases it is still a difficult matter to bring the outside cables successfully to their respective terminals. A glance behind a number of boards sometimes reveals a tangled mass of copper strip and insulated cables, which strongly resemble the scrap heap of a cable stores. It is painful to contemplate the effect of a fire among these connections, and although such occurrences are becoming less frequent, there are still great risks run if some definite method of assembly is not resorted to. The indiscriminate mixing of feeder and generator cables at the back of the board is to be strongly condemned, as highly conducive to mistakes in disconnection and the possibility of shock when working behind the gear. Fortunately the pressures controlled are not generally dangerous to life, though there are instances of accident in which the victim might well have chosen electrocution to the fearful burns he has received.

The comparative safety with which low-pressure currents can be handled has tended to delay the adoption of a form of board having all connections and operating portions on one working face. The adoption of this gear for high-pressure working soon became a necessity in that particular section of the electrical industry, as the board with high-pressure connections at its back soon proved to be a death trap for even the most experienced men. With low-tension currents, however, the case has been entirely different, and as long as accidents have been confined to burns or slight shocks, little or no attention has been paid to them, nor has it been thought advisable to radically alter the design of the board. The raising of pressures to 600 or 700 volts has, however, done much to discover faults in the old design of board, and it is interesting to note that steps have been taken by the makers of gears with but one working face (originally used for high-pressure purposes only) to adapt these designs for the control of the medium voltages.

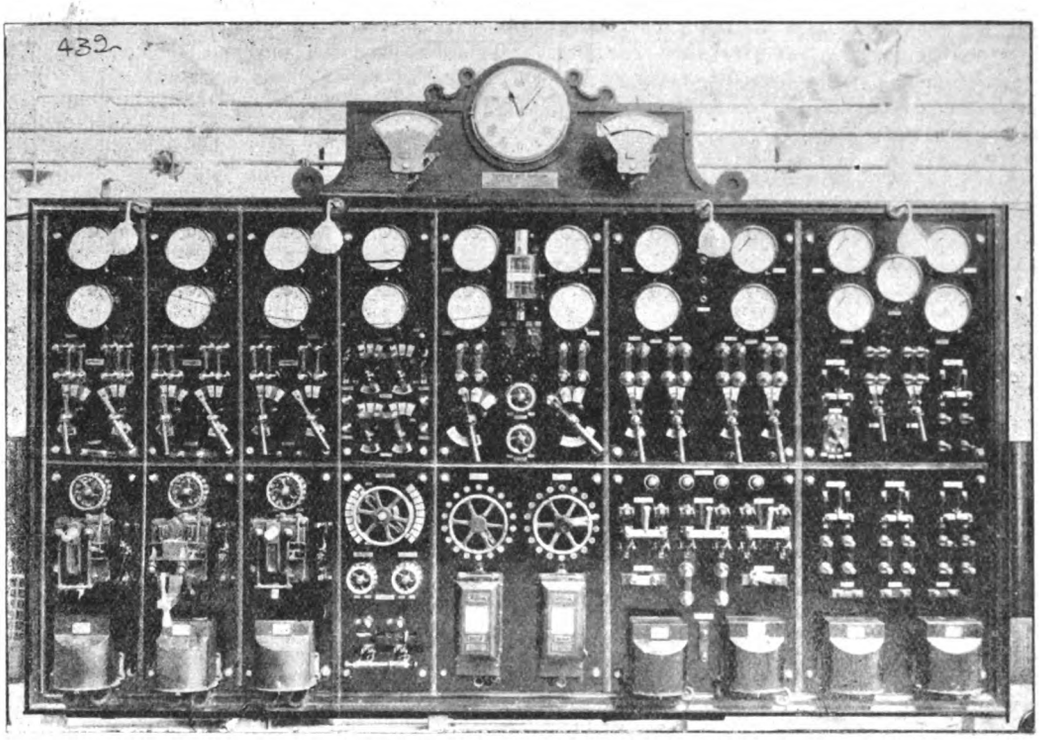

FIG. 1.—Three-Wire Switchboard (Crompton).

In spite of this fact, the general opinion of engineers is in favour of a board having two working faces, and as this type can be constructed comparatively cheaply in competition with its cellular opponent, it is likely to maintain its hold for some time to come. One of the first steps towards the introduction of the wall surface design of gear will be the classification of switchboards on a similar basis to that employed in the consideration of generating units; the space occupied per unit controlled will be the chief feature in the design of the switching apparatus, and gears of a straggly nature will necessarily fall into disuse. It is not a difficult matter to realise that future power plants will occupy much less space than they do at present, and if this reduction continues in anything like the same degree, it will be absolutely necessary to restrict the wall area allotted to the controlling apparatus. With extra high pressures it is not a very hard matter to adopt some system

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of distance control, but the different conditions to be met by direct-current plants would probably veto any such plan being carried out for controlling low-tension power. Under these circumstances it would appear that the present scattered design of low-pressure boards is likely to develop

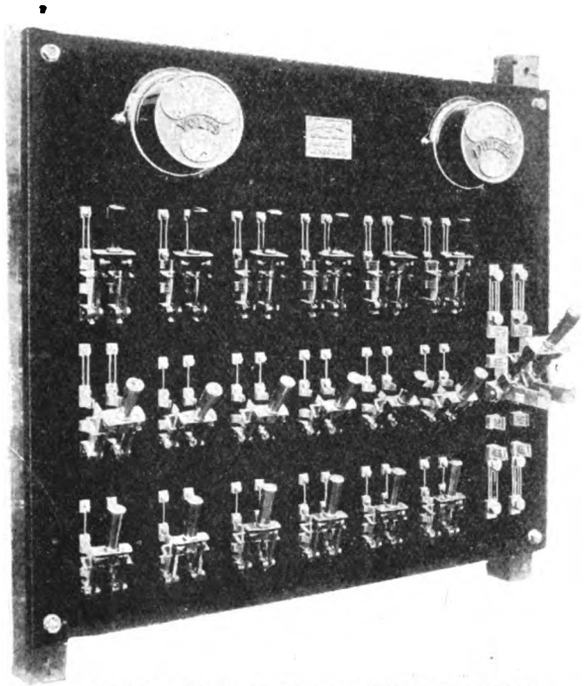

FIG. 2.—Small Board for Heavier Currents (Johnson and Phillips).

into the preferably more concentrated form with every corresponding advantage.

The following examples will serve to illustrate the manner in which the problem has been dealt with up to the present time, and a comparison of the examples quoted will no doubt give rise to some speculation as to the probable future type of direct-current gear. It would be impossible in the space at disposal to deal with every form of low-tension board, as so many different kinds are installed, and for such a variety of purposes. Certain standards have, however, become more or less adopted for two and three wire boards, traction and lighting boards (both combined and independent), and battery boards for operation in conjunction with Highfield or other boosting appliances.

Fig. 1 represents a switchgear constructed for three-wire distribution, and suitable for controlling three generators, one booster and balancer, one battery, and two feeders. A wrought-iron skeleton framework supports the 1½in. enamelled slates upon which all instruments, switches, wattmeters, and rheostats are mounted. A substantial polished teak beading surrounds the board, and strips of the same material cover the spaces between the panels, and thus give

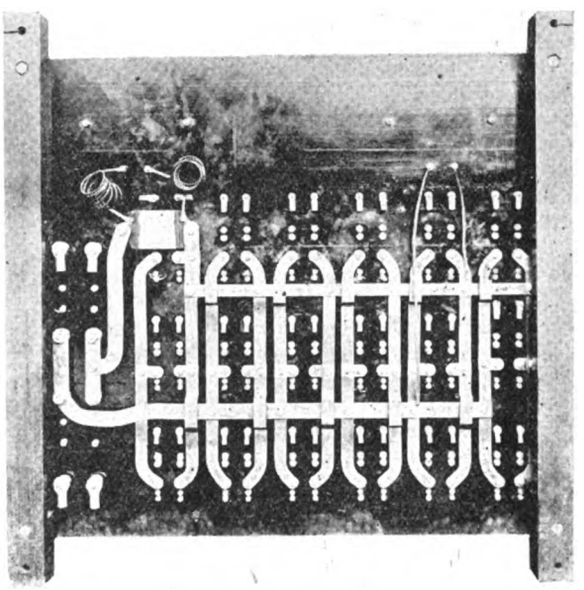

FIG. 3.—Back of Board shown in Fig. 2.

the board an elegant and well-finished appearance. The generator panels, to the left of the illustration, are each fitted with (starting from the bottom) a recording wattmeter, a reverse-current cut-out, field-breaking switch, and shunt regulator; also duplex fuses on each pole, an ammeter, and a paralleling voltmeter. Next on the right, at the bottom half of the panel, the apparatus for the balancer is fitted, comprising a double-pole starter, a minimum current automatic switch, a double-pole fuse, and two shunt-regulating rheostats. Directly above this, on a slate base of the same width, is the booster panel, fitted with two-way change-over switches, field-breaking switches, and shunt regulators

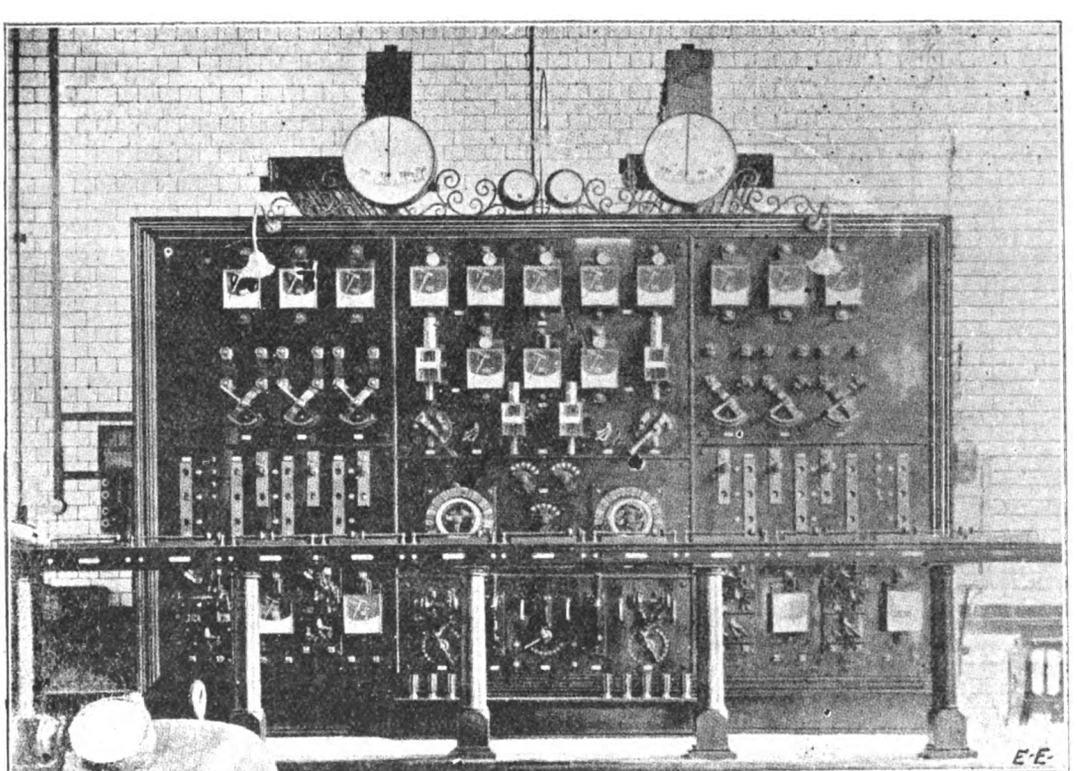

FIG. 4.—Three-Wire Board for Small Electricity Works (Johnson and Phillips).

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(placed for convenience' sake on the battery panel), while at the top of the panel the balancer ammeters are fitted. The centre of the board is devoted to the battery control, and the lower section of this panel contains the charge and discharge meters and the hand-wheels for operating the regulating switches. These latter are placed behind the board, and form part of the wall of the battery-room, thus reducing the length of cable from the cells to the switches. An indicator at the front of the board shows the exact number of cells in circuit, and an electric alarm is automatically put into action when the brushes have been left bridging over two contacts. The upper section of the slab is fitted with charge and discharge ammeters and voltmeters for reading the pressure of the battery alone, or of the dynamo and booster in series. Multi-contact switches are also fitted for placing the battery directly on the 'bus bars, or for coupling the cells in series, independent of the mid wire, when charging. The panels on the extreme right are allotted to main feeders and subsidiary circuits, the instruments and fittings in this case comprising chiefly double-pole switches and duplex fuses, also ammeters and wattmeters. The panel on the extreme right is provided with an ammeter switch, so arranged as to enable the current on four motor circuits to be read separately on one instrument. A board of this design controls only very small currents, consequently there is not much fear of accident in its operation, especially as the voltage does not exceed 200. Cable and strip connections are used for coupling up the different portions of the board.

Fig. 2 represents a type of gear for dealing with heavier currents, and consists of a main change-over switch feeding a set of 'bus bars supplying a number of double-pole switches. A back view of this gear is shown by Fig. 3, and the neat manner in which the strip connections have been fixed and placed will be at once evident. A board of this description can be bolted a few inches from the wall, provided sufficient length of cable is left at the back to permit of the slate slab being lifted forward for examination purposes. Fig. 4 represents a typical three-wire, low-tension board commonly employed in small electricity works. It has been arranged in three sections: the left-hand section has all apparatus in the positive pole mounted on it, the middle portion is for the middle wire, and the right-hand section accommodates fittings in the negative pole. The dynamo panels, which are arranged positive and negative on each side of the gear, are fitted with ammeters, switches, and automatic attachments, through all of which current passes to four sets of 'bus bars, mounted horizontally at the back of the board. On the front of each slab a number of vertical strips are fitted and drilled with holes to register with corresponding holes in the horizontal bars behind the board. The insertion of a screw plug into these holes couples a dynamo to a circuit or battery, as the case may be.

*(To be continued.)*

## DESIGN OF CHOKING COILS FOR ALTERNATING-CURRENT CIRCUITS.

BY J. M. R.

Impedance or choking coils are coils having low ohmic resistance and high self-induction. They are formed by winding a coil of copper wire round an iron core, preferably laminated; and their chief use is to absorb some of the pressure between constant-potential alternating-current mains, when it is desired to place between the mains any apparatus which requires a voltage less than that between the mains. Of course, a very obvious means of reducing the voltage would be to place a resistance in series with the apparatus, such that the surplus voltage would be required to drive the current against the resistance, leaving the necessary voltage for the apparatus This, however, is an extremely wasteful device. Say, for example, an arc lamp required a current of 15 amperes at a pressure of 35 volts, and that the main supply was 110 volts. A resistance of five ohms placed in series would absorb 75 volts, leaving the necessary 35 volts for the lamp. But the power wasted in the resistance would be 1,125 watts, whereas the lamp would only use 525 watts. If, as is often the case, the consumer is charged so much per ampere-hour, this waste energy would not affect him, but if, on the other hand, he is charged per kilowatt-hour, he has to pay for this waste. With continuous-current mains, of course, there is no simple alternative, but with an alternating supply the reduced voltage may be obtained by means of a choking coil.

Before commencing the design of a choking coil, we will consider a few elementary principles and formulæ used in connection with "chokers." If a closed circuit carries a current $c$, the number of lines of force of self-induction is $L\,c$. But if $d\,N$ lines of force are cut in an indefinitely small time, $d\,t$, then the induced E.M.F. is given by

$$e = -\frac{d\,N}{d\,t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(The negative sign is prefixed because the E.M F. is always induced in such a direction as to oppose the cause which produces it.) Then, if L is constant,

$$e = -L\frac{d\,c}{d\,t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If the resistance of the circuit is R, then the applied E.M.F. must balance the E M.F. of self-induction by providing a component equal to $+L\frac{d\,c}{d\,t}$, and also drive current through the resistance. Hence,

$$e = L\frac{d\,c}{d\,t} + R\,C \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This equation is only applicable at the instant when the current has a value C. In an alternating-current circuit

$$e = E \sin p\,t,$$

where $p = 2\,\pi\,n$, $n$ being the frequency. The reason for this is because during each revolution of a coil in a magnetic field the E.M.F. rises from zero value to a positive maximum, then passes through the zero value and becomes negative, attaining a negative maximum numerically equal to its positive one, and then returns to the zero value again.

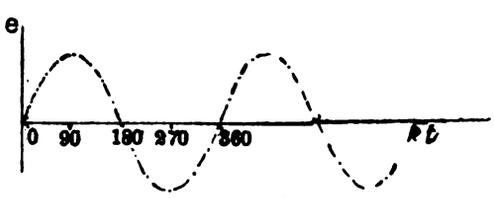


FIG. 1.

A graphic representation of the above formula is given in Fig. 1. Hence we get that the applied E.M.F.

$$E \sin p\,t = L\frac{d\,c}{d\,t} + R\,C \quad . \quad . \quad . \quad . \quad (4)$$

Solving by means of the integral calculus we get*

$$C = \frac{E \sin (p\,t - \theta)}{\sqrt{R^2 + p^2\,L^2}} + A\,\epsilon^{-\frac{r\,t}{L}} \quad . \quad . \quad . \quad (5)$$

where $\theta$ is such that $\tan\theta = \frac{p\,L}{R}$. $\epsilon$ is the base of the Naperian logarithms and A is a constant. $\epsilon^{-\frac{r\,t}{L}}$ becomes negligibly small after a short time, and may be omitted. Writing K for $\frac{E}{\sqrt{R^2 + p^2\,L^2}}$ the equation becomes

$$C = K \sin (p\,t - \theta) \quad . \quad . \quad . \quad . \quad (6)$$

We see from equation (4) that when $t$ is zero, the E.M.F. is also zero, and equation (6) shows that the current is zero where $t = \frac{\theta}{p}$. Hence the current lags behind the E.M.F. an amount of $\frac{\theta}{p}$. The E.M.F. of self-induction is

$$-L\frac{d\,c}{d\,t} = -p\,L\,C\cos(p\,t - \theta) = p\,L\,C\sin\left(p\,t - \theta - \frac{\pi}{2}\right)$$

which shows that the E.M.F. of self-induction lags behind

* Rhodes, "Treatise on Alternating Currents."

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the current by an amount $t = \frac{\pi}{2p}$. Since the periodic time T is $\frac{2\pi}{p}$, the lag $\frac{t}{T} = \frac{\pi \times p}{2\pi \times 2p} = \frac{1}{4}$ of a period, or 90deg. Therefore, the E.M.F. of self-induction lags behind the current by a quarter of a period.

When considering choking coils, there are two cases for consideration: (1) that in which the apparatus is non-inductive; and (2) that in which it is inductive. Let us consider for a moment that the apparatus to be worked is non-inductive, in which case the pressure, $V_1$, and current, C, required for working the apparatus will be in phase. Then, assuming the resistance of the choking coil is negligible, the current lags 90deg. behind the E.M.F. between its terminals. In alternating-current circuits root mean square values are measured, the reason being that the average value of a periodic current is zero, and, therefore, any instrument in which the deflection is proportional to the current would show no deflection. Any instrument, however, in which the deflection is always in the same direction measures the mean square of the periodic quantity, and, therefore, root mean square (R.M.S.) values are obtained, and in the case of currents and E.M.F.'s are equal to the maximum values divided by $\sqrt{2}$.

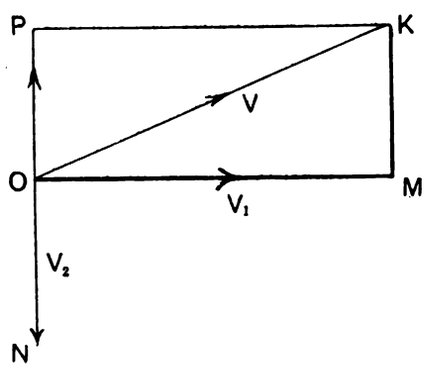


FIG. 2.

Let V be the R.M.S. voltage of supply, and $V_2$ the pressure between the terminals of the choking coil, and $V_1$ and C, as already stated, the pressure and current required for working the apparatus. Representing these pressures vectorially, as shown in Fig. 2, we see that V has to supply a component, O M, to drive the current against the resistance of the non-inductive apparatus under consideration, and another component, O P, to balance the E.M.F. of self-induction of the coil. Therefore V, the voltage of supply, is represented by the vector O K.

Therefore $V^2 = V_1^2 + V_2^2$, or $V_2 = \sqrt{V^2 - V_1^2}$.

But where L is the self-induction of the choking coil, and $p = 2\pi n$, where $n$ is the frequency of supply,

$V_2 = p\,L\,C$. $\therefore p\,L\,C = \sqrt{V^2 - V_1^2}$, whence $L = \frac{1}{p\,C}\sqrt{V^2 - V_1^2}$

where C is the R.M.S. value in amperes, which gives the value of the self-induction of the choking coil necessary for the purpose.

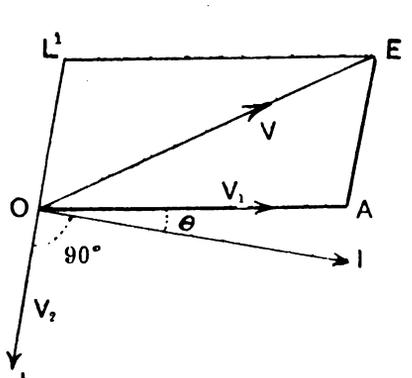


FIG. 3.

*If the apparatus is inductive*, the self-induction of the coil is slightly different. We must take into consideration the resistance of the apparatus, $R_1$, and its self-induction, $L_1$. The current, C, lags behind $V_1$ by an angle $\theta$, as already explained, where $\tan\theta = \frac{p\,L_1}{R_1}$.

In Fig. 3, let O A represent $V_1$ and O I represent C, where the angle I O A = $\theta$. O L, then, must be 90deg. behind O I, as it represents the E.M.F. of self-induction. As before, the voltage of supply, V, must balance the two components, O A, to work the apparatus and O L to balance the self-induction of the choking coil, and is, therefore, vectorially represented by O E.

Now since $A\,O\,L_1 = \left(\frac{\pi}{2} - \theta\right)$

$$V^2 = V_2^2 + V_1^2 + 2\,V_1\,V_2 \cos\left(\frac{\pi}{2} - \theta\right)$$

$$= V_2^2 + V_1^2 + 2\,V_1\,V_2 \sin\theta.$$

Hence $V_2 = \sqrt{V^2 - V_1^2 \cos^2\theta} - V_1 \sin\theta$.

Therefore, as before,

$$L = \frac{1}{p\,C}\{\sqrt{V^2 - V_1^2\cos^2\theta} - V_1 \sin\theta\}.$$

The value of $\theta$ will usually be known for any particular class of apparatus, such as induction motors, and then L becomes determinate.

Having determined the value of L, the principles upon which a choking coil is designed are as follows: Let N be the number of turns of wire on the coil, and F sin $p\,t$ the flux of magnetic lines through the iron core at time $t$. The total flux is then N F sin $p\,t$. Since the E.M.F. generated when $d\,N$ lines of force are cut in an infinitely small time, $d\,t$ is given by

$$e = \frac{d\,N}{d\,t},$$

in this case the E.M.F. produced by the variation of the flux is

$$e = \frac{d\,N\,F \sin p\,t}{d\,t} = p\,N\,F \cos p\,t$$

by ordinary integration. The R.M.S. value, as already shown, is therefore

$\frac{p\,N\,F}{\sqrt{2}}$, or reduced to volts $V_2 = \frac{p\,N\,F}{10^8\sqrt{2}}$.

But since

$$V_2 = p\,L\,C. \quad \therefore p\,L\,C = \frac{p\,N\,F}{10^8\sqrt{2}};$$

whence $N\,F = 10^8\sqrt{2} \times L\,C$.

If we let A be the area of cross-section of the iron core in square centimetres, and B the maximum induction in the core, then

$$F = A\,B. \quad \therefore N\,F = N\,A\,B.$$

Having studied the principles of design, we will proceed with a concrete example.

*A choking coil is required* for use with a non-inductive apparatus, which takes 19·75 amperes at 85 volts, the main supply being at a pressure of 110 volts and a frequency of 50. The voltage required between the terminals of the coil is

$$V_2 = \sqrt{V^2 - V_1^2} = \sqrt{110^2 - 85^2} = 69{\cdot}8 \text{ volts.}$$

But from above

$$p\,L\,C = V_2. \quad \therefore \frac{p\,N\,F}{10^8\sqrt{2}} = 69{\cdot}8, \text{ whence } N\,F = 314{\cdot}036 \times 10^5.$$

We must now assume a value for B, the maximum induction. In transformer cores the value of B must be kept fairly low, because the current is often constantly passing through them, and eddy-current and hysteresis losses become a matter of great importance, and the iron loss is always going on. With choking coils, however, a somewhat higher value of B may be taken, the coil being in use only when the accompanying apparatus is working.

A very usual figure for B is 14,000, then N A = 2,243; for N A B = N F. Now, if the iron core forms a closed circuit, so as to have small reluctance, and if we take the number of turns, N = 100, we get the area of cross-section, A = 22·43 square centimetres.

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| B. | μ. | H. |
|---|---|---|
| 10 000 | 2,000 | 5 |
| 11 000 | 1.692 | 6·5 |
| 12,000 | 1,412 | 8·5 |
| 13,000 | 1,083 | 12 |
| 14 000 | 823 | 17 |
| 15,000 | 526 | 28·5 |
| 16,000 | 320 | 50 |
| 17,000 | 161 | 105 |

FIG. 4.—Annealed Wrought Iron.

On referring to the above table, which relates to the permeabilities of some samples of iron examined by Hopkinson, we see that where B = 14,000 the permeability $\mu = 823$.

The magnetising force is given by

$$H = \frac{4\pi C N}{10 l} = \frac{4\pi \times 19{\cdot}75 \times 100}{10 l} = \frac{2{,}480{\cdot}6}{l};$$

where $l$ is the length of the magnetic circuit—*i.e.*, the average length of the *closed* lines of magnetic induction. Therefore, since

$$B = \mu H; \quad 823 \times \frac{2{,}480{\cdot}6}{l} = 14{,}000, \text{ whence } l = 145{\cdot}8$$

centimetres.

The dimensions of the core stampings could be such as are shown in Fig. 5, and built up to a thickness of 7·48 cm. or 7·5 cm.

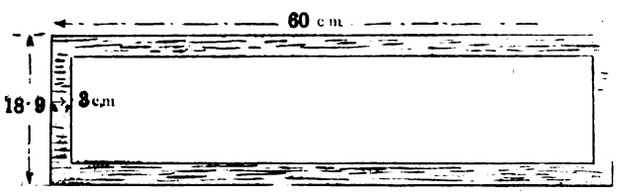


FIG. 5.

The wire to be used should be equivalent to $^{7}/_{16}$ S.W.G. or $^{19}/_{20}$ S.W.G., as these will carry 22·3 amperes and 19 amperes respectively at a current density of 1,000 amperes per square inch.

The self-induction of the coil is given by $p$ L C = 69 8, whence L = 0·0113 henry.

Our calculation is not quite correct, as, until the dimensions of the core were fixed, we could not take into account the iron losses in the core of the choker.

| Maximum induction per sq. cm. | Ergs lost per cycle per cubic cm. |
|---|---|
| 9,000 | 4,200 |
| 10,000 | 5,000 |
| 11,000 | 5,920 |
| 12,000 | 6,720 |
| 13,000 | 7,650 |
| 14,000 | 8,650 |
| 15,000 | 9,670 |

FIG. 6.—Hysteresis Loss.

From the above table* we see that since the maximum induction in the core is 14,000 lines per square centimetre, the hysteresis loss is 8,650 ergs per cubic centimetre per cycle. Since the volume of the iron core is 3,280·5 cubic centimetres, the total loss in ergs per cycle is

$$3{,}280{\cdot}5 \times 8{,}650 = 28{,}376{,}325.$$

In order to provide for this a certain amount of power is required.

$$\left(\frac{28{,}376{,}325}{10^7} \times 50\right) = 141{\cdot}88 \text{ watts},$$

for the frequency of supply is 50, and one watt is equal to $10^7$ ergs per second. The current taken for this loss is, therefore,

2·03 amperes at 69·8 volts.

which is only 10 per cent. of the total current, and is therefore small. The eddy-current losses may also be neglected, but, by working at a lower induction in the core and by making the magnetic circuit open instead of closed, the losses may be still further diminished.

It may be stated that the above dimensions for the stampings may be adjusted to suit any requirements, provided that the length of the magnetic circuit and the area of cross-section remain the same. The above calculation can only suffice to show the principles and methods of design of choking coils, as the number of turns and the value of the induction are purely arbitrary.

* Rhodes, "Treatise on Alternating Currents."

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

669. Explain, with sketches, the method of magneto-electric ignition for modern medium-size gas-engines (about 100 b.h.p.). In central-station work is this method reliable? If so, what are the possible faults?—H. B.

670. A small single-phase synchronous motor (four-pole) is often found on starting up to run at half synchronous speed. Explain clearly the reason of this. The motor in question was used for driving the mirror in an oscillograph, and was started by hand, but this seems to be a property of all synchronous motors.—S. P. S.

### ANSWERS.

*Question No.* 661.—In an actual installation for electrically driving a bar-drawing machine a compound-wound, belt-driven generator is used to supply current to a compound-wound motor, this motor supplying nearly all the generator load. When at work the generator will suddenly stop and run backwards against the belt for a time at high speed, then stop again, and restart in its correct direction to again repeat the cycle of operations. The motor during this time varies considerably in speed. What explanation can be offered of this apparently miraculous phenomenon?

*Answer to No.* 661 (*awarded* 10*s.*).—It is not difficult to lay one's finger upon the probable cause of this strange behaviour, and if "M. E. G." will investigate matters, I think he will find that the compound-wound motor has been connected up in such a manner that the series coil opposes the shunt winding. It is surprising, however, to find that the effects of this are as great as the above statement shows, and it seems safe to say that fuses are either entirely wanting in the circuits or else are vastly too large for their work. The current necessary to cause the generator to reverse and run against the belt must be enormous, and the manufacturer of the plant could hardly wish for a better testimonial than that the armatures are not both burnt out.

The information given, though considerable, leaves a good many subsidiary details unmentioned, but we can probably make pretty shrewd guesses in such cases. The motor, we are told, drives a bar-drawing machine, and no doubt the power it requires varies very greatly, dropping suddenly from full load to almost nil at the moment when the finished bar passes out of the machine. There is bound to be a large number of revolving parts, as the kinetic energy of the machine will be great, while quite possibly there is a heavy flywheel provided to assist steady running. We are not told what is the motor drive, but presumably it is through spur gearing, or if by belt, then by a much stronger or tighter belt than that on the generator. Again, we are told that the generator is compound wound. Probably it is some little distance from the motor and over-compounded 10 per cent. to compensate for drop in the leads, the series coils at full load supplying about 40 per cent. of the ampere-turns given by the shunt windings. The motor was probably designed to run at a fairly constant speed, with series coils supplying but a seventh or eighth of the total ampere-turns at full load. This will mean that while a fair extra torque is obtained at starting, yet the series winding is not enough to cause a drop in speed of more than 5 or 7 per cent. when full load comes on. Naturally, if a heavy flywheel is provided, the motor must be such as will run without much variation in speed, and this, too, would probably be unsatisfactory in the bar drawing. But, as stated above, it appears that the series winding has by mistake been connected so as to oppose the shunt—*i.e.*, at full load we get a *reduction* in the ampere-turns on the

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field of 15 to 18 per cent., or, in other words, the motor will tend to increase in speed as the load comes on.

Let us now consider the working of the motor from the time it is first put into use. At starting, since the series coil opposes the shunt, the torque is poor, and a large current is required; but as the machine is running light the motor will gradually get up to its proper light-load speed. Next a billet is placed in the machine and the motor has heavy work thrown upon it. The current in the series coil again weakens the field and a heavy draught of current is taken; but the motor succeeds not only in running the billet through the rolls, but also in speeding itself up 8 or 10 per cent. and the whole system, flywheel included, to a proportionate amount; and this speed is maintained until the bar is complete and passes out of the machine, at which moment the work to be done becomes simply that required to run the apparatus in its bearings. This is the critical moment, and the changes in the system that takes place now need careful following. The motor has been running fully loaded and taking a large current, *c*, while its field strength has been that produced by a winding of $n$ V – N C ampere-turns; where V is the voltage across the motor terminals, C the current taken, and $n$ and N constants depending on the shunt and series coils. Directly the load passes off the bar-drawing machine, the torque exerted by the motor becomes spent in increasing its speed, and thereby raising the counter E.M.F. in its armature and choking back the large current it has been taking—*i.e.*, in raising "V" and reducing "C." From both causes, therefore, the amper- urns on the field, $n$ V – N C, become increased, and with their increase, of course, the counter E.M.F. of the motor is still further raised, and the current taken still further reduced. Thus we see that the motor, having its series coils opposed to the shunt windings, is in an unstable condition for sudden fluctuations in load, and in this particular case it evidently happens that the above described cumulative effect is so great, that when the load is suddenly removed from the motor, its back E M F. rises so much as to pump back current to the supply circuit, and it will be noticed that directly the motor succeeds in reversing the direction of the current in its armature, the ampere-turns on its field become $n$ V + N C—*i e*, the series coil assists the shunt, still further tending to keep up the E M.F. it is generating. Of course, a motor can only return current to the supply circuit if it has some source of mechanical energy to draw from—in this case the kinetic energy of the flywheel and rolls.

We are told that the motor forms practically the only load upon the generator. Hence there is nowhere for the current pumped back by the motor into the mains to go to but back to the generator, which thus becomes, *pro tem.*, a motor. But the whole phenomenon is by no means explained yet, for normally when current is pumped back into a generator from the line, there is no tendency for the generator to reverse—*e.g.*, the very customary case of a three-wire balancer, where each side is alternately motor and generator, running perfectly sweetly the whole time. There must be something special to account for this reversal, and this is undoubtedly the hypotheticated fact that the series coils on the generator are a very large proportion of its total winding, and that the machine is over-compounded. For in these circumstances, directly the motor back E.M.F. begins to rise and choke back the large current that has been flowing, the generator E.M.F. will fall, and as soon as the current is reversed the generator field becomes that due to $n_1$ V – $N_1$ C ampere-turns—*i.e.*, is reduced by increase of current. The effect of the reversal of current in its armature, accompanied by a weakening of its field, is to cause it to motorise and endeavour to increase its speed. This it cannot do quickly, owing to the heaviness of the engine, and therefore its (now) back E.M.F. is unable to choke back a heavy rush of current, which still further weakens the field and reduces once more its back E M.F. Thus, owing to the cumulative effect of the series winding on both motor and generator, we get an extremely heavy return current flowing—so great, indeed, that the series coil on the now motorisng generator completely overpowers the shunt coil, and even produces a field in the reversed direction. But a reversal of field means that there will be a powerful torque trying to turn the armature in the opposite direction to that in which it has been revolving, and with the huge current flowing (for there is now no back E.M.F., but, indeed, momentarily the E.M.F. of the generator armature helps to suck current from the line) the torque is so great that it succeeds in causing the belt to slip, and once slipping, since the friction is largely independent of the velocity of rubbing, the motor is not only pulled to rest, but is started up and run to a considerable speed in the opposite direction—*i.e.*, against the motion of the belt. But this only lasts for a very short time. The power lost in friction against the slipping belt is very large and quickly dissipates the energy of the flywheel and reduces its speed. At the same time, the reversal of the armature causes it again to generate a counter E.M.F. and cut down the huge current that has been flowing, while the reduction of this current diminishes the effective pressure of the flywheel-driven motor. Hence in a very small space of time the torque becomes insufficient to overcome the grip of the belt, which succeeds in bringing the motor back to its proper direction and to its normal speed, when the speed of the motor having now fallen so low that the voltage it generates is below that of the generator when running at its proper speed, the latter once again takes charge of the circuit and runs the motor up to speed again, the cycle of operations probably being repeated the next time the load on the motor suddenly ceases.

If one had exact data as to the generator, motor, line resistance, etc., one might be able to exemplify the above outline account, and obtain interesting figures as to the maximum currents that must flow. These must truly be enormous, for at the moment when the generator armature is pulled to a dead stop the circumstances are those of a motor thrown direct on to the line without a starting resistance, the entire voltage of the supply (here given by the flywheel-driven motor) being absorbed in the C R loss of the line, armature, and series coil. The supply voltage, of course, is low at this moment, since in spite of the compounding coil on the (generating) motor, its armature reaction must of necessity be very large, indeed, and its own C R drop by no means negligible.

It is not altogether clear from the wording of the question whether the reversal of the generator takes place at some definite point of the cycle of operations of the motor, or apparently fortuitously, and in the explanation suggested of the phenomenon the former is assumed to be the case. But where the circumstances are that a compound-wound generator is driving a differentially-wound motor, it is seen that there must be a strong tendency to instability, since both series coils help the machine that for the time being is on top. It is quite conceivable that the series windings might have such a critical relationship that a change of 10 per cent. in the state of the load should throw the system out of equilibrium, and in this case the generator might commence its antics at any time without the reason being apparent. But naturally, if the motor was in the midst of a heavy operation at the time, its kinetic energy would very speedily be absorbed, and the generator revert to its proper duties. Could "M. E. G." obtain the loan of a recording voltmeter and ammeter? If so, the cards he obtained from his power circuit would certainly be well worth publishing in the *Electrical Engineer*.—C. E. C.

*Answer to No.* 661 (*awarded* 7*s.* 6*d.*).—It is evident that during the occurrence of the phenomenon described in this question, power is being returned in the form of electrical energy to the generator, and the inference is that this power is supplied by the motor, which, we are told, forms the chief source of load. Hence there must be energy stored up in the machine driven by the motor, which is available for this return of energy, so that we may at once conclude that the motor flywheel supplies the power which is returned to the generator. It now remains to be seen how it comes about that the generator allows power to be returned to it in this fashion, and how it is that this return of electrical energy should cause the consequences stated in the question. And we shall see that the combination of a compounded dynamo with a differentially-wound motor can, under certain circumstances, behave as described. By a differentially-wound motor is meant one in which the series turns are wound in such a direction as to weaken

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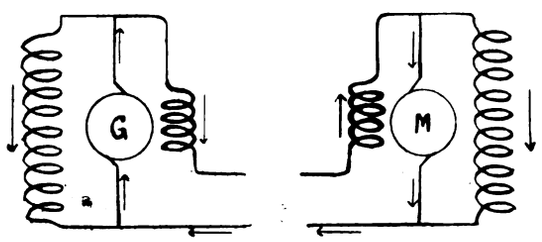
the field as the current increases, so that an ordinary compounded generator, if used as a motor, is a differentially-wound one if the direction of rotation remains unaltered; for while the current in the shunt winding remains unaltered, the current in the series winding is reversed in direction along with the current in the armature, when the machine ceases to generate and becomes a motor. A reference to the sketch will make this clear. It will there be seen that in the two field windings of the generator the currents are assisting, while in the motor windings they are opposing. It is also seen that the two machines are interchangeable—that either of them may act as a compound-wound generator or a differentially-wound motor, for if the current is reversed in the mains it does not become reversed in the shunt windings.




Suppose, now, that the motor is heavily loaded; we then have a weak field in the motor and a strong field in the generator, owing to the action of the series winding in each case. Hence the speed of the motor armature is much greater than that of the generator, and this will be the normal running condition under load; whereas at no load the series winding will have scarcely any effect, and the two speeds will be nearly equal. This is assuming that the machines are wound for the same speed, which is, of course, quite immaterial; if they are wound for different speeds, instead of above, read the *ratio* of motor speed to dynamo speed increases with increasing load. Now, suppose whilst running heavily loaded, all at once the load falls off—a condition of things which is often occurring with a bar-drawing machine—the armature current at once falls, with the result that the field strength of the motor rises rapidly, and the field of the dynamo is considerably reduced; in fact, the back E.M.F. of the motor becomes greater than the generated E.M.F. of the dynamo; the machines exchange duties and the main current is reversed. Now, if the voltage on the dynamo does not fall below a certain amount when the field was suddenly weakened, the effect of this reversal of current will be to still further weaken the field, and the generator will rush up to speed again under the combined driving action of the engine and the reverse current; but if the speed of the dynamo is such that when the flux in the field magnets is reduced, the voltage is very small, then the current in its shunt winding may be so small as to have its action completely neutralised by the rush of current in the series winding. If this happens, as no doubt is the case in the instance dealt with in the question, the voltage of the dynamo fails rapidly to zero, hence the reverse current increases rapidly. This now reverses the field of the dynamo. This again reverses the torque due to the reverse current, which now, instead of assisting the engine to increase the speed of the dynamo, succeeds by its magnitude in overcoming the belt drive, rapidly stops the dynamo, and runs it up to a high speed in the reverse direction. All this takes place at the expense of the energy stored in the motor-driven parts, and by-and-by this fails, the reverse current falls off, and the dynamo yields to the action of the belt and revolves in the original direction once more. Its field has been reversed, and the direction of the current it supplies is, therefore, in the opposite direction to what it was before it took the *rôle* of motor. This, however, is of no importance as far as the motor is concerned, since if both field and armature current are reversed simultaneously there is no effect on the direction of rotation.

"M. E. G." does not ask how to remedy the peculiar happenings, but it would be an improvement if the series winding of the motor were reversed, as in this case the load would be much more constant, the speed of the motor slackening with increase of torque and drawing upon the flywheel, while the load on the dynamo would be almost constant, not only torque multiplied by speed being more uniform, but each factor—driving effort and speed—being nearly constant.—SUPERHEAT.

*Answer to No.* 661 (*awarded* 5*s.*).—The above phenomenon is due to the interchange of the functions of motor and dynamo; the motor periodically absorbing the kinetic energy of the bar-drawing machine and acting as dynamo, drives the real dynamo as motor. In order to completely understand how this may happen, consider first the properties of compound wound machines. When a motor has heavy intermittent loads to overcome it is usual to provide it with series turns, so connected that they assist the shunt, strengthen the field, and enable the motor to give increased torque at a slower speed. Should they be so connected as to oppose the shunt, the motor *tends* to run faster when load comes on, taking a heavy armature current, which however gives much less torque than in the previous case, as this same current diminishes the total field by its action in the series turns. In a compound dynamo the series turns are connected so as to increase the voltage as load comes on by assisting the shunt field. If a shunt dynamo be supplied with current, it runs as motor in the same direction as it does as dynamo, but a series dynamo reverses its direction of rotation. In "M. E. G.'s" case there is a compound-wound motor subject to heavy intermittent loads, and it will probably be found that the series coils *are wrongly connected* so as to weaken the field, and the dynamo belt seems rather slack also. The following is what happens: (1) The motor has to deal with a momentary heavy load and takes a very large current owing to its weakened field. (2) The dynamo (which supplies little beside the motor) is consequently overloaded, slips on the belt, and the voltage is reduced both by the heavy load and fall in speed. This reduction further weakens the shunt field and reduces the voltage still more. (3) The load is overcome by the motor, which rapidly accelerates its speed and the current taken by it falls. (4) This reduction of current causes a further fall in the dynamo voltage, as the series turns, which were a moment ago supplying a large proportion of the voltage, now carry much less current. (5) As the dynamo pressure falls a time comes when the back E.M.F. of the motor is the greater, and driven by the momentum of the machine the motor begins to supply current to the dynamo. Now the moment the motor begins to give out current the series coils strengthen its field (because the direction of the current through them is now reversed), so that the motor voltage rapidly rises, and for a short time a very heavy current is driven back through the dynamo. (6) This heavy current enables the series field of the dynamo to completely overcome its weakened shunt field, and the dynamo runs as series motor, reversing its direction of rotation and slipping in the belt. (7) The necessary energy has been supplied by the momentum of the machine and motor, which are consequently slowed down, the motor voltage falls, the belt begins to get a grip of the dynamo pulley and turn it in the original direction, the dynamo shunt field builds up and it again begins to supply current to the motor, which gradually again attains normal speed, and the original conditions are now restored. Probably the reversal of the series connections on the motor will put a stop to this interesting cycle, which will be a pity. The motor should, however, act much more efficiently.—W. W. W.

*Question No.* 662.—Several water-tube boilers that had been working for about 12 months have had each a number of tubes in the bottom rows replaced with new ones. This was owing to the tubes being badly bulged and in places reduced too thin to render them fit for further service. The boilers are of the straight-tube type, and it should be borne in mind that the trouble was confined to the tubes in the bottom rows only. The feed water is of an average hardness of about 15deg., this being reduced to about 3deg. by means of a lime-soda water-softening process. The boilers, since retubing, have been in constant service for the past two years, and no recurrence of the above-mentioned trouble has been experienced during this time. Would any readers give what, in their opinions they consider to be the cause of the trouble?

*Answer to No.* 662 (*awarded* 7*s.* 6*d.*).—There can be no doubt as to what has really happened in this case. The cause of the bulging in the tubes was excessive heat while under steam pressure, and the owners may congratulate themselves that the tubes did not burst with disastrous

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results. The fact is that a good deal of incrustation was deposited upon the inside of the tubes by the boiling of the water, which, of course, would be most vigorous in the hottest tubes—*i.e.*, those nearest the fire. A hardness of 3deg. would in time produce a scale (or incrustation), but probably the process was not attended to, and consequently the hardness of the water was a good deal more than the supposed 3deg. for hours, if not days at a time. This incrustation prevents the water from making contact with the metal of the tubes, and is, moreover, a very bad conductor of heat, therefore the tubes become red hot and soft enough to give way before the pressure of the steam. We must bear in mind that when the tubes are too hot they are burning away from the outside, and so becoming thinner and weaker. If these tubes had been carefully inspected they would have shown marks of the incrustation, and also of the burning, although probably the act of bulging would have broken the scale away. It is, however, more than probable that a good deal of deposit occurred at the ends of the tubes, and this prevented the proper circulation of the water. In this case the intense heat of the furnace would convert all the water in the tube into steam, and if the ends of the tubes were sufficiently blocked the steam inside would prevent water entering, when the tube would become red hot and burn, even if no incrustation were deposited at the actual part where the burning and bulging occurred, for steam is not able to conduct the heat of the furnace away from the tubes at anything like the rate that water can. It is water and nothing else that prevents the tubes from getting dangerously hot. A very interesting little experiment may easily be made to verify the truth of this statement—viz., put some water into a common tea-kettle and put it on to a clear fire to boil, then take it off the fire and immediately touch the bottom of the kettle, which will be found quite cool. After a very little while the metal will conduct heat from the hot water inside, but putting it on the fire again will have the effect of cooling it. Having tried this myself I can confidently recommend "Night Shift" to satisfy himself on the point. It is not so easy at this distance to see the cause of the more satisfactory performance of the new tubes, but probably the makers saw the defect and were able to supply the remedy. I would, however, suggest that most probably the water softener was made to work more satisfactorily and perhaps more strictly and certainly. In addition to this they may have opened the end of the tubes to allow the water to circulate more freely, and also they may have moved the central or hottest part of the fire a few inches with respect to the tube so as to distribute the heat more evenly. There is also another very important though small detail well worth attention in the inside of the tube, and that is roughness, for a tube rough inside would boil the water much more gently and safely than a smooth tube. Rough points seem to be a starting place for a constant stream of bubbles of steam, which rise easily to the surface, but it is well known that water in contact with a smooth hot surface boils fitfully and even explosively. It seems to lie in contact with the smooth metal until it gets so hot that a very large bubble of steam is formed, and this is a long time (comparatively) in getting away, during which time the metal is accumulating heat. Some very interesting information may be gained by boiling water in a thin glass chemical test tube, which can be purchased for a penny, and allows the phenomena of boiling to be seen as far as possible.—F. G. A.

*Answer to No.* 662 (*awarded* 7*s.* 6*d.*).—The damage to the tubes in the lower rows is quite a common experience with straight-tube water-tube boilers. The impurity of the water has, of course, a large effect on the life of the tubes as a whole, but as the boilers have now been in use for a considerable time without further trouble, it may be taken that the water evaporated is sufficiently pure and soft for the boilers. The main reason for the deterioration of the boiler tubes is the wear by the actual work they have to do, and this wear will depend on the amount of work they have to do—*i.e.*, the amount of water they have to evaporate. The following shows the results of a recent trial on a similar boiler to those in the question. It shows the percentage of the total water evaporated in the eight bottom rows of tubes in the boiler: first row evaporated 22·5 per cent. of total water; second row, 14·5 per cent.; third row, 10·55 per cent.; fourth row, 8·75 per cent.; fifth row, 7·48 per cent.; sixth row, 6·54 per cent.; seventh row, 6·2 per cent; and eighth row evaporated 5·63 per cent. of total water. From this it will be seen that the bottom rows of tubes are more liable to deterioration than are the upper rows of tubes. These results are of some importance to boiler designers, for they clearly show the necessity of a stronger design of tube for the bottom rows than for the top rows in a water-tube boiler. Another cause of the rapid deterioration of the lower rows of tubes is the fact that they are almost continually in contact with the actual flames of the furnace fires, whereas the upper rows are seldom, if ever, reached by the flames, the heat of evaporation being supplied to them by the ascending hot gases.—J. R.

*Answer to No.* 662 (*awarded* 5*s.*).—This trouble with bottom tubes in boilers supplied with soft water free from grease may be due to a cause apt to be overlooked. A careful enquiry into a case of a similar nature to that stated revealed the trouble to have been due to shortness of water in the tubes, brought about, as far as could be ascertained, by an excessive rate of evaporation. A consideration of the forces controlling the circulation will explain what may take place in tubes when an over-evaporation is occurring in them. To permit steam bubbles to form at the heating surface, the water there must be at a pressure and temperature which is greater than the steam pressure at the water-level by an amount approximate to the weight of a unit section of the superincumbent column of water. Let this excess pressure due to the higher temperature be called P. The steam leaves the scene of its formation by a circulation which is a function of the difference of the static weights of the descending and ascending columns of water—that is, if A and B respectively represent these static weights, their difference A – B will equal F, the propelling pressure. That the normal condition of circulation may exist, the excess pressure, E, must never exceed A, the static weight of the downward column. As the rate of evaporation increases, A – B = F will increase, and a more rapid circulation will prevail. The propelling force in this normal direction of circulation is E – B = F. But in the case of a tube working at an over-evaporation, the delivery area of the tube will not be sufficient, and E will increase and overcome A, causing the circulation to be arrested and an oscillatory movement of the steam and water to be set up, permitting steam to issue from both ends of the tube and to form in pockets directly above the zone of greatest combustion. Here the propelling force will be in the direction E – B = G, and the result will be that the tube is overheated and probably ruined. In the above case the coal consumption was at the rate of about 30lb. per square foot of grate per hour.—M. C.

*Answer to No.* 662 (*awarded* 5*s.*).—In replying to this question, one would like to know whether the conditions during the first 12 months mentioned were precisely the same as in the two succeeding years. Were the boilers fired as hard after the trouble as before? Was the same attention given to the cleaning of the boilers and to the working of the softening apparatus prior to the trouble? Can the uniformity of the hardness of the treated water be vouched for? In some cases it has been found that the hardness of the water treated with the lime-soda water-softening process was not always reduced to the same degree, owing to inefficient attention to the apparatus wherein the process takes place. In some softeners water flows through an adjustable orifice into the lime saturator. This displaces an equal volume of lime-water, which overflows from the saturator and mixes with the water to be treated. Should the orifice become even partially blocked by slime or other accumulations, the quantity of lime-water displaced will be insufficient for the process to be satisfactory. Again, the strength of the lime-water may vary, owing to a sufficient margin not being allowed for stored and useless matter contained in each charge of lime. The same fault may also render the soda solution more or less inefficient. Moreover, these quantities of lime and soda ought to be added for every

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certain quantity of water that is treated. Often there is no indication of the amount of water passing through the softener. In such cases it is possible that the recharging does not always take place as frequently as the case demands. In certain types of water purifier the attendant has only to keep the receptacle replenished with undissolved chemicals, the apparatus being otherwise automatic. In such cases the attendant is less indispensable to its successful working. When cutting out bulging tubes it is often found that the tube-cutters work through the underside of the tube—*i.e*, the side next the fire—sooner than through the top, the metal of the underside having become softer than the top through being subjected to a higher temperature. The underside of the bottom-row tubes is exposed to a higher temperature than any other part of the boiler. When matter is deposited in a boiler of the straight-tube type, it is circulated with the water, and settles either as soft sediment or as scale in the steam drum and tubes. The bottom row of tubes have been found with hard scale, the rest of the boiler being coated with *soft* deposit only. The hard scale covered only about one-half of the circumference of the tube—the half which was directly exposed to the heat of the furnace. The scale extended over that length only of the tube which was over the fire, the remainder between back end and bridge being quite free from scale. When a boiler is hard fired, or even moderately, with such a deposit, overheating of the metal of the tube beneath the scale takes place, sometimes resulting in the bulging of the tubes in one or more places. When precipitation takes place in boilers, blowing down should be regularly done to rid the boiler of sediment that might otherwise settle in the tubes. Of course, the nature of the water ought to determine the frequency of the cleaning of the boilers.—H. J. W.

## THE SUPPLY OF ELECTRICITY TO SMALL TOWNS.*

BY T. TOMLINSON.

It is quite evident that the supply of electricity to small towns on a paying basis, especially in a poor country, is beset with difficulties.

It is quite easy to make out a scheme and to draw up a hypothetical balance-sheet, shewing a profit when a certain lamp connection shall have been attained; but everyone with experience of these enterprises knows that these balance-sheets have an awkward knack of not materialising in practice, mainly for two reasons—first, that the expected lamp connection does not come on at a reasonable rate; and second, that the running costs turn out larger than expected.

If your scheme depends upon electrical supply for lighting alone it will be wise to secure beforehand firm promises of an initial loading in some reasonable proportion to the minimum paying load—it is a rather hopeless game starting practically unloaded and trying to creep up to a paying load. Under the conditions of depending for your earnings entirely upon the supply of electrical energy for lighting, I think that most of you will agree that the possible financial margin will be too narrow to be worked out to a profit under the management of an urban council, or ensure an adequate return to outside capital, even under the better business management which this ensures.

In fact, I think it is fairly certain that in small towns, say, of 8,000 inhabitants and under, the supply of electrical energy for lighting only, with a mere casual power connection, is, unless in extremely favourable and exceptional circumstances, commercially unprofitable.

A pure lighting load is an extremely bad load. One is earning money for some few hours out of the 24, say four or five, and one is losing money for the balance, some 19 or 20. The engineer of a city job may hope to work up a casual power load and so decrease the hours of working at a loss; but the engineer of such a job as we are considering need have no such expectations.

If the undertaker of the lighting be the urban district council, then I think the question of electric lighting, public and private, should not be considered alone, but in conjunction with all the town services which the council undertakes, or should undertake. Take the most obvious sanitary duty—the collection and disposal of refuse. The burning of the refuse in a modern destructor will almost certainly supply steam for all the non-paying part of a lighting load in this country—at a very small cost, indeed, to the electric lighting side of the township accounts. The destruction of town refuse is a sanitary duty which no town can in the long run afford to neglect, and money spent on this is money spent equally for the good of all—unlike money spent on a non-paying electric lighting scheme, which is, in fact, spent mainly for the benefit of those who can afford the light.

I may say that I have quite recently been led to reconsider the question of power from refuse destructors by coming across some recent records of work done by them. In 1894, when electrical and municipal engineers and town councillors were being dazzled by the prominency of the destructor matters of the day, I was asked by the editor of the *Electrical Review* to examine such records of performance as were available and state the results. This I did, and wrote a series of articles in the *Electrical Review*, afterwards reprinted in "Refuse Destructors" by Mr. C. Jones, M.I.C.E. These articles undoubtedly did good work at the time, and prevented a large waste of public money upon the faith of exaggerated expectations of results which were then incapable of realisation.

In a table given by Mr. Francis Goodrich in a paper on the subject read before the Exeter congress of the Royal Institute of Public Health in 1902, was shown the enormous advance that has been made in late years in destructor practice. This advance is entirely due to the modern high-temperature destructor, and it is satisfactory to know that this increase in the steam-raising properties of the destructor has also increased its value as a destructor in the direction of inoffensiveness, as well as the hardness, and, therefore, value, of the other by-products—the clinker produced. Although refuse burned in a destructor gives results closely approximately to about one-fifth of that of an equal weight of coal, you cannot treat it as the equivalent of so much fuel to be burned at what rate you choose: it must be regarded rather as variable water power to be utilised, if possible, over the whole 24 hours. The night lighting of a town is, I think, well within the average working rate of burning, taking the annual collection of refuse at about 4cwt. per head of population per annum, provided the town is supplied by a direct-current system or on an alternate-current system with cutting out of transformers, but we shall have to find work for it during the daytime if we are to get the best economical results.

Consider now the question of the collection of the refuse: you know how it is done now, and how large a proportion of the work, time, and cost of labour of men and horses is occupied in the transport of the refuse after collection, even when to save the cost of transport the dumping ground is placed in a position wholly unsuitable. Now, in the towns of the size with which we are dealing, a line or lines a mile long will cover the main street or streets, and a suitable site for a destructor. If this length were equipped with double trolley wires at 400 volts (the outers of a three-wire system) there would be no difficulty in devising an electrically-driven wagon, travelling on the road surface—no rails would be required—and taking current for the wires, which, by reducing the task of men and horses to that of collection on short lines at right angles to the trolley line, would materially reduce their number or much increase their efficiency.

The line would cost about £1,000 per mile, and every man and horse displaced would mean a saving of about £90 per annum, and I think there are good grounds for supposing that a direct saving to the rates, as well as a distinct advance in sanitation, would result. The demand for power on such a line would not be limited to the transport of the refuse. The scavenging, watering, and rolling of the roads traversed by the trolley line—and for that matter for some 200 or 300 yards on each side of it—are all mechanical work capable of being operated from it.

Other township demands for power will readily occur to you: pumping water supply, pumping sewage, breaking road metal, road scarifying, etc., are such uses. All these can be so worked as to make up almost an all-day load for part of your generating plant, if it be, which is not at all certain, beyond the reach of the destructor-driven plant.

The whole matter is one which should be worked out in a given case, with full information on all the data required; and I am in hopes—through the influence of some member of this association—that some up-to-date council engineer, with all the figures at his command, may think it worth his while to go into the matter, and that the supply of electrical energy in a small town may be put upon a sounder financial basis than that upon which it rests at present. The idea I would seek to impress upon you is this: that the electrification of a small town is best tackled from the sanitary and general purposes end.

As to the undertaking of the electric lighting of small towns in this country by private enterprise, I think the chances are almost too remote for profitable consideration. It could be done profitably by a large power user or association of power users in a town, or by a company working a selected group of towns under one management, so as to economise in the matter of supplies, account keeping, correspondence, and skilled direction; but, unless under extremely favourable circumstances, I fear no money can be got for it from private sources. As to the power to be used, I think water power, gas (producer),

* Abstract of paper read before the Dublin Local Section of the Institution of Electrical Engineers, March 10, 1904.

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or oil engines most suitable. Water power is most suitable if available, but the trouble with our water powers is that they are in general small in amount; the fall is usually small—6ft. to 12ft.—and they are terribly subject to rises in the tail-race which makes them unreliable. In a flood you have too much water, and your turbine is nearly useless on account of the rise in the tail-race. I have seen recently an account of some extremely successful attempts by Mr. Steiger, of London, to deal with this problem, which is of immense importance to us. In a recent case he has dealt successfully with a normal fall of 4ft. 3in., subject to reduction in floods to 2ft.; and in yet another case—that of a mill situated on a tidal river—with a fall of from 0ft. to 4ft. 10in.

Mr. Steiger, in a recent paper reprinted from the *Transactions* of the Civil and Mechanical Engineers' Society, thus refers to the problem of dealing with these variable falls. More modest, but certainly not less interesting, are the many small and moderate falls in these islands, with a very short water supply in the dry summer months and an abundance in winter or after continued rain. Certainly the irregularities of the water supply, which sometimes affect the fall also, are a great drawback to using such sources of energy, but to say they are useless is absurd. If only constant waterfalls were useful, then we should have no water-power installations in Switzerland.

We shall now see how such falls can be most satisfactorily utilised. The first occasion on which the author had to deal with such a varying waterfall in this country was when Cossey Mills, near Norwich, was converted to the new roller system. The water supply of the River Wensum, on which the mill is situated, varies between 4,200 cubic feet per minute, in the very driest weather, and more than 10,000 cubic feet per minute in flood time. The fall as well as the amount of the water supply varies, so that the highest fall of 6ft. 3in. corresponds with the minimum supply, and the minimum fall at ordinary flood times of 3ft. 10in. corresponds with a supply of 10,000 cubic feet or more. The minimum supply not being sufficient to produce the necessary power, the turbine had to be supplemented by a steam-engine, and the author decided to adopt a turbine which would give the highest possible efficiency with the minimum supply, but at the same time to make it large enough to produce the full power required—*i.e.*, 50 b.h.p. under the minimum fall of 3ft. 10in. Thus the use of steam power would be reduced to a minimum.

The type which would fulfil this condition in the best manner was the double-crowned Jonval turbine. These are axial flow pressure turbines, which require the buckets to be entirely filled by the water passing through them. In order to obtain a good efficiency, with a reduced water supply, these wheels are divided into two or more compartments, so that the outer one is just large enough to pass the minimum quantity of water under the full head, while the inner one can be opened according to requirement when the fall is reduced. The outer compartment, having a mean diameter of 9ft., is used with the higher fall when the velocities of the water and that of rotation is greatest, while the mean diameter of the turbine when fully opened for use, under the minimum fall, is only 7ft. 6in. Thus the subdivision of parallel-flow turbines into several compartments of different diameters enables us, besides securing a good efficiency with a diminished water supply, to obtain also a constant speed under a varying fall. At Cossey Mills the turbine runs at a constant speed of 27 revolutions per minute, whether the fall is 6ft. 3in. or 3ft. 10in. Although the efficiency of pressure turbines generally is much less affected by the so-called critical speed, the advantage of a carefully designed parallel-flow turbine with several compartments is, in many cases, of greater importance than the possibly somewhat higher efficiency of certain radial-flow turbines, especially where the variations of the fall are great. This type has been extensively used on the Continent under similar conditions, and the author has had equal success with low falls in this country down to 24in.

In a personal letter on this matter he, however, writes that the Jonval parallel-flow turbine is now seldom used, and that inflow turbines with specially designed gates to give good part gate efficiency are preferable, of which examples are cited at Sligo and Newry.

The preference for gas or oil engines over steam-engines for such plants is due to the smallness of the units, the simplicity of the working, and the low cost of running. The only oil-engine I know of as available is the Diesel. Of this I have no practical knowledge, but I have heard extremely good accounts of it from one who has, and its claims should be considered. I am in hopes that some gentleman will be able to give us some first-hand information on this matter. Meantime, here are some as given by Mr. H. Ade Clarke in a paper read before the Leeds Section of the Institution of Mechanical Engineers, a result which is much in favour of the Deisel engine.

TOTAL COST PER BRAKE HORSE POWER HOUR.

| Engines. | Diesel. | Gas. | Steam. |
|---|---|---|---|
| | d. | d. | d. |
| 35 b.h.p. | 0·59 | 0·69 | 0·89 |
| 80 b.h.p. | 0·39 | 0·52 | 0·63 |
| 160 b.h.p. | 0·32 | 0·40 | 0·49 |

As regards the system of generation, I think, unless long distances have to be run to pick up load, that 400 volts, three-wire, direct will give most satisfaction all round; though much might be said for alternate current, three-wire, at the same voltage, with sub-stations, and with the cutting out of transformers on night load by hand, provided one could be sure of getting a single-phase motor which would start on load.

On this point I have some recent information from the Lahmeyer Company as to the Ferranti-Scheurer single-phase motor, which they are now making, and which I hope shortly to be able to test. A five-horse motor is started to start with an initial torque equal to three times full load torque on an initial current equal to twice the full-load current.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 11.

**Royal Institution.**—At 9 p.m., "The Motion of Viscous Substances," by Prof. F. T. Trouton, F.R.S.

**Physical Society.**—At 8 p.m., "The Whirling and Transverse Vibrations of Shafts," by Dr. C. Chree.

**Institution of Electrical Engineers.** — Manchester Students' Section: At 7.30 p.m., "Switchgear for Traction and Transmission," by Mr. John W. Bell.

**Institution of Civil Engineers.**—Students' Section: at 8 p.m., "The Premium System of Payment for Labour," by Mr. W. G. Banister.

**Junior Institution of Engineers.**—At 3 p.m., visit to the works of the Electrical Power Storage Company at Millwall.

SATURDAY, MARCH 12.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture IV.).

**West Hartlepool Scientific Society.**—Paper on the "Three-Wire System."

MONDAY, MARCH 14.

**Society of Arts.**—At 8 p.m., Cantor lecture by Mr. Bertram Blount on "Recent Advances in Electro-Chemistry" (Lecture II.).

**Institution of Mechanical Engineers.**—Graduates' Section: "Two-Cycle Marine Petrol Motors," by Mr. H. Gaskell, jun.

TUESDAY, MARCH 15.

**Institution of Civil Engineers.**—At 8 p.m., "The Barrage across the Nile at Asyut," by Mr. George Henry Stephens, C.M.G., and "The Use of Cement Grout at the Delta Barrage in Egypt," by Sir Robert Hanbury Brown, K.C.M.G.

WEDNESDAY, MARCH 16.

**Society of Arts.**—At 8 p.m., "Artificial and other Building Stones," by Mr. L. P. Ford.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the pianoforte works of Messrs. John Broadwood and Sons, Old Ford.

**Royal Meteorological Society.**—At 7.30 p.m., "Water Vapour," by Mr. R. H. Curtis.

**Institution of Electrical Engineers.**—At 2.10 p.m., visit to the British Thomson-Houston Company's works at Rugby; at 7.30 p.m., "Localisation of Faults on Low-Tension Networks," by Mr. W. E. Groves.

**Chemical Society.**—At 5.30 p.m., ordinary meeting.

**Institution of Electrical Engineers.**—At 7.30 p.m., students' meeting, "Notes on Commercial and Experimental Testing of Continuous-Current Machinery."

THURSDAY, MARCH 17.

**Rugby Engineering Society.**—At 8 p.m., adjourned discussion of Mr. Hopp's paper on "Automobiles."

**Birmingham University Engineering Society.**—"The Present Possibilities of the Locomotive," by Mr. G. Bulkeley.

FRIDAY, MARCH 18.

**Institution of Mechanical Engineers.**—At 8 p.m., "Compound Locomotives in France," by Mr. Edouard Sauvage.

SATURDAY, MARCH 19.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture V.).

**Institution of Electrical Engineers.**—Glasgow Section: special smoking concert in the Grand Hotel.

**Junior Institution of Engineers.**—Conversazione at 7 p.m. at the Westminster Palace Hotel.

**Glasgow Technical College Scientific Society.** — At 7.30 p.m., "The Diesel Engine for Marine Purposes," by Mr. A. J. Lawson.

**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 23; Newcastle, May 6 and 7; Buxton, May 20 and 21.

**Lichfield.**—The City Council, after considerable discussion, on Wednesday adopted a report of the Electric Lighting Committee detailing the steps that had been taken to obtain a supplemental provisional order for the supply of electricity outside the city boundaries, to include Whittington Barracks and Trent Valley Station.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## GUERNSEY TELEPHONY.

There is an old saw which says, "It is just as well to be hung for a sheep as for a lamb," hence we venture while treating the telephonic question elsewhere to also touch upon it in this column. Facts are stubborn things, and hard to controvert. No doubt, however, attempts will be made to pick holes in the telephone accounts of Guernsey just published; but this as it may be, it will be difficult to show the prognosticated failure. Six years of working life have passed, though adverse critics predicted a collapse in two or three years; and, worse for the critics, the figures show improvement. Accepting the engineer's unit, the capital cost per instrument line, or per instrument, is $\frac{21,262}{1,217}$ = £17. 9s. 5d. per line. The population served is 40,300, so that Guernsey is blessed with a telephone per every thirty-three or thirty-four inhabitants, and as these cannot all be adults having public, private, or business correspondence, it must be admitted that Guernsey is the best telephoned area in the United Kingdom. We say these figures will be combated as earlier figures have been, the iteration being, "A profit can be shown if altogether inadequate sums are set aside for sinking fund and renewals." Experts, especially when in opposite camps, may differ as much as they please, but the figures given in the balance-sheet do not show a very parlous state. The capital is £25,093, and the total reserves or sinking funds, or whatever name they be given, amount to £4,227. 11s. 10d., which surely means getting rid of the capital account well within the twenty years (evidently estimated as "the life") even allowing a much heavier annual item for repairs than the £313 used during the past year. It may be interesting to give more exactly the figures relating to this venture. The capital is £25,093, which with the reserve funds and a small amount due by creditors brings the liabilities to £29,388. On the asset side of the account £23,584 has been spent on lands and buildings and equipment: stores, tools, etc., stand for £883, the balance £4,326 being in cash and securities. But, of course, the initial cost of a concern is one thing, a more important one being revenue and expenditure. The necessary expenditure, including interest on capital—which, by the way, is not a necessity when dealing with companies' accounts—is £2,709, while the revenue is £4,064, thus leaving a good balance of £1,355 The Guernsey people have out of this amount put 5 per cent. of the amount charged to construction account to a reserve account for depreciation and capital sinking fund account, have written off a small amount of expenses, and called £201 profit. Of course, this is not the profit in an ordinary sense, but as interest and sinking fund are compulsory in municipal or similar dealings, the so-called profit is the balance remaining after having allowed for such payments. All this, however, is again less interesting than some other figures—namely, those relating to cost per subscriber or per call. The tariff in Guernsey is of three kinds—A, B, and C. A pays £1. 10s. per annum and 1d. per call; B pays £2 5s. per annum and ½d. per call, while C pays £5 per annum and has 3,200 calls free. Whatever the conditions prevailing, and however these figures are manipulated, it is clear that the tariff is exceedingly low and the result exceedingly good. Our interest in this work at Guernsey is two-fold—first, we have consistently and persistently recommended that the Government, having a legal verdict in their favour, should work the telephones of the country; secondly, the Guernsey work shows, we think conclusively, that the cost of telephoning in this country is much greater than it need be. While it is in the hands

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of private adventurers the owners are justified—amply justified—in getting the greatest return they can for their money. That is their business. Philanthropy does not and should not enter into business. It is, however, legitimate to compare or direct attention to work going on under our eyes, whether that work be by a company or a municipality. To go back to our figures, it is evident the Guernsey folk are not rabid telephonists. The total number of calls during the year was only 679,989, or some 2,113 per day (excluding Sundays), and this from 1,217 instruments—less than two calls per instrument per day. Each line brought in £3. 6s. 9d. during the year, and all this goes to show the extensive moderateness of the cost to the user. There are some important considerations in connection with this and similar undertakings which cannot be touched here, but which are always more or less under discussion, hence no apology is necessary for giving prominence to the latest balance-sheet of Guernsey telephony.

## CORRESPONDENCE.

### ELECTRICAL PUMPS.

SIR,—I note in your issue of the *Electrical Engineer* of Jan. 22, p. 129, an article with reference to electrical pumps in South Africa. This article is in the main correct, but I would like to call your attention to the fact that the 15-kw. transformers referred to were not under water at all. When it was decided to allow the mine to fill up the transformers were removed, but owing to the large amount of water encountered in this shaft there was no time to remove pumps, motors, and switchboards, and the shaft cables were also left in position. I would say that the motors were under water from October, 1899, to July, 1903—about 3½ years.

It is hardly correct to say it was contrary to expectations that these motors were successfully dried out and put into commission without rewinding, as we certainly expected this treatment to be successful. I would add that these motors are operated at 115 volts, the current being taken down the shaft at 3,300 volts and transformed in the pump stations, which are respectively 500ft. and 1,000ft. in vertical depth from the surface.

The original cables are still in use, as it did not prove necessary to remove them. These particular cables had vulcanised-rubber insulation, and were allowed to drain until they had gotten rid of the water that had been forced into them. In the other shaft on the same property paper cables had been installed, and these were also submerged, but were dried out with low-tension current while in position, and are to-day in use carrying the 3,300-volt current.—Yours, etc. A. W. K. PEIRCE.

Germiston, Feb. 15, 1904.

### RADIUM AND SPARKING DISTANCE.

A simple way of showing that radium radiation increases the conductivity of the air is to arrange two spark-gaps in parallel, one being subject to the action of the radium, the other being shielded from it. Then, if the length of the gaps is adjusted so that sparking occurs at both simultaneously, it will be found that the gap influenced by the radium is the greater of the two. Such an arrangement set up in connection with a large Wimshurst machine, each spark-gap being provided with a micrometer-screw adjustment, so that its length could be accurately measured, was used by Mr. Stanley Allen, who described the results of this experiment in a paper read before the Royal Philosophical Society. The length of the ordinary spark was altered by ½mm. at a time, and the gap subject to the radium was adjusted till sparking took place at both gaps. The exact point could not be determined very definitely, as sparks would cross both gaps, though the "radium gap" was slightly increased or diminished. The first set of experiments was made with spherical terminals. With gaps about 1mm. long there was not much difference in length, but as the gap increased so did the difference between the two gaps, until for a 3mm. gap the difference amounted to 15 per cent. After this the difference again diminished. With point terminals the difference between the gaps was more marked. The radium produces more apparent effect in this case. As with the spherical terminals, the difference was most pronounced for a gap 3mm. or 4mm. long, but in this case the spark-gap subject to the radium rays was three or four times as long as the ordinary gap for the same sparking potential.

## SOME NOTES ON THE COST OF GENERATING ELECTRICAL ENERGY.*

BY E. J. FOX.

In replying to the kind invitation from your president to read a paper before this society, I have felt it might be of some interest if I brought to your notice a few points closely connected with the cheap production of electrical energy in installations possessing a good load factor such as usually prevail in engineering works, with a view of showing that extremely economical results can be obtained, even in isolated plants of a comparatively small size. The figures given in this paper refer to results obtained with reciprocating steam-engines; the costs of working with steam-turbines and gas-engines are at the present time more difficult to obtain, and equally reliable results will scarcely be available for another few years. The future for both these new forms of prime mover is, however, of a promising nature, and the firm with which the author has the honour of being connected believe sufficiently in both to have warranted them making extensive arrangements for the manufacture both of the one and of the other. In many cases where central power plants are installed for the generation of electrical energy about a works, the savings in working costs are usually so great in comparison with previous methods of working that it is to be feared many losses in the actual generating of the power are liable to escape notice, which during 12 months' working are capable of running into high figures. A good deal of friendly rivalry has existed for some years past among engineers in charge of the various electric lighting and traction stations in our towns, with a view of obtaining the lowest works costs per B.T.U., and as these results have been made up and published annually at the instigation of the Board of Trade, they have acted as a strong incentive towards introducing further economies into working. In fact, in the opinion of many, too much attention has in some of these cases been paid towards reducing the working costs at the expense of capital outlay, an outlay on auxiliary plant and refinements which a poor yearly output per kilowatt of plant installed has in many cases not justified.

The problem which works managers have to face, however, is of a different nature, and provided simplicity and reliability are not materially sacrificed, the very much greater output obtainable per kilowatt of plant installed justifies in most cases every reasonable step being taken towards reducing the working costs to a minimum, the capital outlay and additional attention which invariably accompany auxiliary plant under these circumstances being of secondary importance only. As an instance of this point, I would refer you to the case of Bradford in Table D, and Messrs. Watson's in Table E. Due to the very much greater annual output per kilowatt of plant in the case of Watson's installation, Bradford would have to make a saving in working costs 3·8 times greater than Watson's to bring the total sum saved per annum to the same figure. It is probable, therefore, that the extra cost of refinements in a case like Watson's would be justified, whilst it might not be in a case like Bradford. Auxiliary plant invariably requires a certain expenditure in power to enable it to fulfil its functions, and this power is largely constant, regardless of the load, and is liable, if the plant is frequently worked at light loads, to cost more than the savings which it introduces. Then, again, refinements must be kept up to their maximum efficiency if they are to bring about a maximum economy in working, and this involves attention and labour, which is liable to be a serious charge on a small output. In the case of the Salford station, Mr. Taite has shown that the auxiliary plant in his station absorbed between 6·5 and 8·3 per cent. of the total units generated, depending on the state of the load factor. Of this lower figure, the motor-driven air-pump was responsible for 4·67 per cent., the motor-driven boiler feed pump for 1·18 per cent., the remainder being divided between the mechanical stokers, ash conveyors, economiser scrapers, coal elevators, and workshops. I should say very few central stations with a load as low as that prevailing at Salford are working at a less figure for their auxiliary plant, and as a comparison with the above figures, I would point out that the electrically-driven auxiliaries in the case of Crompton's works at Chelmsford, when taken

* Paper read before the Cleveland Institution of Engineers at Middlesbrough.

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over a period of six months' working, amounted to 3½ per cent. only of the total units generated, showing how great is the saving in running the auxiliary plant with an improvement in the load factor. This figure of 3½ per cent. has, however, not been obtained without being carefully watched and without improvements being introduced from time to time, leaving us with the moral that attention should be paid to these points.

*Boiler Feed Pumps: Steam versus Electric.*—Steam-driven boiler feed pumps are renowned for their wastefulness, and although much of the exhaust heat can be recovered in feed-water heaters, there is no doubt that a motor-driven feed pump whose consumption can be checked from day to day has its advantages. Their somewhat slow adoption has no doubt been due to the difficulty of obtaining a variable volume of water from them economically. This difficulty has, however, I believe, been overcome by Messrs. Mather and Platt, who employ a variable-speed electric feed pump, and by Messrs. Crompton and Co., who use a belt-driven feed pump, the motor and pump being each arranged with coned pulleys. The accompanying Tables A and B will, I think, show the higher efficiency obtainable from electrically-driven pumps, and were communicated by Messrs. Taite and Downe in a paper read before the Manchester Section of the Institution of Electrical Engineers. Table A shows the guaranteed steam consumption of a standard 6,000-gallon pump, while Table B gives equivalent figures for an electrically-driven pump. It will be seen that the electrically-driven pump delivers 147lb. of water per pound of steam used, against 84lb. of water for the steam-pump, on the assumption that each unit requires 30lb. of steam to generate it, which is more than 25 per cent. above the full-load consumption of the steam-engines installed.

TABLE A.

| Gallons delivered. | Pounds steam used per hour at 160lb. pressure. | Pounds water delivered per pound of steam used. |
|---|---|---|
| 1,000 | 130 | 77 |
| 2,000 | 253 | 79 |
| 4,000 | 490 | 81·5 |
| 6,000 | 714 | 84 |

TABLE B.—4,000-Gallon Motor-Driven Pump at Salford.

| Gallons delivered. | Units used. | Pounds water delivered per pound of steam used. |
|---|---|---|
| 8,971 | 27·6 | 108 |
| 15,822 | 36 0 | 147 |

Table B shows the superiority of the electrically-driven pumps from the point of view of duty per pound of steam, and this in spite of the electrically-driven pump being worm geared with a full-load efficiency of only 60·67 per cent. Tests carried out at Southport on steam-pumps which had been in use for three or four years, gave the average result of several tests, each extending over 24 hours under working conditions, as 49·1lb. of water delivered per pound of steam used. The pumps had been recently thoroughly overhauled and fitted with new pump rings; the great discrepancy, therefore, between the figures obtained and those given by the pumpmakers must be due to the intermittent nature of the load. On the basis, therefore, that the Salford electrically-driven pump absorbs 1·18 per cent. of the total output of the station, the Southport steam-driven pump would be requiring from 2½ to 3½ per cent. of the total output. In Table C are given some figures which Mr. Earle contributed in the discussion on Messrs. Taite and Downe's paper comparing the efficiency of different types of feed pump:

TABLE C.

| Load. | Capacity, gallons. | ——Pounds of water per pound of steam.—— | | | |
|---|---|---|---|---|---|
| | | Worthington. | Old pump | Electrically driven. | Electric variable stroke. |
| Full. | 64,000 | 86 | 58 | 164 | 164 |
| ¾ | 48,000 | 85 | 56 | 123 | 163 |
| ½ | 32,000 | 84 | 49 | 82 | 152 |
| ¼ | 16,000 | 80 | 36 | 41 | 129 |

The figures given by the pumpmakers are interesting as showing how slight is the increase in efficiency of a steam-pump from light load to full load. The electrically-driven pump, on the other hand, delivers 36 per cent. more water per pound of steam at full load than it does at half load. This points to the desirability of a careful sub-division of plant where ordinary motor-driven pumps are used, or better still, of a variable-stroke electric pump. As the motor-driven pump costs about three times that of the steam-pump, the interest and depreciation on the extra capital expenditure must be debited to the saving in the coal bill.

*Superheated Steam.*—I think there can be no question that considerable savings are to be effected by using steam moderately superheated, although many of the extravagant claims put forward in the past by advocates of various forms of superheater have not only been misleading, but in many cases untrue. In ordinary practice a total steam temperature of 500deg. to 600deg. F. at the engine stop valve would seem to be the highest temperature at which it pays to work. Higher temperatures are liable to give considerable trouble, due to the difficulty of lubricating, as well as in the valves and steam-piping. The savings in steam consumption obtained in some recent tests carried out on the Willans engine are shown in Diagram F, from which it will be seen that with a superheat of 50deg. F. a saving of 10 per cent. is effected, with a superheat of 100deg. F. a saving of 16 per cent., and with a superheat of 150deg. F. a saving of 20 per cent. The actual saving in coal is not quite as great as this, due to fuel being required for obtaining the superheat, but there is no doubt that the saving is an appreciable one. In Table G I give a copy of a trial carried out on a 470-h.p. Willans engine which had been at work in a Lancashire cotton mill during the past eight years, the object of the test being to ascertain what savings had been introduced by the recent adoption of superheated steam. It will be seen that the savings are very considerable, due to the uneconomical conditions under which the engine was previously working.

*Test of 470-h.p. Two-Crank Compound Willans Engine, No. 2,304, July, 1903.*—This test was carried out to ascertain what savings had been made by introducing a superheater into the downtake of a Lancashire boiler. The amount of superheat obtained on the engine was not definitely known, but as far as could be ascertained it was somewhere between 50deg. F. to 100deg. F. The length of steam-pipe between the boiler and the engine was 120ft., and it was found that before the superheater was fitted 18 per cent. of moisture was present in the steam at the engine stop-valve. The figures given below, both with saturated steam and with superheated steam, are the mean results of four tests carried out under both conditions—viz., eight tests in all.

TABLE G.

| — | Figures obtained using superheater | Figures obtained with saturated steam. | Gain in favour of superheater | Gain per cent. in favour of superheater. |
|---|---|---|---|---|
| Water per I.H.P. per hour. | 13·7 | 16·08 | 2·38 | 14·8 |
| Coal ,, ,, | 1·76 | 1·89 | ·13 | 6·88 |

Although savings of this description are to be obtained in practice, sight should not be lost of the fact that there are several possible sources of loss which must be guarded against when adopting superheated steam, losses which, as in the case of condensing, previously mentioned, in some cases have exceeded the gains. As an example of my meaning, I might mention that to obtain the most economical results from superheated steam when used in most types of engines, the degree of superheat should be maintained as nearly constant as possible. If the temperature is allowed to vary between wide limits, which is liable to occur in practice unless guarded against, there is a danger of damage at the higher temperatures, and the probability of considerable steam losses at the lower temperatures, due to valve leakage. Superheaters fitted in the downtake of Lancashire boilers give a fairly constant degree of superheat on varying loads, but if fitted inside water-tube boilers require a little attention to maintain a constant temperature. Due to the position occupied by the superheater coils inside the boiler, irregular firing will produce variations in temperature which must be watched. The most usual types of superheater at present at work in this country are: (1) the "downtake" superheater, so called because it is fitted in the downtake of Lancashire and Cornwall boilers; (2) the "Babcock" superheater, which is fitted immediately under the drum of the well-known Babcock and Wilcox water-tube boiler; (3) the "Schmidt" flue-fired superheater; and (4) the "independently-fired" superheater, which, as its name implies, is a self-contained apparatus, and fired quite independently of the boilers in conjunction with which it is used. Of "downtake" superheaters, the "Dixon" (as made by Musgrave and Hick-Hargreaves, of Bolton) and the "Bolton" superheater (made by Messrs. Easton and Co., Limited, of Erith) may be taken as fairly representing the type. With superheaters of this type, when fitted to high-pressure boilers—say, 140lb. to 180lb. per square inch working pressure—a total steam temperature of about 550deg. F. is usually obtained at the superheater. The cost of fitting a superheater of this type to a Lancashire boiler, 30ft. by 8ft., inclusive of pipes and valves, is approximately £150. The "Babcock" superheater is now very well known and needs but little explanation. This superheater usually adds 100deg. F. to 150deg. F. superheat to the steam. The "Schmidt" flue-fired superheater is applicable to Lancashire, Cornish, Economic, and dry-back boilers. It is placed in a separate chamber behind the boiler and has a much larger heating surface than can be provided in a superheater of the downtake type, the main object being that by suitably regulating the flow of gases through the superheater, the temperature of the steam can be maintained very steady irrespective of the state of the fires. The flues are so arranged that the superheater can be instantly shut off if necessary. A superheater of

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this type, suitable for a 30ft. by 8ft. Lancashire boiler, and capable of adding, say, 250deg. F. superheat to the steam, costs about £250. This is a very durable superheater, and is well spoken of by those who have had experience of its working. The chief merit of the "independently fired" superheater is apparent where water-tube boilers are used. To get the full advantage of superheat, the temperature of the steam at the engine stop valve should not be less than 550deg. F., or, say, 200deg. F. of superheat, and it is often difficult in water-tube boilers to find room for sufficient superheating surface to give this temperature. When installing independently-fired superheaters in conjunction with water-tube boilers, care should be taken never to stint the heating surface of the superheaters. They must, if they are to work successfully and prove durable, have ample surface for the work required of them, and if this precaution is taken there is no risk in putting in approved makes of this type of superheater. Experience has shown that the temperature can be maintained very steady, indeed, and many of the best engineers of the day prefer this type of superheater to any other. An independently-fired superheater, capable of adding 250deg. F. to 10,000lb. of high-pressure steam per hour, costs, exclusive of brick setting, about £400.

*Engines: High versus Slow Speed.*—Where the load on the plant is maintained at a high figure for many hours per day, the fuel consumption becomes of primary importance, and triple-expansion engines working condensing and with a high boiler pressure, the steam being superheated, are undoubtedly to be recommended. Where the load is liable to be very variable and the full load not maintained for many hours per day, it is doubtful whether triple-expansion engines are justified, and in such cases it may be advisable to substitute compound engines, either condensing or non-condensing. Compound engines have the advantage for variable power work of being able to deal more readily with overloads. As an advocate of the high-speed enclosed type of engine, you must forgive my drawing your attention to the fact that 10 of the 12 lowest stations in working costs have achieved these results with this type of engine, the lowest station in working costs with slow-speed engines being Bolton, which comes fifth on the list, and then South Shields, which comes eighth. These costs include all repairs and maintenance. This would seem to prove what has been known for many years past, that the actual steam consumption is not the only item making up the works costs, and that there are other factors almost equally important. The idea was prevalent in the minds of many some years ago that so-called high-speed engines must of necessity be more short-lived and costly in maintenance than so-called slow-speed engines, the contention being framed on the idea that the internal wear must of necessity be higher, due to the increased speed, and, further, due to the working parts being reversed so many more times a minute, the wear and tear must be greater. If these two assertions were correct, there might be some truth in this belief, but, as a matter of fact, the piston speed is less in most high-speed engines than it is in slow-speed engines (in the case of the Willans high-speed engine the piston speed ranging between 500ft. and 600ft. per minute); hence, other things being equal, the internal wear should be less in high-speed engines. The question of internal wear in an engine due to frequent reversal of parts is overcome in different ways in different types of engines, perhaps the most perfect being the arrangement adopted in the Willans engine, where the working parts never reverse their stresses. Nor do the repairs of high-speed engines seem to increase with running, as is sometimes supposed. In fact, up to 15 years' running, which is the most that the writer has been able to obtain reliable figures on, compiled from the results of eight of the oldest stations in this country, the repairs are as small during the later years as they were during the first years. Then, again, the idea was prevalent some years ago that high-speed engines required a special staff of attendants, and hence were unsuitable for small isolated plants. This idea has, however, been proved false in practice, on the grounds that it is better to have an engine which can be overhauled and kept in running order by a driver who is not a mechanic, and who, in case of repairs being necessary, can replace the defective parts from stock with a minimum of time lost, than an engine which, in the event of repairs being necessary, has to be repaired locally without facilities. If proof were necessary that this type of engine can be overhauled and kept in good running order by drivers who have had no previous experience, I might refer you to numerous cotton mills—perhaps the most conservative of all users—who have found that their drivers, previously accustomed to slow-speed engines, can master the necessary points in connection with high-speed engine within the first few months' running.

*Condensing versus Non-Condensing.*—In the case of steam-driven condensing plants, the actual power absorbed in driving the condensers is not an easy figure to check in working, and is usually unknown. In the case of electrically-driven condensing plant, however, the measurement is easily taken, and it is almost surprising what a big portion of the total units generated can be absorbed by the condensing plant when the plant is frequently run lightly loaded. Mr. Taite has found, in the case of his power station at Salford, that the jet condensers absorb 4·6 per cent. of the total units generated; whilst Mr. Downe, the borough engineer at Southport, has found that the power required for circulating water for the ejector condensers during a three hours' trial came out at 5·8 per cent. of the power of the engine, and 7·26 per cent. of the total units generated when taken over an evening's working. Then again, Mr. Denton, the Corporation engineer at Crewe, has found that the power absorbed for circulating water for his ejector condensers has come out at 6·3 per cent. of the total units generated when taken over a period of 12 months' working. I do not wish to imply that condensing has not paid in these three cases, but mention these figures as they are representative of the cost of condensing in stations with a comparatively poor load factor, and to show that they are sufficiently important to command attention. If water is expensive, and artificial cooling arrangements have to be adopted, the cost of condensing will, of course, be further enhanced. In addition, the capital charges, repairs, and maintenance of the condensing plant have, of course, to be further added to the actual running costs. I think every plant that aims at obtaining low running costs should make a point of recording the amount of power expended in condensing for different periods of the day, when it may be found that whilst condensing pays during certain periods of the 24 hours, it may be cheaper to run non-condensing during other periods. I need scarcely remind you that considerable advantage can be taken of the heat contained in the exhaust steam from non-condensing engines, in the way of heating up the boiler feed water, and as an instance of what has been done most satisfactorily in this direction, I might refer you to the three stations belonging to the Corporation of Nottingham, designed and laid down by their engineer, Mr. H. Talbot. In this town 6,000 kw. of plant has been installed, all running non-condensing, and their costs certainly compare favourably with many stations which are running condensing. In their No. 1 boiler-room, the feed water is first heated by being passed through a Berryman feed-water heater and then through a Green's economiser, the resulting temperature being 260 deg. F. to the feed water. In their No. 2 boiler-room, where dry-back boilers are used, no Green's economiser is provided, due to the low temperature of the flue gases; the feed water is, however, heated in a Berryman heater, through which the exhaust steam is passed, the resulting temperature being 200deg. F. At their St. Anne's power station, where Lancashire boilers are used, the feed water is first heated by being passed through a Berryman feed-water heater and then through a Green's economiser, the resulting temperature being 200deg. F. Considerable benefit has, therefore, been derived from the heat contained in the exhaust steam, and although it is no doubt possible to obtain a temperature of 300deg. F. in the feed water passing through a Green's economiser alone (at Crewe, for instance, the water is raised from 60deg. F. to 290 deg. F. in a Green's economiser), it means a large economiser, and where exhaust steam is available for use in heaters, the same result can be obtained with a more moderate sized economiser. High-speed engines usually necessitate the condensers being separately driven, and for this reason the cost of maintaining the vacuum is slightly higher than in the case of slow-speed engines with air and circulating pumps direct driven off the main engine. The difference, however, is not a large one, and whilst 2½ per cent. of the full load power of the engine is sufficient to allow for separately driven condensers, 1½ per cent. to 2 per cent. is the usual allowance for similar jet condensers in the case of slow-speed engines. The advantages of having the condensers independent of the main engines would seem to compensate for the slight extra cost involved in driving them.

Summarising these remarks, I think where the load justifies extremely low working costs being aimed at, a plant of the following description is most likely to bring about the desired results: Commencing with the boilers, these should be capable of generating steam at 180lb. to 200lb. pressure, and would be arranged with superheaters. If Lancashire boilers were adopted, the superheaters would be fitted in the downtake of the boilers, if of the water-tube type, the superheaters would be separately fixed. In either case a waste heat economiser of the Green type would be installed. If the coal available in the locality were suitable, the water-tube boilers might with advantage be fitted with revolving chain-grate stokers, which have been shown to give extremely high evaporative results with small and cheap coal. The boiler feed pump should, I think, be electrically driven, although a duplicate might with advantage be installed and be steam driven. The engines would be of the enclosed high-speed type, and would be triple-expansion, condensing and working at a steam temperature of about 550deg. F. The condenser, of whatever type, would be electrically driven, and a separate watt-meter should be installed for reading the power consumed by the condenser pumps, boiler feed pumps, and any other auxiliaries about the station.

(*To be continued.*)

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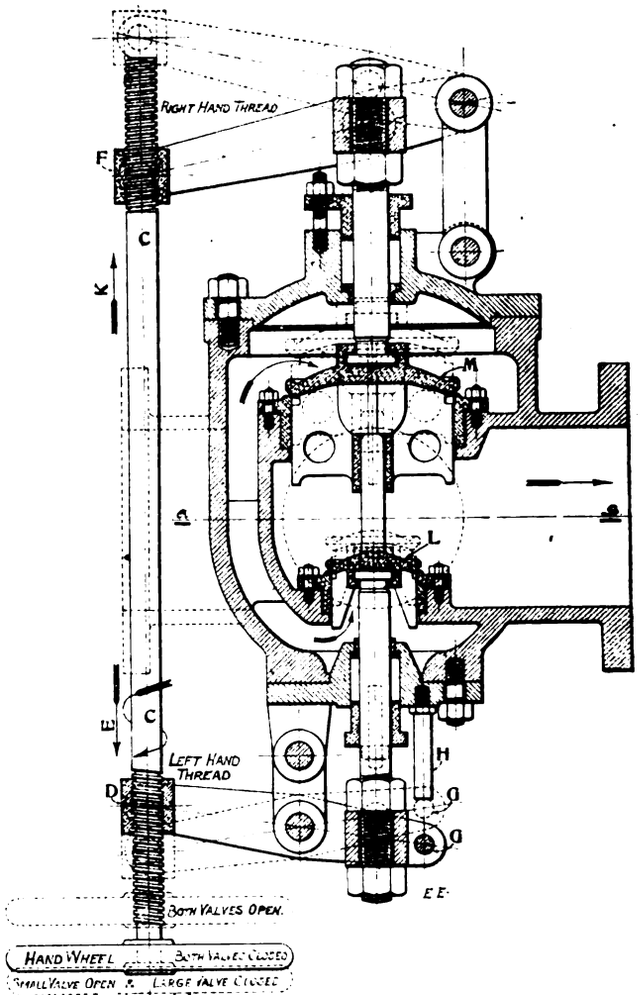
## TRADE NOTICES AND NOVELTIES.

### Green's Valve.

From Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester, we have received a copy of their new list, No. 62, wherein is described Green's patent balanced stop-valve. This valve, we are told, has been designed to overcome the difficulties experienced in other types, more particularly in regard to steam at high pressures, due to leakage resulting from unequal expansion, and at the same time provide a valve which can be opened by one man easily and without force. Referring to the accompanying illustration, it will be seen that the smaller valve has the pressure on the underside and the larger valve the pressure on the top. By this arrangement the smaller valve is the first to open on putting the operating gear into motion, and continues opening until the pressure is equal on both sides of the larger valve. The extent of lift on the smaller valve is controlled by a stop on the cover. On this stop coming into operation, the larger valve (which in the meantime has become balanced) commences to open. To open the valve the handwheel must be revolved with a left-hand motion. The spindle, C, is thereby revolved, and the nut D, having a left-hand thread, travels along the spindle, C, in the direction of arrow E. The nut F, which is screwed with a right-hand thread, is meantime held stationary owing to the pressure being on the top side of the larger valve, M. This disposition causes the spindle, C, to travel through nut F in direction of arrow E at the same time as nut D is also travelling along the spindle in same direction. This action opens the smaller valve, L, and continues to do so until the pin, G, comes in contact with stop, H. The pressure is now equal on both sides of the larger valve, M, and as nut D cannot travel farther in direction of arrow E (owing to stop, H), the continual revolving of the handwheel causes the spindle, C, to travel through nut D in opposite direction (arrow K). At the same time the nut F will also travel in direction of arrow K, this action opening the larger valve. By revolving the handwheel with a right-hand motion the operation is, of course, reversed, the larger valve, M, having the pressure on the top side, closing first.

### Artistic Fittings.

The accompanying illustrations (Figs. 1, 2, and 3) are selected from the new catalogue of artistic electric light fittings recently issued by the Edison and Swan United Electric Light Company, Limited. It will be remembered that we noticed this catalogue in our issue for last week. It contains hundreds of equally meritorious designs, which makes it impossible to do it full justice by means of a limited selection such as the pressure on our space compels. Our readers will appreciate this difficulty when they examine the catalogue. For very high-class work the firm's repoussé switch and plug covers, one of which is shown in Fig. 3, should commend themselves.




Green's Equilibrium Valve—Sectional Elevation.

Fig. 1.

Fig. 3.

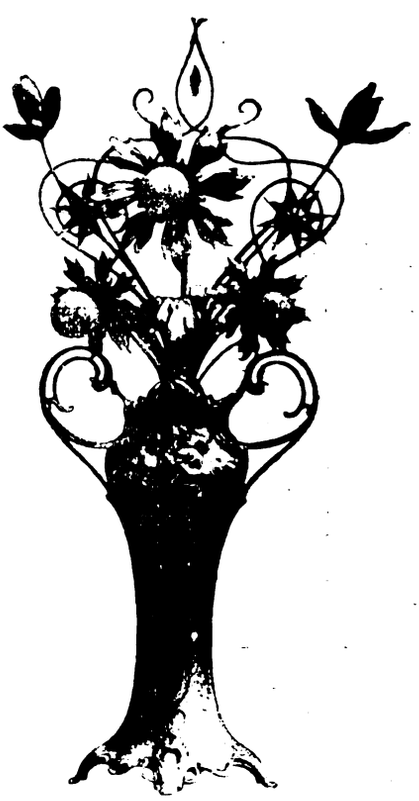


Fig. 2.

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# LEGAL INTELLIGENCE.

## DISPUTE BETWEEN ELECTRICAL COMPANIES.

In the Westminster County Court on Friday his Honour Judge Woodfall had before him the case of the National Electric Construction Company v. the Pall Mall Electric Light Company, in which the plaintiffs sought to recover damages against the defendants for alleged breach of agreement. The action was a remitted one from the High Court.

**Mr. Vaughan Williams** was counsel for the plaintiff company, and in opening the facts of the case said that some years ago an agreement was entered into between the two companies, by which the plaintiffs undertook to supply installations to the defendants' consumers, and the defendants agreed to collect the rentals of such installations and hand them over to the plaintiffs. Some time ago the plaintiffs found that they were not receiving the rentals as they should have done, and complaints were made to the defendant company, who, in reply, suggested that some of the customers had gone away without paying, whilst others would not pay. The plaintiffs then made enquiries and found that some of the customers who were supposed to have gone away were still consuming light and using the installations, and they then suggested that the defendant company should take legal proceedings against certain of the consumers, and offered to indemnify them for any loss which they might sustain by so doing, but they refused to adopt the suggestion, and this action was brought to recover damages for breach of the agreement.

The defendants admitted that certain small sums were due to the plaintiffs and paid into court the sum of £2. 1s. 3d.

Evidence was then called to show that in some cases the plaintiffs' fittings did not work properly, and were consequently useless.

**Mr. Harper** was called and said the plaintiffs' installation was so bad that he was unable to use the light for a period of two years, and finally he requested that the whole of the fittings should be removed.

It was submitted by the defendants' solicitor that, so far as the disputed items were concerned, in some cases no energy was supplied, and in other cases it had not been paid for.

In giving judgment, **His Honour** said the defendants in this case were really in the position of trustees to the plaintiffs, and the question was as to whether or not they had done all that was reasonable. After going through the various items, he had come to the conclusion that there should be judgment for the plaintiffs for £5. 17s. 4d., to include the amount paid into court.

# PERSONAL.

Mr. C. E. Davies, who for just over three years has been deputy tramway engineer to the Cardiff Corporation, has been appointed chief engineer to the Wakefield and District Light Railways Syndicate.

Last week at the Howard Hotel, Rotherham, a presentation of a portmanteau and a purse of gold was made to Mr. W. D. Newsum, one of the clerks in the Corporation tramway offices, who is about to leave England for Canada to go into the farming industry. The presentation was made by Mr. C. Webster, chief clerk. Mr. W. Grant, the tramways manager, presided.

A presentation, consisting of a silver tea and coffee service, which had been subscribed for by the staff of the Callender's Cable and Construction Company, has been made to Mr. F. E. Wilkinson, who is leaving the service of the company to take up the important position of secretary to the British and American Mortgage Company.

# APPOINTMENTS VACANT.

**Electrical Engineer**, Radcliffe. Salary, £150 per annum. Applications by March 19. See advertisement.

**Electrical Engineer**, Singapore. Salary £360 to commence. Applications to Mr. C. C. Lindsay M.I.C.E., 217, West George street, Glasgow, by April 19.

**Parcels Superintendent**, Manchester Tramways. Applications to Chairman, Tramways Committee, 55, Piccadilly, Manchester, by 12th inst.

**Assistant Electrical Engineer**, tramway department, Blackburn. Salary £150 per annum. Applications to Mr. Alfred S. Giles, Corporation Electricity Works, Blackburn, by 12th inst.

**Assistant Electrical Engineer**, Leek. Salary, 30s. per week. Applications to Mr. C. Henshaw, town clerk, by March 12. See advertisement in last issue.

**Overhead Electrical Equipment Inspector**, Swansea, during construction of tramways. Wages, £3. 3s. per week. Applications by March 19. See advertisement in last issue.

**West Riding.** The County Council offer four technological scholarships (each of the value of £60), open to residents within the administrative area of the West Riding of Yorkshire, and available for courses of instruction in connection with textiles, dyeing, engineering (mechanical and electrical), metallurgy, or other approved industry. Particulars may be obtained from the Director, Education Department, County Hall, Wakefield. See advertisement in last issue.

**Draughtsman**, Birmingham Corporation Electric Supply Department. Salary, £150 per annum. Applications to Corporation Electricity Offices, Birmingham, before March 12. See advertisement in last issue.

# COMPANIES' MEETINGS AND REPORTS.

## CITY OF LONDON ELECTRIC LIGHTING.

The directors' report for the year ended Dec. 31, 1903, states that the expenditure on capital account during the year ended Dec. 31, 1903, amounted to £81,029. 12s. 7d. The total revenue for the year amounted to £242 885. 19s. 5d., from which must be deducted expenses of generation and distribution, £55,698. 19s. 8d.; repairs and maintenance of buildings, plant, mains, etc., £15 948. 3s.; rent, rates, taxes, general, and special charges, £36,837. 10s.; interest transferred to debenture stock premium redemption fund, £1,192. 0s. 8d.; staff superannuation fund, £289. 2s. 7d.; leaving, with the balance brought forward from 1902, £22,619. 3s. 5d.—a total available revenue of £155,539. 6s. 11d. Of this sum the following amounts have been distributed or provided for: (*a*) interest on first and second debenture stock for year ended Dec. 31, 1903, £31,825; (*b*) transfer to reserve account and leasehold redemption, £45,500; leaving for dividends on preference and ordinary shares and for "carry forward" to 1904, £78,214. 6s. 11d. The directors now recommend that the following dividends for the year ended Dec. 31, 1903, be declared, subject to the deduction of income tax, to members registered in the books of the Company at the closing of the transfer books on Feb. 24, 1904: Preference shares, 12s. per share, being a distribution for the year at the full rate of 6 per cent.; ordinary shares, 10s. per share, being a distribution at the rate of 5 per cent. for the year, leaving to be carried forward to 1904, £21,881. 14s. 5d. On Feb. 10, 1904, there were 700,766 8-c.p. lamps (equivalent) applied for, out of which 661,195 were connected, and the customers numbered 11,255. The Board of Trade units sold during the year 1903, excluding public supply, were 13,596,075, as compared with 12,988,615 in 1902, and 11,526 951 in 1901. The appeals to the House of Lords as to the contracts with the Corporation of London were heard on May 14 last, and judgment, having been reserved, was given on Aug. 7. The House of Lords affirmed the decision of the Court of Appeal that the two contracts for the western and central districts of the City are invalid, and that the contract for the eastern district is valid. As these appeals had in effect reference only to the public lighting of the main thoroughfares of the City, this decision of the House of Lords does not in any way affect the validity of the Company's statutory powers for the supply of electricity for lighting and motive power to private consumers throughout all the City. The Company is still continuing the supply to the public street lamps as heretofore.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 58,154 | 11 | 3 |
| Distribution of electricity | 13,492 | 11 | 5 |
| Rent, rates, and taxes | 18,327 | 14 | 4 |
| Management expenses | 13,880 | 10 | 9 |
| Special charges, insurances, etc. | 4,629 | 4 | 11 |
| | 108,484 | 12 | 8 |
| Balance carried to net revenue account | 133,616 | 19 | 7 |
| | £242,101 | 12 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current | 211,186 | 5 | 7 |
| Revenue under contracts | 13,277 | 3 | 5 |
| Meter rentals | 9,212 | 15 | 0 |
| Rents receivable | 7,978 | 19 | 0 |
| Transfer of probate fees | 88 | 6 | 0 |
| Rental of fittings, testing fees, etc. | 358 | 3 | 3 |
| | £242,101 | 12 | 3 |

ABSTRACT OF BALANCE-SHEET.

| Dr. Liabilities, etc. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 1,805,950 | 0 | 0 |
| Sundry tradesmen and others | 18,644 | 16 | 6 |
| Sundry creditors on open accounts | 6,144 | 0 | 3 |
| Advance from bankers | 54,000 | 0 | 0 |
| Interest on debenture stock accrued to date | 15,982 | 5 | 10 |
| Unclaimed dividends | 45 | 0 | 4 |
| Sundry deposits from consumers | 2,029 | 8 | 2 |
| Ditto from tenants | 16 | 1 | 0 |
| Advance taken over on property acquired | 2,600 | 0 | 0 |
| Provision for doubtful debts | 1,400 | 0 | 0 |
| Reserve account | 219,642 | 8 | 11 |
| Debenture stock premium redemption account | 50,860 | 2 | 4 |
| Stores adjustment account | 1,746 | 4 | 1 |
| Net revenue account | 50,171 | 11 | 5 |
| | £2,229,231 | 18 | 10 |

| Cr. Capital Expenditure and Assets. | £ | s. | d. |
|---|---|---|---|
| Capital expenditure | 2,037,237 | 13 | 10 |
| Stores at stations and elsewhere | 46 826 | 13 | 3 |
| Sundry debtors for current supplied | 81,655 | 10 | 8 |
| Other debtors and payments in advance | 2,536 | 7 | 11 |
| Cash at bankers and in hand | 1,670 | 2 | 6 |
| Investments at cost and dividends accrued thereon | 59,305 | 10 | 8 |
| | £2,229,231 | 18 | 10 |

**Mr. George Herring**, the chairman, presided at the ordinary general meeting of the Company at Salisbury House on Wednesday. He hoped that the shareholders had been, to a certain extent, pleased with the report (already published by us). The gross revenue of the Company had decreased by £8,000, owing principally to competition; but the net revenue had increased by £2,000, in consequence of the economies effected in the generating expenses. In coal they had saved

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£7,567, only £1,105 of which was due to the reduced price of coal, the balance, £6,400, representing economies created by their engineer, Mr. Frank Bailey. They were placing to the reserve account £45,000, and to the leasehold redemption fund £500. The directors were very hopeful regarding the future, and he believed that this was the last year he would have to ask them to be content with a 5 per cent. dividend. The Company had issued £400,000 of first debenture stock, which had to be redeemed at 125. They were getting on much more comfortably with the City of London Corporation, and he hoped there would be no necessity to refer again to what had happened in the past. As to competition with the Charing Cross Company he must say that they had fought very fairly and honourably, but at the same time it seemed very ridiculous for them to continue fighting each other as at present. Mr. Bailey, the engineer, had instituted a bonus system in connection with any reduction in the expenses, and the amount paid in that direction during the past year was included in the increase of £2 700 in wages. The report was adopted and the dividends recommended agreed to.

## HOVE ELECTRIC LIGHTING.

The report of the directors for the year ending Dec. 31, 1903, states that the result of the year's working has been satisfactory, and the net profits have increased from £10,043 in 1902 to £11,215 in 1903. The equivalent in 8-c.p. lamps now connected is 77,366. With the balance £215. 6s., brought forward from last year, and interest on deposits, there is a total sum of £11,482. 12s. 1d. to dispose of. After deducting debenture interest and income tax paid and accrued, and the interim dividend at the rate of 7 per cent. per annum paid in October last, there remains a net balance of £7,100. 2s. 4d to the credit of net revenue account. The directors propose to place £3,000 to the credit of the reserve fund account, to place £500 to the credit of the maintenance reserve account, to declare a dividend, payable on April 15 next, at the rate of 10 per cent. per annum for the half-year on the share capital paid up, making with the interim dividend 8½ per cent. for the year, and to carry the balance, £250. 2s. 4d., forward. During the past year 2,000 shares were offered and allotted to the shareholders, and the premiums realised (£5,000) were added to the reserve fund. With the addition now proposed to be made, the sum at credit of the reserve fund account will amount to £32,326. 12s. The directors have issued during the year £8,230 additional 4 per cent. debenture stock. The total liabilities in respect to debentures and debenture stock now stand at £44,600. The amount (£600) annually set aside for repairs and maintenance, in accordance with the contract with the Hove Corporation, has proved insufficient to meet the necessary outlay on this account during the year. The excess (£13. 12s. 11d.) has been taken from the maintenance reserve account together with £900 in reduction of capital expenditure on batteries as mentioned in last report. This fund, with the £500 now proposed to be added, will stand at £561. 14s. 6d. The expenditure on capital account during the year has amounted to £20,610. 18s. 4d. after deducting the £900 mentioned in the foregoing paragraph. Of this amount £4,655. 14s. 8d. has been expended on land and buildings, £3,968. 17s. 5d. on extension of mains, £12,478. 12s. 2d. for machinery and tools, and £379. 9s. 11d. on meters. The new generating station has been completed and set to work. The buildings, machinery, and mains of the Company have been maintained in good repair.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 4,530 | 15 | 4 |
| Repairs and maintenance | 600 | 0 | 0 |
| Rents, rates, and taxes | 691 | 14 | 0 |
| Management expenses | 1,850 | 11 | 2 |
| Special charges, insurances, etc. | 147 | 8 | 11 |
| Total expenditure | 7.820 | 9 | 5 |
| Balance carried to net revenue | 11,214 | 18 | 2 |
| | £19,035 | 7 | 7 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current (779,985 units) | 18,209 | 19 | 0 |
| Rental of meters and other apparatus | 798 | 7 | 0 |
| Transfer fees | 4 | 0 | 0 |
| Rents receivable | 9 | 15 | 9 |
| Miscellaneous receipts | 13 | 5 | 10 |
| | £19,035 | 7 | 7 |

Abstract of Balance Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Share capital account—amount received | 68 420 | 0 | 0 |
| 4½ per cent. debentures | 7,300 | 0 | 0 |
| 4 per cent. debenture stock | 37,300 | 0 | 0 |
| Sundry creditors | 5,655 | 16 | 3 |
| Consumers' deposits | 72 | 0 | 0 |
| Creditors for interest accrued | 326 | 1 | 9 |
| Unclaimed dividends | 10 | 19 | 9 |
| Reserve account | 29,325 | 12 | 0 |
| Maintenance and repairs account reserve account | 61 | 14 | 6 |
| Balance at credit of net revenue account | 7,100 | 2 | 4 |
| | £155,573 | 6 | 7 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 147,714 | 5 | 11 |
| Stores on hand Dec. 31, 1903 | 390 | 0 | 6 |
| Sundry debtors | 6,582 | 9 | 2 |
| Cash at bankers and in hand | 886 | 11 | 0 |
| | £155,573 | 6 | 7 |

## NOTTING HILL ELECTRIC LIGHTING.

The fourteenth annual report of the directors states that the expenditure on capital account, which at the date of the last balance-sheet stood at £210,257. 16s. 1d., has been increased during the past year by £6,077. 7s., of which the principal items are: £2,125. 15s. 3d. for new mains; £2,297. 9s. 8d. for a new 500-h.p. motor-generator erected at the Bulmer-place station; £710. 9s. 5d. incurred in completing the conversion of the leasehold property in Lancaster road into freehold. Debentures amounting to £5 000 have been issued to meet the cost of this capital expenditure. The cost of the joint station to date has amounted to £141,772. 10s. 11d., and joint debenture stock amounting to £135,000 has been issued. This stock is subject to a cumulative sinking fund, which now amounts to £9,233. 7s. 7d invested in trustee securities. The number of consumers is now 2,052, and 97 per cent. of these are supplied at 200 volts. The gross revenue of the Company shows an increase of £605, and the net profit an increase of £408. The net profit would have been larger by about £5,100 had the charge for current been the same as that for 1902, but the directors were under agreement with the local authority to reduce the charge for current from 6d. to 5d., and the result has been that practically the whole of the profit arising from fresh business has been absorbed. The reduction promises to result in an increase of business, which should augment the net profits in the near future. There has been transferred out of profits to the depreciation, renewal, and reserve fund account the sum of £1,250, and, in addition to this, the sum of £1,030. 11s. 6d. has been paid over to the trustees of the cumulative sinking fund of the joint debenture stock referred to above. From the net profit remaining is to be deducted the interest on the debentures amounting to £2,155. 14s. 4d., the interest on the joint debenture stock £1,966. 16s. 3d., leaving £8,606. 15s. 4d available for dividend. The directors now recommend the payment of the usual dividend of 6 per cent. on the ordinary shares, which, added to the 6 per cent. on the preference shares already paid, amounts to £8,310, and that the balance be divided—one-half being credited to the founders' shares undivided profit account, and the remainder to the other classes of shares. An interim dividend of 3 per cent. on the ordinary shares was paid on July 1, and the balance of 3 per cent. will be paid forthwith. The directors also recommend a dividend of 5s. per share on the founders' shares Suggestions have been made with a view to some modification of the capital arrangements which will be more convenient both to the holders of the founders' and the ordinary shares, but will not appreciably alter the respective rights as between the various classes of shareholders either in the profits or the eventual surplus assets. The suggestions will be brought forward at the general meeting.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 8,187 | 13 | 7 |
| Distribution of electricity | 692 | 13 | 7 |
| Rent, rates, and taxes | 1,857 | 10 | 11 |
| Management expenses, salaries, etc. | 3,444 | 16 | 1 |
| Special charges, insurances, etc. | 242 | 13 | 2 |
| | 14.425 | 7 | 4 |
| Balance carried to net revenue account | 15,018 | 4 | 7 |
| | £29,443 | 11 | 11 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current less discounts and bad debts | 27,013 | 17 | 5 |
| Rental of meters and other apparatus | 1,324 | 11 | 11 |
| Connecting installations, sale of stores, etc. | 676 | 2 | 4 |
| Rents receivable | 421 | 1 | 9 |
| Transfer fees, etc. | 7 | 18 | 6 |
| | £29,443 | 11 | 11 |

| Dr. Abstract of Balance-Sheet. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 199,000 | 0 | 0 |
| Due from sundry tradesmen and others | 3,396 | 5 | 11 |
| Sundry creditors | 4,690 | 10 | 6 |
| Unclaimed dividends | 5 | 9 | 6 |
| Depreciation, renewal, and reserve fund account | 17,750 | 0 | 0 |
| Founders' shares undivided profit account | 12 | 9 | 7 |
| Preference and ordinary shares undivided profits | 157 | 9 | 6 |
| Balance at credit of net revenue account | 4,451 | 15 | 4 |
| | £229,464 | 0 | 4 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 216,335 | 3 | 1 |
| Sundry debtors for current supplied, etc. | 9,919 | 18 | 9 |
| Other debtors | 111 | 12 | 3 |
| Stores on hand | 761 | 18 | 9 |
| Stock (movable plant and tools) | 305 | 15 | 2 |
| Cash at bankers and in hand | 2,029 | 12 | 4 |
| | £229,464 | 0 | 4 |

## METROPOLITAN ELECTRIC SUPPLY.

The report of the directors for the year ending Dec 31, 1903, states that the capital expenditure, which at the end of 1902 amounted to £1,846,448. 4s. 10d., has now reached a total of £2,090,763. 8s., being an increase during the year of £244,315. 3s. 2d. Of this total the sum of £598 807. 14s. 3d. represents expenditure in Marylebone, which will be written off on completion of the purchase by the Borough Council. The gross revenue for the year amounted to £281,422 5s. 8d., as compared with £261,073. 4s. in 1902, being an increase of £20,349. 1s. 8d. The cost of generation, which in 1902 was £113,746. 17s. 6d., amounted in 1903 to £98,592. 10s. 8d., or a decrease of £15,154. 6s. 10d. On Aug. 7 the Company obtained judgment in the High Court against

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the St. Marylebone Council for payment of the sum of £1,212,000 due under the award, and for the repayment of capital expended in St. Marylebone since 1901. The date originally fixed by the Court for these payments was Dec. 31 last, but an extension of time was subsequently granted until Feb. 29, 1904 (subject to payment on Jan. 31 of £60,000 on account of the capital expenditure referred to), to enable the Council to promote a Bill in Parliament for the purpose of borrowing the money required. On 26th ult. a further extension of time was granted until April 30 next, subject to payment on 31st inst. of an additional sum of £15,000 on account. Meanwhile, it has been agreed that the Company shall retain the profits in lieu of interest on the amount of the award, but interest is payable to the Company in respect of capital expended since 1901. The arbitration held under the provisions of the London County Council (Improvements) Act, 1899, in connection with the compulsory acquisition by the Council of the generating works at Sardinia-street, has resulted in the Company being awarded the sum of £183,150. It is expected that this money will shortly be received, and the new site to be provided by the Council vested in the Company. During the past year the share capital of the Company was increased from £1,000,000 to £1,500,000 by the creation of 100,000 4½ per cent. cumulative preference shares of £5 each. Of these, 65,104 shares were taken up at par by holders of ordinary shares under the terms of the circular dated June 9, 1904, and a further 7,919 shares were subsequently disposed of at a premium. The loans from bankers, which on Dec. 31, 1902, stood at £390,000, were reduced during the year to £290,000, and now stand at £210,000. The Company have entered into an agreement with the Acton District Council for the supply of electricity in bulk for the purpose of the Council's provisional order. The balance at the credit of the revenue account, before providing for depreciation, is £142,872. 2s. The directors have set aside £18,000 as an addition to the depreciation and reserve fund, which now amounts to £116,447. 5s. 10d., carrying to the credit of the net revenue account the sum of £124,872. 2s., which, with the balance brought forward from last account and other receipts, makes a total of £129,587. 2s. 8d. After deducting interest on debenture stocks and loans, dividend on preference shares, and other charges, there remains a balance of £89,736. 3s. 6d. An interim dividend of 8s. per share (being at the rate of 8 per cent. per annum) on the ordinary share capital was paid on Aug. 11, 1903, amounting to £40,000, and the directors recommend that a further dividend of 9s. 6d. per share (being at the rate of 9½ per cent. per annum) on such shares be now paid, making a total distribution for the year of 17s. 6d. per share, or 8¾ per cent. This will absorb a further sum of £47,500, and leave a balance of £2,236. 3s. 6d. to be carried forward to the next account. The total number of 8-c.p. lamps connected at the end of 1903, was 823,000, being an increase of 100,000 during the year. The present number connected is 838,000.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 98,592 | 10 | 8 |
| Distribution of electricity | 3,646 | 19 | 10 |
| Rents, rates, and taxes | 13,945 | 16 | 9 |
| Management expenses, salaries, etc. | 19,096 | 2 | 5 |
| Law and parliamentary charges | 1,339 | 13 | 9 |
| Special charges, insurances, etc. | 1,929 | 0 | 3 |
| | 138,550 | 3 | 8 |
| Depreciation and reserve | 18,000 | 0 | 0 |
| Total expenditure | 156,550 | 3 | 8 |
| Balance carried to net revenue account | 124,872 | 2 | 0 |
| | £281,422 | 5 | 8 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current (13,551,936 B.T. units) | 271,465 | 0 | 5 |
| Rental of meters | 9,547 | 7 | 2 |
| Rents receivable | 319 | 5 | 4 |
| Net proceeds of work done and goods supplied | 90 | 12 | 9 |
| | £281,422 | 5 | 8 |

| Dr. Abstract of Balance Sheet. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 1,847,990 | 0 | 7 |
| Due from sundry tradesmen and others | 44,522 | 9 | 3 |
| Sundry creditors on open accounts | 10,813 | 14 | 9 |
| Loans from bankers | 290,000 | 0 | 0 |
| Depreciation and reserve fund | 116,447 | 5 | 10 |
| Balance at credit of net revenue account | 49,736 | 3 | 6 |
| | £2,359,509 | 13 | 11 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended | 2,090,763 | 8 | 0 |
| Stores on hand | 25,313 | 15 | 7 |
| Sundry debtors for amounts paid on contracts | 657 | 18 | 6 |
| Sundry debtors for current supplied | 100,625 | 15 | 2 |
| Other debtors | 1,687 | 12 | 3 |
| Suspense accounts waiting adjustment | 23,517 | 0 | 8 |
| Deposits (provisional orders, etc.) | 175 | 0 | 0 |
| Investments at cost | 98,103 | 17 | 0 |
| Cash at bankers on current account | 18,665 | 6 | 9 |
| | £2,359,509 | 13 | 11 |

## SOUTH LONDON ELECTRIC SUPPLY.

The report of the directors for the year ended Dec. 31, 1903, states that the total receipts for the year amount to £45,273. 14s. 11d., and the outgoings to £26,337. 8s. 6d. After placing the sum of £4,000 to depreciation, thus raising the depreciation fund to £6,448. 5s. 7d., and writing off £4,020 in reduction of preliminary expenses, there is a balance of £10,160. 16s. 1d. Out of this the Board recommend the payment of a dividend of £3 per cent. per annum, carrying forward £410. 16s. 1d. The directors have, during the past year, given careful and prolonged attention to the question of how best to deal with the item of preliminary expenses. Their view, in which they are supported by the opinion of counsel, is that this charge should be written off gradually so as not to interfere with the payment of reasonable dividends to the shareholders in the meantime. They therefore recommend that the amount should be spread over a period of 10 years, and they have accordingly allocated for that purpose the sum of £4 020 for the first year. The same amount plus accrued interest at the rate of 3 per cent. per annum should be written off out of profits each year until at the end of 10 years the item of preliminary expenses would disappear from the balance-sheet. The shareholders are asked by adopting this report to approve of the above arrangement. The plant, machinery, and mains have been maintained in a high state of efficiency. The supply of power to the London County Council for working the tramways was commenced on May 15 last, and, having been uninterruptedly continued since then, has considerably reduced the cost per unit sold. At the end of 1902 there were connected to the Company's mains the equivalent of 72,601 8-c.p. lamps; at the end of last year these figures had risen to 91,902 8-c.p. lamps, being an increase of 19,301 lamps for the year, or over 26 per cent. At the present time the number on circuit is 92,321, besides which applications have been received for a further 5,000 lamps.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 20,840 | 17 | 9 |
| Distribution of electricity | 499 | 7 | 3 |
| Maintenance and repairs of public arc lamps | 163 | 17 | 6 |
| Rents, rates, and taxes | 1,101 | 7 | 3 |
| Management expenses | 3,051 | 18 | 3 |
| Law and parliamentary expenses | 450 | 11 | 4 |
| Testing meters and insurance | 229 | 9 | 2 |
| Balance | 18,936 | 6 | 5 |
| | £45,273 | 14 | 11 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter, after deducting bad debts | 43,958 | 6 | 0 |
| Meter rentals | 898 | 2 | 10 |
| Transfer fees | 16 | 4 | 6 |
| Discount on purchases | 10 | 17 | 3 |
| Sale of electric lamps, rental of fittings, etc. | 390 | 4 | 4 |
| | £45,273 | 14 | 11 |

Abstract of General Balance Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 325,000 | 0 | 0 |
| Due from sundry contractors and others | 6,782 | 12 | 0 |
| Sundry creditors on open accounts | 3,106 | 7 | 8 |
| Temporary loan secured upon the works | 33,800 | 0 | 0 |
| Depreciation fund account | 6,448 | 5 | 7 |
| Net revenue account—balance | 10,160 | 16 | 1 |
| Unclaimed dividends | 2 | 6 | 0 |
| | £385,300 | 7 | 4 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 323,593 | 10 | 3 |
| Cost of acquisition of provisional order | 42,129 | 0 | 0 |
| Stores on hand at Dec. 31, 1903 | 4,333 | 11 | 6 |
| Sundry debtors for current supplied | 12,126 | 7 | 0 |
| Deposit with local authority for repaving streets | 100 | 0 | 0 |
| Cash at bankers and in hand | 3,017 | 18 | 7 |
| | £385,300 | 7 | 4 |

Statement of Electricity Generated, Sold, etc.

| | | | |
|---|---|---|---|
| Board of Trade units generated | | | 5,478,272 |
| Sold to consumers and used by public arc lamps | | | 4,805,481 |
| Quantity utilised | | | 4,979,891 |
| Quantity expended in distribution. | In batteries and motor-alternators | 128,730 | 421,660 |
| | In feeders | 52,419 | |
| | Transformers | 240,511 | |
| Total quantity accounted for | | | 5,401,551 |
| Quantity unaccounted for | | | 76,721 |
| Number of lamps (equivalent in 8 c.p.) on circuit | | | 91,902 |

**Mr. George Ellis, J.P.,** who presided at the ordinary general meeting on Tuesday at Cannon-street Hotel, E.C., said that during the year the number of lamps had increased by over 19,000, and since the report was issued there had been a further satisfactory increase. Since the London County Council commenced running its electric trams in May all the steam power required by them had been satisfactorily supplied by the Company. Counsel had advised that, provided adequate yearly provision was made for preliminary expenses, so as to extinguish them within a reasonable period, the dividend could be distributed as and when earned. The directors had, therefore, arranged a scale of gradual payments, commencing with £4,020, which would extinguish the amount in 10 years. The units sold in 1903 were 4,805,481, against 1,093,029 in 1902, the increase due to the Company's own consumers being 36 per cent. The balance had been generated by the London County Council's plant temporarily erected at the works, and to which the Company had supplied steam under contract. The net profits since Jan. 1 already amounted to more than those in the first six months of last year, the figures being £6,200, against £5,210. The overdraft at the bank in the early days of January had increased to £35,000. In order to liquidate that overdraft the directors had accepted an offer of the brokers, who undertook to find £50,000 of debentures bearing interest at 5 per cent.

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## HARROW ELECTRIC LIGHT AND POWER.

The report of the directors, presented to the shareholders at the ordinary general meeting of the Company yesterday, was very satisfactory. The revenue account shows a surplus carried to net revenue account of £3,381. 17s. 8d., as against £2,547. 19s. 4d. in the previous year. The amount at credit of the net revenue account, including £101. 7s. brought forward from last year, amounts to £3,576. 10s. 4d. After paying interest interim dividend on preference shares, and placing an additional £1,000 to depreciation account, there is an available balance of £1,497. 6s. 7d. Out of this the directors recommend that the following dividends be paid: final preference dividend, £360. 13s. 11d.; dividend on ordinary shares at 3 per cent., £752. 9s. 8d., leaving to be carried forward the sum of £384. 3s. In order to induce consumers to use their lights more freely, the directors decided to reduce the price per unit on the maximum demand system, and issued an advertisement to that effect in the local papers early in November last. This reduction has taken place from Jan. 1, 1904. The number of lamps installed during the year amounted to 1,769; the number of units supplied to consumers was 229,452, an increase of 14,373 over the previous year. The works costs shows a considerable reduction, amounting to 1·87d. per unit, as against 2·24d. in 1902 and 3·02d. in 1901. The total costs amount to 2·87d. per unit in 1903, as against 3·43d. in 1902 and 4·32d. in 1901. A scheme of steam condensing and superheating will be carried out during the ensuing year, which will not only increase the boiler power, but will reduce the consumption of coal. The directors consider it desirable to issue £3,000 more of ordinary shares to provide the necessary funds, and are prepared to receive applications from the shareholders. Mr. C. E. Ashford has resigned his seat on the Board, the vacancy being filled by Mr. G. Townsend Warner, and Mr. E. M. Butler has accepted a seat on the Board, thus filling the vacancy caused by the death of Mr. Charles Colbeck. Mr. G. W. Spencer Hawes has also been added to the number, thus bringing the Board up to its previous strength.

## SWANSEA IMPROVEMENTS AND TRAMWAYS.

The report of the directors for the half-year ended Dec. 31, 1903, states that the gross receipts amount to £15,485. 17s. 7d., being an increase of £1,725. 9s. 10d. upon the corresponding period of last year, and the expenses (including debenture and other interest) to £10,121. 14s. 8d., an increase of £504. 18s. The profit on the half-year's working is £5,364. 2s. 11d., which, added to the balance of £1,322. 1s. 9d. brought forward, makes a total of £6,686. 4s. 8d. at the credit of profit and loss account. The directors recommend that this sum be allocated as follows: to be placed to reserve fund and applied in reduction of balance of advances due to the British Electric Traction Company, Limited, £1,000; to dividend on 984 preference shares at the rate of 6 per cent. per annum, £295. 4s; to dividend on 4,016 preference shares at the rate of 5 per cent. per annum, £1,004; to dividend on 13,000 ordinary shares at the rate of 2½ per cent. for the year, £3,250; to be carried forward to next account, £1,137. 0s. 8d. An action brought by the Corporation to determine their rights of purchase of the Company's undertaking under the various Acts of Parliament, more particularly that of 1882, has been decided by Mr. Justice Buckley in a manner favourable to the Company. The construction of the Swansea Corporation tramways and light railways has been commenced by the Corporation. When completed, the lines, as previously stated, will be leased to the Company. It is anticipated that one section will be opened for public traffic in the early summer. The working of the Mumbles Railways and Pier shows a profit of £738. 16s. 8d., which, deducted from the deficiency of £2,543. 10s. 6d. for the half-year ended June 30, 1903, leaves a net deficiency of £1,804. 13s. 10d. on the year's working. In terms of the agreement, this amount is to be provided by the British Electric Traction Company. The exceptionally wet weather during the greater part of the year seriously affected the traffic.

## W. T. HENLEY'S TELEGRAPH WORKS.

The report of the directors for the year 1903 states that a net profit has been made of £44,450. 3s. 6d. After payment of directors' and auditors' fees, debenture interest and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, etc., there remains £36,742. 13s. 6d., making, with £25,967. 13s. 11d. brought forward from last year, a total of £62,710. 7s. 5d. The directors have transferred £1,000 to the debenture redemption sinking fund, and they recommend the payment of a dividend on the ordinary shares at the rate of 15 per cent. (less income tax), including the interim dividend of 6 per cent. paid on Sept. 1 last. These payments will, together with the preference dividend for the year, amount to £35,125, leaving a balance of £27,585. 7s. 5d. to be carried forward.

## COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

In their report for the year ended Dec. 31, 1903, the directors state that the capital expended during the year under review in respect of the Company's London districts amounted to £133,772. 6s., making the total expenditure on account of those districts up to Dec. 31 last £1,300,088. 19s. 11d. The balance from last account amounted to £4,956. 7s. 1d., and the balance from revenue account was £70 972. 15s. 11d., making a total available revenue for the year 1903 of £75,929. 3s., from which should be deducted interest on the first and second debenture stock, including interest on instalments paid in advance and interest on temporary loans to Dec. 31, 1903, less income tax, £27,874. 16s.; interim dividend on 30,000 6 per cent. preference shares for half-year ended June 30, 1903, less income tax, £8,512. 10s.; interim dividend on 40,000 ordinary shares at 4 per cent. per annum for half-year ended June 30, 1903, less income tax, £7,565. 13s. 4d.; amount carried to reserve for depreciation, repairs, renewals, etc., £10,000; amount carried to contingency account, £500; leaving for further distribution £21,476. 3s. 8d. The directors now recommend: (1) that payment of the interim dividend on the 30,000 6 per cent. preference shares for the half-year ended June 30, 1903, less income tax, be confirmed; (2) that payment of the interim dividend on the 40,000 ordinary shares, at the rate of 4 per cent. per annum, for the half-year ended June 30, 1903, less income tax, be confirmed; (3) that a further dividend on the 30,000 6 per cent. preference shares for the half-year ended Dec. 31, 1903, less income tax, be declared; and (4) that a further dividend on the 40,000 ordinary shares for the half-year ended Dec. 31, 1903, at the rate of 4 per cent. per annum, less income tax, be declared, and that the said dividends be paid to all proprietors registered at March 3, 1904. This will absorb £16,220. 16s. 8d., and leave a balance of £5,255. 7s. to be carried forward. In order to provide the necessary funds for the development of the Company's business, an issue of £250,000 4½ per cent. second debenture stock was made in April of last year at the price of 103 per cent. The London Electric Supply Corporation, Limited, applied to Parliament last year for an extension order in competition with this Company throughout the borough of Camberwell. The Board of Trade, however, after holding a public enquiry and hearing evidence on both sides, refused to grant the order. The Borough Council of Bermondsey again applied for a competing order for St. Olave, but the Board of Trade, without taking evidence, refused to grant the order. The directors propose to change the name of the Company to the "County of London Electric Supply Company, Limited." The necessary resolution embodying the above proposal will be submitted for approval at the shareholders' meeting to be held on the 14th inst., and, if approved, will then be submitted for confirmation as a special resolution to an extraordinary general meeting which will be subsequently convened.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Engineers' salaries and wages (generation) | 6,896 | 4 | 4 |
| Coal and other fuel | 15,956 | 6 | 7 |
| Oil, waste, water, etc. | 1,886 | 9 | 5 |
| Repairs of buildings and plant | 3,660 | 6 | 9 |
| Engineers' salaries and wages (distribution) | 4,741 | 1 | 6 |
| Repairs and maintenance | 1,746 | 8 | 8 |
| Rents payable and rates, taxes, and insurance | 7,760 | 12 | 2 |
| Directors' fees, wages, and proportion of salaries | 6,554 | 0 | 9 |
| Printing, stationery, and postage | 1,367 | 0 | 0 |
| General charges, advertising, and travelling | 2,031 | 9 | 7 |
| Trustee's fee | 157 | 10 | 0 |
| Auditors' fees—Board of Trade and Company's | 359 | 0 | 0 |
| Legal charges | 248 | 13 | 2 |
| Reserve for bad debts | 200 | 0 | 0 |
| Depreciation of office furniture | 222 | 4 | 10 |
| Amount written off general suspense account | 394 | 11 | 9 |
| | 54,181 | 19 | 6 |
| Less repairs and renewals as above | 5,406 | 15 | 5 |
| | 48,775 | 4 | 1 |
| Balance carried to net revenue account | 70,972 | 15 | 11 |
| | £119,748 | 0 | 0 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Receipts from sale of current | 105,316 | 7 | 4 |
| Rental of meters | 3,700 | 18 | 2 |
| Testing fees | 3 | 2 | 0 |
| Rents receivable, discounts, etc. | 2,101 | 10 | 11 |
| Transfer fees | 66 | 1 | 0 |
| Interest and dividends receivable | 6,861 | 15 | 1 |
| Profit on investments realised and commissions | 1,698 | 5 | 6 |
| | £119,748 | 0 | 0 |

ABSTRACT OF BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital issued | 700,000 | 0 | 0 |
| 4½ per cent. debenture stock | 400,000 | 0 | 0 |
| 4½ per cent. second debenture stock | 250,000 | 0 | 0 |
| Loans against security | 75,500 | 0 | 0 |
| Reserve for depreciation, repairs, etc. | 33 044 | 7 | 1 |
| Reserve (from premiums on shares) | 5,000 | 0 | 0 |
| Sundry creditors on open accounts, and bills payable | 66,052 | 9 | 3 |
| Balance at credit of net revenue account | 21,476 | 3 | 8 |
| | £1,551,073 | 0 | 0 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended | 1,300,088 | 19 | 11 |
| Stores on hand | 23,681 | 10 | 9 |
| Lands, buildings, etc. | 11,122 | 10 | 0 |
| Preliminary expenses and suspense account | 22,366 | 19 | 1 |
| Investments in associated supply companies | 120,483 | 9 | 8 |
| Head office furniture, books, etc. | 1,915 | 19 | 3 |
| Sundry debtors | 65,873 | 3 | 5 |
| Cash at bank and in hand | 5,540 | 7 | 11 |
| | £1,551,073 | 0 | 0 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | |
|---|---|
| Quantity generated in Board of Trade units | 8,130,515 |
| Quantity sold to private consumers by meter | 5,754,633 |
| Quantity used on works | 534,249 |
| Total quantity accounted for | 6,288,882 |
| Quantity not accounted for | 1,841,633 |
| Total maximum supply demanded (kilowatts) | 5,342 |

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## LONDON ELECTRIC SUPPLY.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C.

**Mr. Robert H. Benson,** who presided, said that the gross revenue for the year under review amounted to £77,190, or a decrease of £1,145; but the net revenue was £36,177, against £35,342, an increase of £835. The saving in expenditure had been entirely in the cost of generation. The number of lamps had increased by 17,877, and the units sold had increased. It might be asked why the Company made less in gross with more lamps and an increase in units sold. The answer was—competition. The price now was 4½d. per unit, but the Company made more in net at a lower figure than at a higher price. It was more profitable to do a large business on a small margin of profit than a small business on a large margin of profit. The improvement in revenue from the contract with the London County Council to supply power for the South London tramway did not begin until Jan. 17 of the current year, so that last year's accounts had not benefited. The Company's experience since then had been satisfactory, and the contract had tended to reduce the cost of generation. The Company, he expected, would sell 8,000,000 or 10,000,0000 units this year. The contract was at a cheap rate, but the load came upon the engines chiefly in the daytime, when they were running light. The capital expenditure during the year amounted to £36,198 which was a small amount for a company with such an area and a growing business. The directors could now forecast a capital expenditure of £58,000, but the whole of that was not likely to be required in the current year. The Company had borrowing powers unexercised for £45,000 in debenture stock, but they could not be run too fine. He hoped that at some time it would be possible to provide capital expenditure by the issue of ordinary shares, but as that time had not come, the best course open was to increase the issue of preference shares. The time had arrived when the growing business required that the Board should be increased, and Mr. Robert Norton and Sir William Pollitt had been appointed additional directors.

The report was adopted, also a resolution for the creation and issue of 20,000 new £5 preference shares.

## LONDON UNITED TRAMWAYS (1901) LIMITED.

An extraordinary general meeting was held on Wednesday at the offices, Chiswick. The following resolution passed at an extraordinary general meeting held on the 22nd ult. to approve Bills now being promoted in Parliament were confirmed: (1) For conferring powers on the Company for constructing tramways and widening and altering roads and acquiring lands in the counties of Middlesex, Bucks, Surrey, and London; and (2) for empowering the Company to construct railways between certain of their existing and authorised tramways and the Hammersmith Station of the Metropolitan District Railway Company.

## NEW COMPANIES REGISTERED.

**Tramways Extension Syndicate.**—Capital, £5,000. Object: to acquire or construct and work (by electricity, steam, horse, or other power) tramways, railways, etc.

**Hove and Worthing Electric Tramways, Limited.**—Capital, £100,000. Object: to carry on the business of carriers of passengers and goods, manufacturers of and dealers in railway, tramway, electric apparatus, etc. Registered office: Donington House, Norfolk-street, W.C.

**Musselburgh Construction Syndicate, Limited.**—Capital, £76,000. Objects: to adopt an agreement with the National Electric Construction Company, Limited, and to carry on the business of railway and tramway proprietors, suppliers of electric light and power, electrical engineers, etc. Registered office: 34, Victoria-street, S.W.

**Cleminson Electric Lamp Attachment, Limited.**—Capital, £2,500. Objects: to adopt an agreement with N. Cleminson, and to carry on the business of electric light engineers, electricians, dealers in electrical, telegraph, telephone, and traction supplies and appliances, manufacturers of electrical plant, etc. Registered office: 19 and 20, York-chambers, 27, Brazennose-street, Manchester.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Gijon (Spain).**—The Municipality requires tenders for a telephone line between Gijon and Gala de Siero by March 22.

**Retz (Lower Austria).**—The Municipality require tenders for the installation, etc., of an electric light works. Tenders by March 20.

**Seville (Spain).**—The Department of Commerce, etc., at Madrid require tenders for installation and working of tramways at Seville by March 21.

**Plasencia (Spain).**—The Municipality require tenders for installing and working an electric lighting undertaking concession. Tenders by March 28.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Wrexham.**—The Town Council invite tenders for stores, including various electrical fittings. Particulars from the Borough Electrical Engineer. Tenders by March 12.

**Kilmarnock.**—The Corporation invite tenders for the various plant in connection with electric lighting and tramways for the burgh. Particulars from the Town Clerk. Tenders by March 14.

**Aberdeen.**—The Electric Lighting Committee invite tenders for two water-tube boilers and accessories. Specification, etc., may be obtained from the Engineer. Tenders by 31st inst. See advertisement.

**Glasgow.**—The Corporation invite tenders for the construction of new tramways. Specification, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 11 a.m. on 21st inst.

**Preston.**—The Tramways Committee invite tenders for surface condenser cooling tower at new power station. Specifications, etc., may be obtained from Mr. Walter H. Tittensor, 25, Burrow-road, Preston. Tenders by 19th inst.

**Rugby.**—The Urban District Council invite tenders for the construction and erection of a refuse destructor. Specifications, etc., may be obtained at the office of Mr. D. G. Macdonald, A.M.I.C.E., surveyor to the Council. Tenders by March 28.

**London, W.**—The London County Council invite tenders for a 30-ton electric jib crane for Greenwich electricity generating station. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on 22nd inst.

**Stockport.**—The Electricity Committee invite tenders for the supply of one 500-kw. steam generator. Specifications, etc., may be had on application to Mr. A. J. H. Carter, Electricity Works, Stockport. Tenders by 25th inst. See advertisement.

**Gainsborough.**—The Urban District Council invite tenders for telephone instruments, fire alarms, and connecting overhead wires. Specification from Mr. R. W. Fraser, electrical engineer to the Council. Tenders by March 16. See advertisement in former issue

**Brighton.**—The Town Council invite tenders for erection and completion of proposed new converter house, cable culverts, etc. Specification, etc., obtained at the office of Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders before 10 a.m. on 14th inst.

**Swindon.**—The Corporation invite tenders for the electric lighting installation at the car depot Specifications, etc., may be obtained at the offices of the engineers, Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by 25th inst. See advertisement.

**Newport.**—The Corporation invite tenders for tramrails and fish-plates (British standard section and specification), and setts for tramway work. Specifications, etc., may be obtained from the Borough Engineer, Town Hall, Newport. Tenders by 17th inst.

**Sunderland.**—The Corporation invite tenders for the supply of indiarubber-covered cables from April 1, 1904, to March 31, 1905. Specifications, etc., can be obtained from the Borough Electrical Engineer. Tenders by March 31. See advertisement in last issue.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Wallasey.**—The Urban District Council invite tenders for the supply and delivery of alternating-current transformers required during the next two years. Specifications may be obtained from Mr. J. A. Crowther, Sea View-road, Liscard. Tenders by March 16.

**Dartford.**—The Urban District Council invite tenders for the construction and working for a term of years of electric railways. Specifications, etc., may be obtained from Mr. W. Kay, Council Offices, Dartford, Kent. Tenders by March 26. See advertisement in last issue.

**Aston Manor.**—The Corporation invite tenders for two water-tube boilers, superheater, and mechanical stoker. Specifications from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on March 14. See advertisement in former issue.

**Leavesden (near Watford).**—The Metropolitan Asylums Board invite tenders for installations of fire alarms and telephones at the asylum. Specifications, etc., may be obtained at the office of the Board, Embankment, London, E.C. Tenders by 10 a.m. on 22nd inst.

**South Shields.**—The Corporation invite offers for the lease of certain of the tramways to be constructed in the borough, together with the stables and depot. Particulars can be obtained from Mr. J. Moore Hayton, Court-buildings, South Shields. Tenders by March 12.

**Walsall.**—The Guardians invite tenders for the installation of electric light at the new buildings at the workhouse, Pleck-road, Walsall. Specifications, etc., may be obtained on application to Mr. A. H. Lewis, Union Offices, 29, Leicester-street, Walsall. Tenders by 16th inst.

**Ballinasloe (Ireland).**—Tenders are invited for two electric motors, to be driven from the existing plant, for the Joint Committee of Management of the District Lunatic Asylum, Ballinasloe. Specifications may be seen at the office of Mr. J. Smith, M.I.C.E. Tenders by 2 p.m. on March 12.

**Handsworth (near Birmingham).**—The Urban District Council invite tenders for supply and delivery of permanent way, pavement, roadwork, and overhead equipment. Specifications, etc., can be obtained from Mr. H. Ward, clerk, Council House, Handsworth. Tenders by 30th inst.

**Keighley.**—The Corporation invite tenders for rails, overhead equipment, section boxes, bonds, cars, cables, switchboard, and car-shed. Specifications etc., can be obtained on and after the 14th inst. from Mr. Alfred Lister, borough treasurer, Town Hall. Tenders before 10 a.m. on March 25.

**Warrington.**—The Electricity Committee invite tenders for 12 months' supply of electric motors. Specifications, etc., can be obtained on application to Mr. F. V. L. Mathias, A.M.I.E.E., borough electrical engineer, Howley, Warrington. Tenders by 12 noon on 14th inst. See advertisement in last issue.

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**Warrington.**—The Electricity Committee invite tenders for 12 months' supply of paper-insulated cables. Specifications, etc., can be obtained on application to Mr. F V. L. Mathias, A.M.I.E.E., borough electrical engineer, Howley, Warrington. Tenders by 12 noon on 14th inst. See advertisement in last issue.

**Kettering.**—The Urban District Council invite tenders for the wiring of the arc and incandescent lighting circuits and fittings at their generating station. Specifications, etc., may be obtained from Mr. John Bond, Council Offices, Market-street, Kettering. Tenders by 16th inst. See advertisement in last issue.

**Lincoln.**—The Corporation invite tenders for one marine-type water-tube boiler and one high-speed engine coupled to a continuous-current dynamo. Specifications, etc., may be obtained from Mr. Stanley Clegg, Electricity Works, Brayford Side North, Lincoln. Tenders by 21st inst. See advertisement in last issue.

**Leek.**—The Urban District Council invite tenders for electricity meters Specifications can be obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Council, 14, Old Queen-street, Westminster, S.W., on and after March 7. Tenders by 12 noon on March 14. See advertisement in last issue.

**Newport (Mon.).**—The Corporation invite tenders for boosters, balancers, etc., switchboards, tramway poles and brackets, overhead materials, section pillars, cables, and trolley wire. Specifications may be obtained from Mr H. Collings Bishop, M.I.E E., Town Hall. Tenders before March 21. See advertisement in last issue.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated) during the 12 months ending March 31, 1905. Specifications, etc., may be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by 19th inst. See advertisement.

**Hearts of Oak Benefit Society.**—The Society invite tenders for electric lighting, gas lighting, heating, and ventilating, bells and telephones, lifts and enclosures, for new offices at Euston-road, London. Particulars from the Chairman of the Building Committee, 17, Charlotte-street, Fitzroy-square, London, W., not later than 18th inst.

**Norwich.**—The City Council invite tenders for underground cables, rubber-covered wires and accessories, incandescent lamps, continuous-current meters, and motor for 10-ton travelling crane. Specifications, etc., may be obtained from the City Electrical Engineer, Corporation Electricity Works. Tenders by 10 a.m. on March 14. See advertisement in last issue.

**Poplar.**—The Borough Council invite tenders for two 1,000-kw. turbo-driven three-phase alternating-current generators and condensing plant. Specifications, etc., may be obtained at the offices of the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 9 a.m. on March 12. See advertisement in last issue.

**Bootle.**—The Corporation invite tenders for the supply of a one-horse emergency telescopic tower wagon, to be used for the maintenance of the overhead line equipment of tramways. Also a motor wagon for the same purpose, driven by any form of readily-started motor or engine. Tenders before 10 a.m. on 21st inst. Particulars from the Borough Electrical Engineer, Pine-grove, Bootle.

**Londonderry.**—Tenders are invited for carrying out the following works at the District Lunatic Asylum: (Section A) steam set boiler, pipework, switchboard, etc.: (B 1) wiring and cables to villa; (B 2) wiring and cables to new block. Specifications, etc., may be obtained at the office of Mr. R. V. Macrory, consulting engineer, Strand, Londonderry. Tenders before 12 noon on March 17.

**Govan.**—The Corporation invite tenders for the purchase of three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery, and balancer, also for three-wire booster by the British Thomson-Houston Company, Limited. Particulars may be obtained from the Burgh Electrical Engineer, Helen-street, Govan. Tenders by March 29. See advertisement in last issue.

**Middlesex.**—The Light Railways Committee of the County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, and road widenings connected with four lines of double track, junctions, etc. Specifications, etc., may be obtained from Mr. H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster. Tenders by March 14.

**Stepney.**—The Electrical Committee invite tenders for the supply and erection of one 1,000-kw. steam-turbine-driven double-current generator; and four water-tube Babcock and Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump, and accessories. Specifications may be obtained at 27, Osborn-street, Whitechapel. Tenders by March 14. See advertisement in former issue.

**Wimbledon.**—The Urban District Council invite tenders for the supply of engine-room stores, cables, joint boxes and jointing material, transformers, meters, lubricating oils, and incandescent lamps and carbons to the electricity department during the year ending March 31. 1905. Specifications may be obtained from the Chief Electrical Engineer, Electric Light Works, Durnford-road, Wimbledon. Tenders by March 18. See advertisement in former issue.

**Ilford.**—The Urban District Council invite tenders for the supply and erection of the following plant: one 1,000-kw. steam dynamo, comprising vertical engine coupled direct to multipolar dynamo; extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, motor-driven pumps, water-cooling tower, and pipework; water-purifying plant; pipework; feeder and pilot cables, feeder pillar, and joint-boxes. Specifications, etc., may be obtained from Mr. John W. Fenton, Town Hall, Ilford, Essex. Tenders by March 22. See advertisement in former issue.

## RESULTS OF TENDERS.

**Leek.**—The Electricity Committee have accepted the tender of Mr. J. Richards, Burton, at £24, for wiring at the generating station.

**Newcastle.**—The Town Council have accepted the tender of the Campbell Tile Company for the laying of the floor of the electric supply station.

**Glasgow.**—The Electricity Committee have accepted the tender of the Electrical Company, Limited, for providing and erecting six motor-generators at £9,958.

**Swindon.**—The Corporation have accepted the tender of Messrs. Webb and Sons, Leicester, for the wiring of the Euclid-street higher elementary school for electric lighting.

**Lowestoft.**—The Council have accepted the tender of Mr. A. G. Beckett, at £107. 12s., for building the store for the joint use of the tramways and electric supply department.

**Erith.**—The Urban District Council have ordered from the British Westinghouse Electric and Manufacturing Company, Limited, a 500-kw. three-phase engine-type alternator to operate at 3,000 volts 50 cycles.

**Heath Asylum.**—The Sir Hiram Maxim Electrical and Engineering Company, Limited, have received from the London County Council Asylums Committee a contract for a year's supply of lamps to the Heath Asylum.

**Brighton.**—The Lighting Committee have accepted the tender of the Glasgow Electric Crane and Hoist Company, Limited, Parkhead, Glasgow, at £1,100, for a 20-ton 4-motor electric crane for the Southwick power house.

**Canterbury.**—The Drainage Committee have accepted the tender of Messrs. W. H. Allen, Son, and Co., Bedford, at £970, for the supply and erection of four motor-driven centrifugal pumps for lifting sewage at their sewage farm.

**Salford.**—The Council have accepted the tenders of Messrs. T. and R. Lees, Hollinwood, for steam inlet piping to engine from boiler, etc., £71; improved friction clutch, etc., £42. 10s.; and two rope pulleys, three driving pulleys, etc., £96.

**Newport.**—The Town Council has adopted the recommendation of its Electricity Committee to purchase 10 electric cars from Messrs. Dick, Kerr, and Co. for £5,046, and air-brake equipment for six cars, to be used on the Stow-hill service, for £450.

**Whitehaven.**—The Town Council have received the following tenders: electric glow lamps, Edison and Swan and Defries and Sons; meters Ferranti, Limited; fuse boxes, Reason Manufacturing Company, for 12 months ending March 31, 1905.

**Bury.**—The Council have accepted the following tenders: copper lamps, Samuel Gregson, Clerk-street; lamp pillars, Harper and Sutcliffe, Manor-street; steam tubing and fittings John Jardin, Market-street, and W. A. Platt and Son, Walmersley-road.

**Ealing.**—The Corporation have accepted the tender of Messrs. Siemens Bros. and Co., Limited, at £5,811, for Siemens-Paxman steam alternator; and that of Messrs. Bertrams, Limited, of Edinburgh, at £2,360. 10s., for the central surface condensing plant.

**Automatic Telephones.**—The tender of the Private Wire and Telephone Installation Company, 5, Palmer-street, S.W., has been accepted for installing a complete system of automatic intercommunication telephones in the new offices of the *Engineer* now nearing completion in Norfolk-street, Strand.

**Wiring.**—The May-Oatway Fire Appliances, Limited, have accepted the following tenders for wiring buildings for direct connection with the fire brigades: National Telephone Company—Messrs. Fleming, Reid, and Co's mills, etc., Greenock, and Theatre Royal, Edinburgh; Messrs. Wm. Douglas, Limited—Lyceum Theatre, Edinburgh.

**Hull.**—The North-Eastern Railway Company have placed a contract for an extensive installation of power signalling at the new Paragon Station, Hull, with Messrs. Mackenzie and Holland, of London and Worcester, the agents of the Westinghouse Brake Company. The apparatus will be of British manufacture, being made at the works of the Westinghouse Brake Company, Limited, King's Cross, London.

**Colliery Plant.**—Messrs. Ernest Scott and Mountain Limited, Close Works, Newcastle-on-Tyne, have reported the following contracts for electrical transmission of power machinery: two of their enclosed central-valve compound engines of 400 i.h.p. direct-coupled to two of the firm's multipolar continuous-current generators, each of 250 kw. capacity, for the Horden Collieries, Limited, Shotton Colliery, near Castle Eden; two coupled compound horizontal steam-engines, each of 300 i.h.p., driving by ropes on to two continuous-current generators, each of 200 kw. capacity, for the Moss Bay Hematite Iron Company, Beckermet Mines, Cumberland. Also engines for the Charlow and Sacriston Coal Company and for H. Stobart and Co., Etherley Grange Colliery; and an electric pumping plant for the Stockingford Colliery, near Nuneaton.

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**Nelson.**—The Corporation has come to an arrangement with the Burnley Corporation, under which the latter are to take a lease of the Nelson tramway for seven years from March 31, 1902, the rental to be £830 per annum; the Corporation of Nelson to repair and maintain the permanent way and overhead equipment, the Corporation of Burnley paying the actual cost thereof, plus 5 per cent. for supervision; the Corporation of Nelson to provide at their own cost all setts, if any required in substitution for the lava setts with which a portion of the road is paved; the Corporation of Nelson to supply electricity for tramway purposes in Nelson and Brierfield at the price of 2d. per unit at the switchboard at the Nelson electricity works, as previously arranged; upon any renewal of the lease at the expiration of seven years, the rent to be subject to revision in accordance with the increased earning capacity of the section, as indicated by the gross receipts.

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# BUSINESS NOTES.

## TRACTION.

**Reading.**—Tenders are to be invited for six bogie cars capable of seating 70 passengers.

**Colwyn Bay.**—The Urban District Council will oppose the North Wales Power and Traction Bill.

**Scarborough.**—The Scarborough tramways are to be formally opened by the Mayoress on April 30.

**Brighton.**—The Brighton Corporation has decided against the introduction of tramways on the Marine Parade.

**Liverpool.**—The Liverpool Council have sanctioned the purchase of a large site in Hatton-garden for tramway offices.

**Douglas.**—The Douglas municipal tramway profit of last year of £2,350 has been applied to the relief of the rates.

**Belfast.**—The Borough Council has decided to proceed with the Bill for permissive power to purchase the tramways.

**Birkenhead.**—The Tramway Committee are applying to the Board of Trade for a loan of £5,000 to provide top back covers on the tramcars.

**Devonport.**—The Admiralty has decided to substitute an electric tramway for the present train service between the north and south dockyards.

**New Derbyshire Tramway.**—It is proposed to construct a tramway between Rowsley and Cromford, with a prospect of an extension to Sheffield, the cost being stated at £20,000.

**Exeter.**—The tramway company have agreed with Mr. Lucas with respect to the purchase of land on which to build the tramway depôt. The agreement is to be confirmed by the Council.

**Southport.**—The Town Council has appointed the chairman and Councillors Jones and Travis as a sub-committee to consider the cost of the electrification of the pier tramway service.

**Winding-up Court.**—The petition for the winding-up of the Electric Tramways Construction and Maintenance Company, Limited, of F. H. Barr and others has been dismissed, without costs.

**Llandilo.**—The Urban District Council has decided to support the proposed light railway between Lampeter and Llandilo, and to contribute a sum not exceeding £100 towards the cost.

**Berlin.**—It is announced that the combined elevated and underground railway will, as the result of the company's first year's working on their own account, pay a dividend of 3½ per cent.

**Altrincham.**—The Urban District Council has appointed representatives to confer with the Denton Urban District Council upon a suggested alternative route from Denton to Woodley.

**Worcester.**—The Corporation are bringing pressure to bear on the tramway company to force them to construct at once the Bath-road tramways, which should be completed by the 17th inst., and have not yet been commenced.

**West Bromwich.**—The Board of Trade certificate for the Bromford-lane and Spon-lane sections of tramways has been received, and the service was commenced on Wednesday last. This completes the West Bromwich tramway scheme.

**Ormsby.**—The negotiations between the North Ormsby Urban District Council and the Imperial Tramway Company with respect to the extension of the company's system have not so far been successful, and the Council is still opposing the company's Bill.

**Manchester.** — The Corporation Tramways Committee have approved a grant of £50,000 to the relief of the city rates, the sum representing the profits on tramway running for 12 months. The sum placed to the relief of the rates last year was £30,000.

**Witney, Burford, and Andoversford Light Railway.**—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order authorising the construction of a light railway from Witney (Oxford) to Andoversford (Gloucester).

**Hertford.**—The Board of Trade have confirmed the County of Hertford Light Railways (No. 1) Order, 1904, authorising the construction of light railways in the parishes of Arkley, Barnet Vale, Chipping Barnet, Bushey Rural, Bushey Urban, and Watford Urban.

**Ripon.**—At a recent meeting of the Rural Council, attention was drawn to the need of a light railway from Ripon to Kirby-Malzeard. The Corporations of Leeds and Harrogate will not provide funds for the construction of this. A further report on the matter is to be made.

**Glasgow.**—The Corporation passed a minute containing an account of the negotiations between the Tramways Committee and the Caledonian Railway Company and the Distillers' Company with reference to taking a supply of water from the canal for condensing purposes at Pinkston power station.

**York.**—At the annual meeting of the York Tramway Company the chairman alluded to the indecision of the Corporation on the question of purchase. Until this was cleared up the electrification of the lines could not be decided. The delay in the decision would cause much inconvenience to the public.

**New Hertfordshire Light Railways.**—The Board of Trade has confirmed the County of Hertford Light Railways (No. 1) Order, 1904, authorising the construction of light railways in the parishes of Arkley, Barnet Vale, Chipping Barnet, Bushey Rural, Bushey Urban, and Watford Urban, in the county of Hertford.

**Kirkcaldy Tramways.**—During the first year's working of Kirkcaldy Corporation tramway the cars have carried 2,580 000 passengers. The largest amount drawn for one week on the single line was during the annual holidays in July, when the receipts reached £268. Seventy pounds was drawn on one day in connection with Thornton games.

**Swansea.**—The Glamorgan County Council have informed the Swansea Tramways Committee that they will construct the line on the Clydach-road beyond the Morriston boundary. This determines the power of the Corporation to construct the lines. Messrs. Dick, Kerr, and Co. will do the work, which consists of two miles three furlongs of line.

**Bath.**—The proposal to lay electric tramlines through Manders-street was approved, subject to certain restrictions as to the hours of service, at the last meeting of the urban sanitary authority. The company has agreed to pay £16,400 towards the rebuilding of the Midland bridge, if the new bridge is made of ample strength to carry their line, and the Corporation have agreed to this.

**Soothill Tramways Bill.**—The Standing Orders Committee in the House of Commons yesterday heard the objection of the promoters of the Soothill Urban District Tramways Bill to the *locus standi* of the Wakefield and District Light Railway Company and the Yorkshire Electric Tramways Construction Syndicate to oppose the Bill. The committee decided to allow the *locus standi* of the petitioners.

**North-Eastern Railway.**—The electric train trials on the Tynemouth branch have been interrupted recently, owing to the breakage of an engine-shaft in the Wallsend power station. We also understand that the severe weather and the snow have caused considerable trouble in the collection of current from the third rail. The interruption in the trials is likely to delay the opening of the lines for electric traction.

**Burnley.**—The Tramway Committee report that they have arranged to pay £830 per year to the Nelson Corporation for the running rights over the electric tramway system through their area, Nelson to repair and maintain the permanent way and overhead equipment. The committee have not agreed with the Urban District Council of Brierfield. If their offer to Brierfield was not accepted, the matter would go to arbitration.

**Barrow.**—At a conference between the Corporation and the Dalton Urban Council as to the advisability of an endeavour to effect an arrangement for the extension of the Barrow tramway system to Dalton, or, in the alternative, to the watering trough on the Abbey-road, or to the borough boundary at the foot of Little Mill Brow, the Corporation Committee expressed views favourable to the project, and promised their further consideration.

**Warrington.**—Mr. J. Telfer has been appointed tramway manager, and the salary of Mr. F. V. L. Matthias has been increased. The plans of Messrs. Preece and Cardew for the work at the Market Gate have been approved by the Corporation. The Board of Trade have approved of the arrangements of these engineers for securing the safety of the swingbridge. Tenders are now to be obtained for the permanent way and overhead equipment for light railway No. 1.

**Whitefield.**—At the monthly meeting of the District Council a letter was read from the Salford town clerk stating that the Whitefield Council had agreed to accept the offer of the Tramways Committee of £200 for the reinstatement of the roads in Whitefield, and presuming they would now carry out the work and add the £200 to the capital account to be borrowed for tramway purposes, it would, therefore, become payable by the Corporation under the agreement as capital money.

**Bury.**—The work of reconstructing the Bury tramways for electric traction has commenced, and is likely to be completed by September this year. The agreement between the company and the various local authorities interested has been signed, and under it it is arranged that the local authorities shall pay the company at the rate of £5,300 per annum until completion of the purchase. The system will be worked by the company, who take all risks. The local authority will share in the profits.

**Hastings.**—At the meeting of the Town Council a letter from Mr. W. M. Murphy to the town clerk was read denying the allegation contained in Councillor Chesterfield's question whether the company have no intention of starting work this spring, but intend to apply for powers releasing them from the obligation to construct certain outbounds tramways before commencing the Front Line scheme. Mr. Murphy added that he was actively engaged in perfecting his organisation for proceeding with the undertaking.

**Wolverhampton.**—The electric tramways service from Snowhill to the Fighting Cocks was formally opened on Wednesday as the result of a very satisfactory trial trip the previous day by Colonel Yorke, C.E., accompanied by several members of the Corporation. The party subsequently inspected the Willenhall branch, and Colonel Yorke was so impressed with the manner in which the electrification is being carried out that he intimated he should regard this branch of the line simply as a reconstruction, thus obviating the necessity for an official inspection on completion.

**Hartlepool.**—It is stated that the Town Council has decided to waive its claim to the right to take over the Hartlepool section of the tramways when the lease expires. The negotiations with the company, with a view to extending the lease for 21 years, are not definitely concluded, but it is probable that the matter will be settled in a short time. If the lease is extended the company does not, it is believed, intend to construct a double line, but the old line will be relaid. If no unforeseen delay occurs this work will be commenced about Easter, and completed in nine months.

**Liverpool and Southport Electric Railway.**—The electrification of those sections of the Lancashire and Yorkshire Railway Company's system, connecting Liverpool and Southport, has just been completed, and they will shortly be opened. There is to be a trial of the line on Saturday next, to which we have been invited, when full details will be on view. The non-technical Press has made a good deal out of a short-circuit between the third rail and one of the track rails which occurred at Waterloo Station. In this case a drill which was being

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used on the line was knocked down by a train and caused a short-circuit. The arc was quickly extinguished by the use of sand.

**Paris Underground.**—The Metropolitan Railway of Paris has placed an order with the French Westinghouse Company for the equipment of 91 cars on the Westinghouse multiple-unit control system. These cars will operate on the section of the line between Maillot and Vincennes. Each train will consist of three motor coaches and four trailers. The contract likewise includes the supply of nine 200-h.p. double equipments for the multiple-unit control trains which are to be placed in operation during the summer between Villiers and Gambetta. The Metropolitan Railway Company have decided to abolish the locomotive which has hitherto been employed on these sections of their lines.

**Droylsden.**—A deputation from the Urban District Council called recently on the Manchester Tramways Committee and discussed the question of a through service of cars between Manchester, Droylsden, and Ashton-under-Lyne. At present the through cars go along Ashton Old-road, and the Droylsden people want a through service along Ashton New-road, so that the changing of cars at the Ashton boundary may be avoided. The chairman of the committee (Mr. D. Boyle) stated that the agreement between Ashton and Manchester, by which the latter was precluded from running more than one car into Ashton every 10 minutes, put it out of the committee's power to accede to the deputation's request.

**Sheffield.**—The trams on the station route are admittedly a failure. They are being run at a loss of £10. 12s. 6d. a day. There is serious talk among members of the Tramway Committee about abandoning the route, and yet, properly managed, it ought to be one of the most paying routes in the city. The committee have nearly stumbled upon the secret of its failure. They formerly ran the cars every five minutes and charged a penny fare. Then they took about £14 per week. Last month they put on a 2½ minutes' service and reduced the fare to a halfpenny, and at once the receipts mounted up to over £30 a week. This indicates that the committee made a step in the right direction, and should encourage it to look further before thinking they have done all that ought to be done to make the route a financial success.

**Derby.**—The award of the umpire (Mr. J. J. Wainwright, of Liverpool) in the recent arbitration between Mr. Arthur Cox, of Derby, and the Corporation has just been made known. The proceedings arose out of the desire of the Corporation to purchase about 725 yards of land for the widening of Normanton-road, which would also involve certain structural alterations to existing premises and the erection of a boundary wall. The Corporation assessed the value at £2,382, which sum Mr. Cox refused to accept. The latter originally claimed £8,600, which amount was reduced at the hearing to £7,275. The sum awarded Mr. Cox by the arbitrator is £3,080, which, having regard to the circumstances, may be said to be a substantial victory for the Corporation. The arbitrators were Sir John Rolleston, M.P., for Mr. Cox, and Mr. W. Smith, of Derby, for the Corporation.

**Rochdale.**—The agreement for the transfer of the tramway company's undertaking has been signed by all the parties concerned. Application was made to the Board of Trade on the 26th and on the 27th the Board wrote stating that they had appointed Mr. Graham Harris as the arbitrator in the matter. Mr. Harris would inspect the lines and view generally on the 11th and 12th of this month, and there was a prospect of things going ahead after that. It was stated that the double track sanctioned by the Council a month ago would involve an extra cost of £7,019. 10s., and that now proposed on other sections was estimated to cost £4,174, a total of £11.193. 10s. The cost of putting down the length of double track in Mellow-street would be £621, that over Lock Bridge £461, the Smith-street length £644, and that from King-street South to Sudden £2,448. The returns for January showed an increase of £28. 14s. 11d. over those for 1903. Last month the takings were £434. 14s. 6d., or £14. 4s 5d. more than in February 12 months ago.

**Small Heath.**—The extension of the Small Heath tramway to the Swan at Yardley has at last been accomplished. The equipment of the line is complete, and to-day the machinery for the generation of the current at the station opposite the Swan Hotel will be experimentally set in motion. Little now remains but the official inspection, and when this has taken place, and the Board of Trade has notified its satisfaction, the public service can begin, if necessary, within an hour. The cars, eight in number, are ready, either in the sheds at Yardley or Kyott's Lake-road, and it is confidently expected that they will be running within the course of the next fortnight or three weeks. With regard to the change of cars at the boundary, it may be explained that for a couple of years, at any rate, the inconvenience thereby arising will be avoided, the City Tramway Company having secured from the Corporation a short lease of the portion of the line between the boundary and Small Heath Park. The lease has been made coterminous with the one expiring in December, 1905, covering the line between the park and the centre of the city. Till then the change of car will be made at the present terminus of the steam service.

**Lowestoft.**—At a meeting of the Town Council on Tuesday the Tramways Committee reported that the total expenditure on the electrical tramway service amounted to £75,712, which was £9,712 in in excess of the sum authorised. The committee recommended that the town clerk be directed to apply to the Board of Trade for sanction to a loan for this further sum. When the sanction is received, the committee recommended that the Electric Lighting Committee take over the machinery and be responsible for future maintenance and renewal, and pay the annual sinking fund instalments and interest on the loan, and that the amount to be paid for current for power purposes to the Electric Lighting Committee by the committee shall be at the rate of 2¾d. per unit for the present, until the consumption shall reach 250,000 units, when the charge shall be reconsidered. It was estimated that less than £10,000 would pay all the annual expenses. The report was adopted. The total receipts since the commencement amount to £6,698. 1s. 1d.; the total number of passengers carried 1,485,901; total mileage run 169,795 miles; the average receipts per day amount to £31. 15s. 5d., the average receipts per car per mile amount to 9·46d.

**Salford.**—At a meeting of the Town Council the question of the desirability of purchasing an additional supply of tramcars was referred to the Works Sub-Committee. A resolution of the Electricity Committee respecting the price to be charged for the supply of current on the tramways during the ensuing 12 months was read and considered, and it was resolved that the terms contained in the resolution be approved subject to the requirement as to a guaranteed consumption of current being eliminated therefrom, as, whilst the committee have every reason to believe that in connection with the whole of the working of the tramway undertaking they will take the amount mentioned, they do not deem it desirable that a guarantee should be required; it being also understood that the arrangement as to price will be again considered by the two committees at the end of 12 months. A report by the town clerk respecting the supply by the Salford Corporation of the current required to work the Prestwich tramways in Bury Old-road, and instructing the general manager to confer with the electrical engineer as to the date when his department will be ready to supply the current, and afterwards to give the Manchester Corporation formal notice of the alteration proposed, was approved. It was stated that the scheme for laying a double line of railways in Broughton had been abandoned for the present.

**Cheltenham.**—The Town Council has decided to support the application of the light railway company for an order authorising an extension of their lines up High-street, between Cambray and Bath road, subject (1) to the company paving a portion of the High-street with jarrah wood blocks from Ambrose-street to Hale's-road, and the remainder of the extensions with best creosoted deal blocks; (2) to the company forthwith repaving the portions of the roadway along the route of the existing line from a point in North-street to a point in Clarence-street with jarrah wood blocks, and repaving the remaining portions of the roadway along the existing line within the borough with granite setts; and (3) to the extensions not being commenced until the position and construction of the railways and the position and designs of the poles have been approved by the Corporation. The Council stipulated, however, that the company should fulfil its obligations under its agreement with the Corporation in the matter of penny fares from one point to another, and also that, if the extension between Cambray and Bath roads be made all the Leckhampton traffic should pass through Bath-street and Cambray, and that only the traffic to and from Charlton Kings should pass straight along the narrow strip of High-street known as "the neck of the bottle."

**Airdrie and Coatbridge.**—A correspondent writes to the *Glasgow Herald* that the company which works the tramways is stated by the Board of Trade inspector to be the first which has met the suggestions of the Board in regard to an improved type of stairway leading to the top seats of the cars, and also with respect to the intermediate step at each end between the ground and the car platform. These platform steps are made to fold up, and the one on the driver's platform is kept up, so that passengers can make no attempt to board the car at that end, and risk of accident is thus avoided. The Brush Electrical Engineering Company is responsible for the design and manufacture of the cars. The same company has just delivered half-a-dozen new cars to the Greenock Tramways Company, also of a kind which is rather unusual in Scotland. They are single-deck cars, and each seats 10 passengers inside and 10 on open seats at each end of the car, thus giving accommodation for 30 passengers in all. The open end portions have a canopy roof, and the open seats can be used by smokers. This is the kind of car which used to be called the California type, as it appears to have originated in San Francisco, and in some places in England where it is employed it is described as a combination car. The special feature of the Greenock cars, however, is that they have a new kind of radial axle, which allows of a longer wheel base, and thus produces steadier riding, all see-sawing motion being eliminated. Aberdeen is securing from the Brush Company some cars similar in design to those used on the Airdrie and Coatbridge line.

**Bradford.**—At a meeting of the City Council on Tuesday the minutes of the Tramways Committee, which reported that the Works Sub-Committee had instructed the city surveyor to proceed as soon as practicable this year with the extension of the Allerton tramway along Stony-lane at an estimated cost of £4,580, and with the reconstruction of the Wakefield-road tramway from Croft-street to the Barley Mow Inn, and from Davy street to the Royal Engineer Inn at an estimated cost of £5 677, were adopted, but the proposals for the purchase of the Shipton tramways were referred back for further consideration. At a special meeting of the Tramways Committee of the Bradford Corporation on Wednesday the agreement of the Corporation to purchase the lease of the Shipley tramways, which were constructed by the Mid-Yorkshire Tramways Company, was ratified, subject to the approval of the City Council. The terms of the purchase were put before the meeting. The Corporation will be recommended to offer £40,000, which the company are willing to accept. The total cost to the Mid-Yorkshire Company of the construction of the tramways is understood to have been £58 000. The vendors have a 30 years' lease from the Shipley District Council, and this will pass into the hands of the Corporation. By the terms of the proposed purchase, we understand that whilst the Corporation will be responsible for all overhead repairs they are to pay the Shipley Council £100 a year per mile for permanent way repairs. The Mid-Yorkshire Company have about 10 cars. At next Tuesday's meeting of the Bradford City Council the Tramways Committee will recommend that the Allerton tramway extension (estimated to cost £4 580), and the reconstruction of the Wakefield-road tramway from Croft-street to the Barley Mow Inn, and from Davy-street to the Royal Engineer Inn (estimated at £5,677) be proceeded with as soon as practicable this year.

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## LIGHTING AND GENERAL.

**Wallasey.**—The Electricity Committee have earned a profit of £4,700.

**Grimsby.**—The Council are borrowing £2,000 for electric lighting purposes.

**Sheffield.**—The improvements contemplated at the town hall include an electric lift.

**Paignton.**—A revised estimate for the electric light is before the District Council in committee.

**Whitby.**—The Urban District Council intend to apply for a further loan of £3,000 for electric light.

**Leek.**—The Urban District Council intend to apply for sanction to a loan of £600 for main extensions.

**Buxton.**—The Urban District Council intend to apply for sanction to a loan of £2,000 for electricity works.

**Whitstable.**—The Urban District Council appear to be inclined to treat with a company for electric street-lighting.

**St. Helens.**—Application is to be made for sanction to borrow £4,650 for cables, switchgear, meters, and cut-outs.

**Tunbridge Wells.**—The Council are borrowing an additional £1,000 capital account for electric lighting purposes.

**Worthing.**—Sanction has been received by the Corporation to the borrowing of £2,592 for electric lighting extensions.

**Aberdeen.**—The Council have decided to give the National Telephone Company permission to lay wires underground.

**Berwick.**—An automatic apparatus is to be purchased for lighting the town hall clock, which is to be lighted by electricity.

**Primitiva Gas and Electric Light Co.**—The directors recommend a dividend for the past year of 5 per cent. on the ordinary shares.

**Longton**—The output of electricity during February was 11,665 units, being an increase of 11 per cent. as compared with last year.

**Neath.**—The Council propose to apply for sanction to a loan of £5,000 for electric lighting, and that tenders be invited for laying mains.

**Eastbourne.**—The Town Council intend to apply for sanction to borrow £3,221 for the provision of condensing plant at the electricity works.

**Direct Spanish Telegraph Co.**—A dividend at the rate of 4 per cent., tax free, on the ordinary shares for the half-year ended Dec. 31 is declared.

**Removal.**—Messrs. G. H. Prescott and Co. have removed from 34, Church-street to larger premises at 25, Whitby-street, West Hartlepool.

**Camberwell.**—The County of London and Brush Provincial Electric Lighting Company are about to lay mains along the north side of Sternhall-lane.

**Burnley.**—It is estimated that the profits from the electricity works for the year ending March 31 next will amount to about £4,000, against £3,551 last year.

**Fulham.**—The Electric Lighting Committee have definitely decided as to the purchase of a new boiler. An inspector will be engaged during the building of the boiler.

**Tottenham.**—At a somewhat excited meeting last week, at which electric lighting and refuse destructor were considered, it was agreed that another scheme be prepared.

**Direct Spanish Telegraph Co.**—The directors have decided to pay a dividend at the rate of 4 per cent. per annum on the ordinary shares for the half-year ended Dec. 31, 1903

**Colwyn Bay.**—The last report of the managers of the electricity works shows a profit of £340 for the year, the available profits being £480, including £141 carried forward.

**Wealdstone.**—An application from the Harrow Electric Light Company asking the permission of the Council to extend their mains to Warrington and Hindes roads is before the Council.

**Aston.**—It appears that there was really more damage done by water than by fire at the recent outbreak at the electrical manufacturing works of Messrs. B. Verity and Sons in Plume-street.

**Trowbridge.**—The Council have consented to the application of the Western Electric Distributing Corporation for a provisional order to supply electricity for public and private purposes within the urban area.

**Clewer Without.**—It has been decided to convene a parish meeting as soon as may be in order with a view to adopting the Lighting and Watching Act of 1883, and any amending Acts that may be necessary.

**Bredbury and Romiley.**—The electric lighting question has been adjourned pending the receipt of opinions from prospective users. If the replies are considered by the Council to be favourable, a scheme will be proceeded with.

**Hampstead.**—Mains for the supply of electric current are to be laid in Belsize-square and in portions of King Henry's-road and Maygrove-road, England's-lane to Fellows-road, and a conduit across the new railway bridge in Mill-lane.

**Llanelly.**—At Monday's Council meeting it was suggested that the electric traction company should be approached with a view of carrying out electric lighting in the town. It appears that nothing can be done until settlement has been arrived at with the tramway company, against whom the Council are proceeding.

**Pembroke (Ireland).**—The Roads Committee of the Urban District Council have resolved to recommend the Council to adopt Mr. Hammond's scheme for the electric lighting of the district, and to apply for a loan of £25,000 for the purpose.

**Loughborough.**—The Board of Trade have approved of the system for the supply of electrical energy proposed to be adopted by the Corporation under the provisions of the Loughborough Corporation Act, 1899. Sanction to the loan is expected shortly.

**Dublin.**—The Treasury are unable to sanction the loan of £50,700 sought by the Corporation to cover extra expenditure in connection with the electric lighting undertaking, and have declined an interview with a deputation from the Lighting Committee.

**Whickham.**—The Board of Trade have issued a provisional order authorising the Urban District Council to transfer the undertaking authorised by the Whickham Electric Lighting Order, 1903, to the County of Durham Electrical Power Distribution Company.

**Darlington.**—At the end of this quarter the price of current is to be reduced ½d. per unit, and the charge for power purposes will be 2,000 units per annum at 2d. per unit and the remainder at 1½d., instead of 5,000 per annum at 2d. and the remainder at 1½d.

**Exeter.**—As the new works at the Basin will shortly be in full operation, the Electric Lighting Committee propose, after June 30 next, to charge for ordinary lighting, 5d. per unit; motive power and heating, 2½d.; street-lighting, 2½d.; and to reduce meter rents to one-half the amount at present charged.

**Aston Manor.**—The engineer is about to lay a two-way duct and lay in a triple-concentric cable at an estimated cost of £122. 14s. 9d. During the last month 31 additional consumers were connected. The proposed extension of the station is to come before a special meeting of the Council shortly.

**Bristol.**—The Barton Regis Electric Lighting Order, 1902, is to be transferred to the Corporation, with a proviso that the Corporation shall not exercise any powers under that order in the districts transferred to the Thornbury and Chipping Sodbury rural districts without the consent of the respective councils of those districts.

**Southport.**—The Town Council have decided that in future cases of the hire-purchase of motors, etc., costing £100 or under, the purchaser be charged 2½ per cent. on the amount of the account, for specifications, superintendence, etc., and that all motors, wiring, and fittings on the hire-purchase system be insured against fire and electric damage at the cost of the purchaser.

**Pressure-Reducing Valves.**—Messrs. W. H. Bayley and Co., Limited, Albion Works, Salford, Manchester, have issued a pamphlet giving directions for fixing and manipulating the Foster Class W. Foster pressure-reducing valve, used in connection with engines, pumps, elevator service, or wherever it is desired to regulate and reduce the flow of steam, water, gas, or air.

**Watford.**—The Joint Hospital Board are considering a letter from the Watford Urban District Council stating that they would be in a position to lay a lighting cable to the hospital as soon as the new provisional order had been obtained, subject to the Board allowing the erection of a sub-station near the entrance to the hospital, and contributing £200 towards the cost of the cable.

**Swindon.**—Tenders are to be invited for a motor-generator and water softener at the electricity works estimated to cost £590 and £455 respectively. The electrical engineer's last monthly report shows that the number of consumers connected on Feb. 15 was 163, as compared with 155 the previous month. There are now 126 street lamps connected with the electric light, as compared with 115 the previous month.

**Metropolitan Asylums Board.**—The specification and working drawings for wiring hospitals for electric lighting purposes are now approaching completion, and application will be made for sanction to the Managers inviting tenders for wiring the hospitals for electric lighting purposes from six selected firms, and entering into a contract, or contracts, for the execution of the necessary works, without in the first instance advertising for sealed tenders.

**Bermondsey.**—Alderman Cox, chairman of the Electric Lighting Committee, reported at the last Council meeting that the number of equivalent 8-c.p. lamps applied for for private lighting since his last report was 112, making a total of 24,094 8 c.p. lamps applied for to date, or, including public lighting, a grand total of 27,080. The total number of the Council's customers up to date was 149. There were now 14,580 8-c.p. lamps applied for in excess of the capacity of the present plant.

**Air-Compressors.**—We are informed that the Norwalk Ironworks Company, of Connecticut, have appointed John Davis and Son (Derby), Limited, of Derby and London, to represent their interests in Great Britain. Messrs. Davies have recently erected for the Glass Houghton and Castleford Collieries, Limited, a Norwalk compressor which has a displacement capacity of 3,780 cubic feet per minute. This is intended for underground service. The colliery contemplate quadrupling the power eventually.

**Tay Bridge.**—The electric lighting of the Tay Bridge Station has been inaugurated. In all there are 20 arc lamps, which are distributed round the platforms, there being a switchboard to each side of the station. The installation has not yet been completed, the waiting-rooms and offices having to be fitted up. One hundred and eighty lamps are to be used for lighting these places, while 80 lamps are to be fitted up in the locomotive sheds. The Esplanade Station and the Tay Bridge are to be dealt with during the summer months.

**Electrical Trade Union.**—A public meeting of electrical workers in Sunderland and district was held on Monday, at which Councillor Summerbell presided. The object of the meeting was to place before workers not already affiliated with the Electrical Trade Union the desirability and the benefits of being organised. It was stated that since its formation the union had been successful in obtaining much better wages—some as high as 9½d. per hour—for the men, and in combination the condition of electrical workers would be even more advanced.

**Stock Exchange.**—The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the official list: British

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Columbia Electric Railway Company's further issue of £45,000 4½ per cent Vancouver Power debentures of £100 each, Nos. 1 751 to 2,200; Edmundson's Electricity Corporation's further issue of £68,533 4½ per cent. first mortgage debenture stock (redeemable). Application has been made to allow the Oxford Electric Company's further issue of 2,500 ordinary shares of £5 each, fully paid, to be quoted in the official list.

**Carnarvon.**—The Town Council have decided to proceed with the agreement made with the National Wiring Company for the construction of electric light works at a cost of £17,000. Mr. J. Prichard, chairman of the Electric Light Committee, has resigned. It appears that many ratepayers are dissatisfied with the decision of the majority of the Town Council, at its last meeting, not to defend the action threatened by the National Construction Company for the alleged breach of an agreement. A committee has been appointed to arrange for a town's meeting next week.

**New Issues.**—The National Telephone Company invite subscriptions for an issue of £1,000 000 4 per cent. debenture stock, at the price of £95 per cent. The Metropolitan Railway are offering to stockholders only £500,000 of 3½ per cent. preference, convertible into ordinary stock "cent. per cent." at the price of 91. This has been done by circular letter, the amount being payable 10 per cent. on application, 31 per cent. on March 31, and 50 per cent. on July 1. The Canadian Electric Traction Company, Limited, are about to issue 53,000 shares of £1 each, part of an issue of £78,000.

**Teddington.**—The electric light has been installed in Christ Church. The installation consists of 64 16-c p. incandescent lights, three being fixed on each of the pillars, and the others at intervals along the north and south walls, in the sanctuary and on the pulpit. The effect is very brilliant, and so far has given great satisfaction. The Edmundson Company have recently supplied four 1,000-c.p. arc lamps to the order of Messrs. Deayton, which have been fixed outside their extensive premises in Broad-street. Twelve 130-c.p. Nernst lamps are to be placed in Church-road as a test in comparison to gas lighting.

**Barnet.**—It has been agreed, respecting the agreement between the electric lighting company and the Council, that the Council shall be entitled, if they think fit, on giving 12 months' previous notice in writing to the company, to take over the undertaking authorised by the order as a going concern at the expiration of seven years from Aug. 31, 1905, or of any subsequent year upon the terms of paying to the company the amount of capital properly expended by them upon the said undertaking, as appearing by the annual statement of accounts audited by the Board of Trade, and, in addition thereto, a sum equal to one-third of such capital expenditure.

**County of London and Brush Provincial Electric Lighting Co.** The directors recommend the payment of final dividends upon the ordinary shares at the rate of 4 per cent. per annum for the half-year ended Dec. 31, 1903, making 4 per cent. for the year, after placing £10,000 to reserve for depreciation, etc., and carrying forward over £5 000, and on the preference shares at the rate of 6 per cent. per annum for the same period. The transfer books and register of members are closed until the 14th inst., inclusive, preparatory to payment of the final dividends upon the ordinary and preference shares of the company for the half-year ended Dec. 31, 1903.

**Organised Opposition.**—A second conference, organised by the town clerk of Scarborough, of representatives of local authorities in Yorkshire and Lincolnshire affected by the Electric Power Bill, 1904, was held at York on Tuesday. Sir J. Sykes Rymer presided. The meeting decided to secure the services of two or three expert witnesses of the highest standing to supplement the evidence of the local engineers acting in the various districts affected by the Bill. A novel feature of the opposition is that it is an organised opposition between all authorities in Yorkshire concerned. These have divided themselves into two classes—namely, those who object to the Bill *in toto*, and those who, while not objecting to the Bill passing into law, will require the inclusion of protective clauses.

**London Gazette.**—The last day for receiving proofs in the estate of John Frederick Worthington and Gerald Nuttall (trading as J. Worthington and Co.), and separately in the estate of Gerald Nuttall, electrical engineers, Foundry Works, Foundry-street, Hanley, Stafford, is March 19. Mr. C. T. Appleby, official receiver, 25, Corporation-street, Birmingham. A first and final dividend of 9½d. in the £ has been declared in the estate of Henry John Furniss, electrician, 5A, Queen-street, Derby; now payable at Official Receiver's Office. 47, Full-street, Derby. A petition for reducing the capital of the Blackpool, St. Annes, and Lytham Tramways Company, Limited, from £150.000 to £125,000 will be heard at the Assize Courts, Strangeways, Manchester, on March 14, at 10.30 a m.

**Middlesbrough.**—At the last meeting of the Corporation Electricity Committee the Town Clerk (Mr. Alf. Sockett) said he had not yet been able to apply for the loan for the carrying out of the works extensions, because the plans were incomplete. As soon as they were completed he would send them to the Local Government Board with the application. The Borough Engineer (Mr. F. Baker) now submitted the plans, and they were approved. The Electrical Engineer (Mr. H. M. Taylor) stated that 70 000 units were sold during the month, as against 48 000 in the corresponding month of last year. The revenue was £1,019. as against £720, and the cost was £337, or 1·15d. per unit, against £290, or 1·44d. per unit, a reduction of ·29d. per unit. The gross profit, inclusive of interest and sinking fund, was £682. The total number of lights connected and applied for was 44,820.

**New Company.**—The Rhodes Electrical Manufacturing Company, Bishopsgate-street, E C., inform us that one of the first intentions of the new company (noted in our last issue) is to construct and standardise alternating-current motors similar to their R.E. type direct-current motors, with which they have had such great success. It is their intention in their alternating-current work to build machines which shall be of sound mechanical and electrical construction. With regard to the single-phase type of machine, it is intended to manufacture two distinct classes of machines—one a machine which will start up with full-load torque with normal full-load current or less, and the second an ordinary induction single-phase motor, which will run up to synchronism as a split-phase motor and then be thrown on the load, running as a simple induction motor.

**Private Installations.**—We have received the following particulars of electric lighting at the residence of Mr. D. A. Thomas, M.P., Llanwern Park, near Newport, Mon., which has just been successfully carried out by Mr. Ralph Nance, A.I.E.E. The work comprises wiring and fittings throughout the mansion, and the plant consists of an oil engine made by Messrs. Cundall and Sons, Shipley, Yorks, dynamo by Webster's Dynamo and Motor Factory, Bradford, Yorks, and A.B.P. Accumulator Company's Stockton type cells. The water supply for the mansion is also obtained by an electric pump, which is fixed about half a mile distant. The engine when not used for electric lighting drives a chaff-cutter, pulping machine, corn-grinding mill, etc. The contractor for the building of the engine and accumulator house, pump-house, etc., was Mr. W. T. Case, of Newport, Mon.

**Yarmouth.**—Amongst the half-yearly estimates we find that the Electric Lighting Committee estimated the income for the six months ending September, 1904, at £7,176, and the expenditure, including interest and sinking fund, £6,524, leaving an estimated clear profit of £625. The resident electrical engineer's last report is as follows: "During the past month two new consumers have been connected to the mains, representing 121 8-c.p. lamps. There are now connected to the mains 464 consumers, representing 22,819 8-c.p. lamps. Several services have been put in, though not yet connected. The committee recommended that a store be built at the works, at a cost not exceeding £200, and that the cost thereof be equally divided between the electric lighting and tramway undertaking, the proportion to be paid by the electric lighting undertaking to be paid out of revenue." Part of London-road is to be lighted with 11 32-c.p. electric incandescent lamps at £2. 18s. per lamp per annum, equalling £31. 18s.

**Glasgow Contracts.**—The question of whether the contract for the new motor-generators for the Electricity Committee should be given to a German or a British firm was considered by Glasgow Town Council on Monday. Letters were read from the Scottish organiser of the Amalgamated Society of Engineers and from the secretary of the Associated Society of Ironmoulders protesting against the contract going out of the country while so many men were idle. Mr. Willock, in moving the acceptance of the tender of the Electrical Company, Limited, whose sub-contractors are a Berlin firm, stated that on a £10,000 contract the Electrical Company's offer was £1,700 under that of the British Westinghouse Company, who had been prominent in the agitation for reconsideration of the tenders. Mr. Bruce Murray, in seconding, maintained that they should give the ratepayers the full benefit of free trade. He objected to carrying out locally and efficiently what he believed should be carried out Imperially and scientifically. After discussion, the resolution was adopted by 30 votes to 23.

**Swansea.**—The engineer's last report stated that 493 consumers were on the books, and those actually connected to the mains 427. Regarding energy for signs, and the suggestion made that consumers might be allowed to use electricity for illuminating advertisements on a separate meter, the engineer considers that, from a lighting point of view, it was not a desirable load unless an adequate charge were made. He was unable to advise any scale of remuneration, but granted that it might be wise to concede a point in regard to special meters. He advised the committee (1) to allow consumers to have separate meters at the rate of 6d. per unit on the maximum in vogue at the time; (2) to run a separate circuit from the sign to the part of entry of the service cable; (3) to ascertain if the sign be a *bona fide* one, the engineer to decide. He considered the last proviso the most important. On the Swansea municipal telephone system the subscribers connected number 662, instruments working 738, and orders in hand 206. At the meeting of the committee, the manager reported that 19 faults were reported last month through the National Company allowing its wires to fall on those belonging to the Corporation.

**Devonport.**—The *Western Morning News* states that the Admiralty have decided to build at Devonport Dockyard an electric generating station which will supply both yards with electricity for power and lighting. The scheme is a comprehensive one, as it is intended that the whole establishment shall be lighted by electricity. This will be a great improvement on the present means of illumination. It has not yet been decided what steps shall be taken to provide additional heating power. The same plant will, no doubt, in time supply the naval barracks at Keyham, the Royal Marine barracks at Stonehouse, and the Royal Naval Hospital. In time, too, the present steam railway trains in the dockyards will be superseded by electric trains and tramcars; in fact, it is proposed to make electricity the motive power for every kind of machinery used in the yard. The plant will not be delivered until next October, and by the time the scheme is in thorough working order the extension works at Keyham will have been completed. Then, instead of the 10,600 men now employed at the dockyard, 15 000 will be employed. The Admiralty intend to do the work thoroughly, and it has been decided that when it is completed the men shall work a uniform number of hours every day throughout the year. This has been impossible in the past owing to the men being unable to see properly by gaslight.

**Felixstowe.**—The Council have been informed *re* the application to the Local Government Board for sanction to borrow £17,160 for electricity supply, that the Board "have some doubt whether the proposed arrangement is one which is in all respects favourable to the ratepayers. If, however, after consideration of the above expression of opinion upon the part of the Board the District Council desire to press their application, the Board will not refuse to sanction the proposed loan." The Council are pressing their application for sanction. At the last Council

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meeting the Estates Committee reported that the electric light company are pressing to be allowed to increase the motive power at their Felixstowe generating station. Under the terms of the agreement between the Council and the company no extension could be made by the latter pending the completion of the agreement without the consent of the Council's engineer. The company allege their business is being injured by want of additional power, and propose to themselves purchase and erect a gas-driven set, which would assist their load at Easter and Whitsuntide, be in fair working order for the summer, and if only capable of doing 50 per cent. of the guaranteed output, would enable them to get through next summer without additional power. The company agree that this gas-driven plant shall be altogether outside the agreement, and without prejudice thereto. The Council agreed to the gas-engine being obtained.

**Bradford.**—The third 1,600-h.p. engine at the Corporation electricity works, Valley-road, was started last week by the chairman of the Electricity Committee (Mr. G. H. Robinson). The engine is of the slow-speed type, and runs at 85 revolutions per minute. The high and low pressure cylinders are 31in. and 60in. diameter respectively, the stroke being 3ft. 6in. The weight of the flywheel is 75 tons. The whole engine is of massive construction, and has been specially designed to withstand the large and sudden variations in the load that are met with in supplying energy for traction purposes, and is capable of developing 1,600 h.p. with steam at 160lb. pressure per square inch. The generator, which has been built by the British Westinghouse Electric and Manufacturing Company, Limited, of Manchester, has a capacity of 1,000 kw. The electrical connections of the generator are so arranged that it can be used for supplying current either for lighting purposes or for tramway traction purposes. The complete weight of the generator is about 65 tons, and the revolving part about 21 tons. It is capable of producing current for 30,000 8-c.p. lamps, or when put on the tramway supply, for running about 90 tramcars. Subsequently Mr. G. H. Robinson presided at a luncheon at the town hall. Mr. James Hill, chairman of the Tramways Committee, referred to the fact that in transmitting electricity four or five miles to some of the districts a considerable leakage was entailed. He advocated the erection of sub-stations in order to minimise the loss in transmission. Mr. Robinson, in reply, pointed out that the electricity works must go on extending, because every year the demand upon it became greater. Last year 11,000,000 units were sold, and after providing for sinking fund and interest, and setting aside £8,426 for depreciation, a net profit of £487 was made.

**Hastings.**—The accounts for the electricity department for the year ended Dec. 31, 1903, and a comparative statement of the income and expenditure, etc., of the department for the years 1902 and 1903 have been issued. The accounts show that capital account stood at £136,517, but of this amount there was a sum of £4,685. 0s. 9d. unexpended at the end of the year. The revenue account shows an income of £17,977. 14s. 6d., giving a gross profit of £7,873. 6s. 10d. The principal items on the expenditure side were: coal and other fuel, oil, waste, water, repairs, and maintenance, £6,990. 6s. 8d.; distribution of electricity, £359. 12s. 4d.; public lamps (renewals, attendance, etc.), £825. 12s. 11d.; rents, rates, and taxes, £204. 16s. 6d.; management expenses (salaries), £881. 8s. 6d.; statutory and printing, £56. 13s. 1d.; proportion of general office salaries—viz., town clerk's, borough engineer's, and borough accountant's department—£188. 8s. 8d.; management of redeemable stock, £107. 8s.; stamps, travelling expenses, telephone rents, etc., £112. 0s. 11d.; wages of storekeeper and assistant, £159. 18s. 1d.; insurance, £218. 2s. On the receipts side were the annexed amounts: sale of current per meter and lamp charge, £13,020. 1s. 7d.; sales under contract, £47; public lighting, 228,432 units at 1½d., £1,427. 14s.; lamp charge, £1,305; interest and sinking fund on capital expended on lamps, posts, etc., £571. 10s. 8d.; repairs, carbons, trimming, etc., £724. 15s. 2d.; rental of meters, etc., £653. 5s. 7d.; rents receivable, £152; and miscellaneous receipts, £76. 7s. 6d. A comparative statement of income and expenditure for the years 1902 and 1903 revealed that in the first-named year the deficiency was £1,080, as compared with £951 last year. The total expenditure in 1902 amounted to £9,220. with a gross profit of £7,674, as compared with an expenditure of £10,105 and a gross profit of £7,872 last year. The payment of interest was £4,436 in 1902 and £4,495 in 1903, and sinking fund amounted to £4,302 in 1902 and £4 311 in 1903. The total income had increased from £16,894 to £17,977.

**Stretford.**—At Tuesday's meeting Mr. Samuel Lawton, the chairman of the Electricity and Tramways Committee, reported that the financial position was excellent, and said that the generating station was opened on Oct. 26 last for the purpose of supplying power for traction. Up to Feb. 20 there had been supplied 182,423 units for traction purposes. The supply of energy for private lighting commenced on Nov. 1, and up to Feb. 23 the amount of energy registered for this purpose in private consumers' meters amounted to 23,741 units. The total supply of energy consumed for the four months was 211,464 units. The cost of generation, including works costs, establishment and office charges, rates, taxes, etc., was 1·05 per unit. The income for the four months was as follows: lighting, £366. 17s. 11d.; public lighting, £56. 16s.; traction, £1,140. 2s. 4d.—total, £1,563. 16s. 3d. Payments: works costs, £700. 11s. 5d.; establishment charges, £224. 5s. 5d.; interest and loan repayment (seven months), £1,076; interest on overdraft, £20 — total, £2 020. 16s. 10d. This showed a deficit on the four months' working of £457. 0s. 7d., but it should be pointed out that these figures included a charge for repayment of loan and interest during construction, which in a private undertaking would have been charged to capital. If they debited the revenue with its proportion of loan repayment for the period the station had been working, the result showed a surplus of £3. 19s. 5d. The engineer's estimate for the year ending March 31, 1905, showed an expenditure of £6,021 and revenue £7,310, leaving a profit on the undertaking of £1,289. This estimate was based on reasonable data, and the station would be no charge upon the ratepayers; they also hoped confidently to reduce the price for private lighting as the scheme had become self-sustaining. Powers are being sought to extend the tramways to the cricket ground in Seymour-grove, and to Sale and Urmston, and the track mileage would be doubled. As these extensions will require current the income would be increased, and the undertaking would become profitable to the district.

**Cheltenham.**—An enquiry has been held into an application of the Town Council for sanction to the borrowing of £4 132 for extensions of mains, etc., in connection with the Corporation electricity undertaking. The Electricity Committee consider that, having regard to all the circumstances, it is necessary to make a substantial increase in the charge for street-lighting, and therefore recommend: (*a*) That the charge for public lighting be increased as from April 1, 1904, to 3d. per unit, representing an increase of £2 532 per annum. Traction: The present charges for the supply of current to the light railway company are as follows: not exceeding 100,000 units per half-year, £791. 13s. 4d. (that is at the rate of 1·9d. per unit); additional quantities up to 150,000 units per half-year, 1d. per unit; above 150,000 units per half-year, ¾d. per unit. The engineer's report shows that the supply for traction at the present prices is unremunerative, and that an increased charge may fairly be required. The committee, therefore, recommend: (*b*) That notice be forthwith given to the light railway company for a revision of the charges made for traction with a view to fresh terms being arranged. Private lighting: The revenue-earning capacity of the private supply outside works is much greater than the revenue earned, and the committee are satisfied that the principal cause of the annual loss which has hitherto been made on the undertaking is that there are not sufficient consumers to secure an adequate return on the expenditure on these private supply works. The system of rebates now in force is not understood by consumers, and consequently full advantage is not taken of it. They recommend: (*c*) That the existing scale of charges be altered (except in the case of places of worship and special contracts), and that the following scale of charges be adopted as from April 1, 1904 (with a discount of 5 per cent. on all accounts paid within 21 days from the rendering of the account)—namely: 6d. per unit for any number of units up to the equivalent of 500 hours' use per annum of the maximum demand recorded by the demand indicator; 2d. per unit for any consumption during the year beyond the above (*d*) That rent be charged for the hire of meters as from April 1, 1904, according to the following scale—namely, 1s. per quarter not exceeding 50 8-c.p. lamps or their equivalent; 1s. 6d. per quarter not exceeding 100 8 c.p. lamps or their equivalent; 2s. per quarter above 100 8 c.p. lamps or their equivalent. This will produce about £50 per annum on the present number of consumers.

**Junior Institution of Engineers.**—At the meeting of this institution held at the Westminster Palace Hotel on March 4, the chairman, Mr. Samuel Cutler, jun., presiding, a paper was read by Mr. G. C. Allingham, entitled "Notes on Electric Accumulators." After a brief reference to the Edison and other types of cell, the author confined his remarks to the lead storage cell, stating in stationary cells it was now the usual practice to employ Planté type positives and pasted negatives. He then discussed the "formation" of the positives, the "shedding" of the peroxide from them, and buckling. The pasting and formation of the negatives were then dealt with, as well as the gradual shrinkage of the active material, and consequent loss of capacity. The older system of building up the plates into "sections" was contrasted with the modern plan of suspending the plates freely in the cells by their lugs, and the advantages of the practice, which is rapidly coming into favour, of "burning" up all the connections on the spot, after the erection of the battery, were pointed out. The importance of arranging batteries so as to provide every facility for attention and inspection was emphasised. Motorcar and other portable cells were next considered. Here the usual practice was to employ light pasted plates, which have a very short life, but which are made as cheaply as possible, and are simply scraped and replaced by new ones as soon as they begin to give trouble. A brief outline then followed of the chemical action in the lead secondary cell, and of the causes of "sulphating" and the treatment of backward cells. The variations of voltage and specific gravity during charge and discharge were discussed, and the author laid considerable stress on the fact that, in his opinion, the gassing is the best indication of the completion of the charge of a battery. Mention was made of the importance of free circulation and diffusion of the acid, and of the consequent failure of all attempts to construct "dry" or "solid" accumulators, and the variation of capacity with the rate of discharge was touched upon. The paper concluded with a reference to the extreme importance of the chemical purity of the materials, not only of those used in the manufacture of the plates, but also of the acid, and even of the water used for filling up. In illustration of the paper specimens were shown which had been kindly lent by the D.P. Battery Company, the Electrical Power Storage Company, and the Tudor Accumulator Company. A discussion followed, in which Messrs. F. S. Pilling, L. M. Ferreira, W. Alston, J. R Bowden, W. Fennell, W. T. George, A. W. Marshall, E. S. New, and Ancher took part. A vote of thanks was accorded the author, and the proceedings closed with the announcement of the visit to-day (March 11), when the works of the Electrical Power Storage Company at Millwall would be visited.

**Bristol Fire.**—The electrical engineer has reported with regard to the fire which occurred on Dec. 23 last that the old switchboard has been very carefully examined, and several consultations have been held to ascertain the primary cause of the trouble, but there is not sufficient evidence remaining to point conclusively to any special features which constitute the primary cause. It is most probable that the origin is to be found from amongst the following causes: (1) by static discharge from the metal work of the board charged at high pressure over the surface of the insulators and slate to "earth," or, in other words to the other pole of the board, in which case it is further

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possible that this may have been in a measure caused by an invisible crack in one of the insulators; (2) by the breakdown of a cable receiver, or, in other words, what may be termed the joint-box, wherein the cables from the machines or the mains are jointed up to the switchboard; (3) by the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc, breaking the porcelain pot filled with oil in which the fuse is placed. The fuses were examined by the engineer-in-charge just a few minutes before the accident, and their temperature was quite normal. It is very certain, however, that when once the fault commenced the whole of the cause of the spreading of the trouble was attributable to the oil in the fuse-holders. The fault was very much augmented by the fact that it was impossible to get the Avonbank supply cut off till after the elapse of a few minutes, as all our private telephones were rendered useless by induction on the wires, and, owing to the great number of calls from consumers, we were unable to immediately get into telephonic communication over the National Telephone Company's system. It was, therefore, not until the load at Avonbank became very excessive that they shut down the supply at that station. Apart from the oil, there is a small amount of wood on the oldest portion of the switchboard floor, which contributed somewhat to the fire. All portions of the flooring, excepting that first installed, were formed of iron chequer plating covered with linoleum, and this withstood the test perfectly, the linoleum within a few feet of the place where the most extreme heat occurred being quite intact even at the present moment. The window frames are of teak, and they were considerably charred, but these in themselves did not contribute largely to the trouble. In the roof the slates are laid upon matchboarding, and this formed one of the most serious features, as the fire, reaching this, spread rapidly along a considerable length of the engine-room, and necessitated the use of a great amount of water in the extinguishing of the flames, this water doing a considerable amount of temporary damage to the electrical machinery. The cables contributed largely to the flames, although they were all encased in lead, and further protected with steel armouring. The steel armouring, however, is served over with impregnated jute, and this, getting soaked with the oil, was, of course, very inflammable. The insurance claim has been settled at £8,225.

**St. Annes.**—An enquiry has been held into the Council's application for sanction to borrow £4,000 for purposes of electric lighting extensions. The enquiry was conducted by Mr. E. A. Sandford Fawcett, A.M.I.C.E., and the only other persons present were the chairman of the Council (Mr. T. Ferguson) and the officials—Messrs. T. Bradley (clerk), J. H. Clothier (electrical engineer), and H. Gregson (surveyor). The Clerk, in opening the application, said the rate of progress in the rateable value had been phenomenal. Five years ago, in 1899, the rateable value was £34,219, whereas the new valuation which was just being completed brought up the total to within £300 or £400 of £70,000, showing an increase during this short period of over 100 per cent. The Council had obtained a provisional order in 1898 enabling them to erect works for the supply of electricity. An electric generating station was erected, and a supply was first given on March 12, 1901, and has been continuously maintained since. The system was a direct continuous-current distribution by a three-wire system of underground mains with a declared pressure at the consumer's terminals of 240 volts. The total amount of capital expended up to Jan. 31, 1904, on buildings, plant, mains etc., was £31,568. 2s. 11½d., the total sum sanctioned for electricity works being £37,405, made up of three sums sanctioned at different periods. The first loan of £18,161 was sanctioned on Feb. 14, 1900, for a period of 25 years; the second loan of £7,221 was sanctioned in March, 1901, for a period of 25 years, to provide for an additional engine and dynamo and feeder extensions to electric light mains; and a further loan of £12,023 was sanctioned on March 13, 1902, this being rendered necessary by the increasing demands for electricity, both for lighting and traction purposes, the Council having entered into an agreement to supply current to the Blackpool, St. Annes, and Lytham Tramways Company. Of this last loan, which was for the purpose of providing additional plant and traction supply feeder mains, £6,403 had been expended up to Jan. 31, 1904, leaving a balance in hand at the present time of £5,620, which will soon be required, as the Council are proceeding with the laying down of the remainder of the plant sanctioned. The present application for £4,000 was necessary owing to the rapid growth of the undertaking, and the sum was estimated to cover the cost of laying mains, service lines, meters, and apparatus necessary for connecting new consumers' premises during the next two or three years, thus avoiding the necessity of repeated applications to the Local Government Board. Mr. Bradley specially drew attention to the fact that the laying of new mains was not proceeded with without due and careful consideration being given by the Council to each individual case as it arose, and mains were not laid unless the Council were fully satisfied that the outlay would be remunerative and justified. The following figures, culled from the return up to date, illustrated the rapid and continuous growth of the undertaking: for 12 months ending March 31, 1902, the number of consumers connected was 76, and the number of 8-c.p. connections 6,132, making the total number of units sold for the 12 months 93,369; for 12 months ending March 31, 1903, the number of consumers was 175, with 10,822 8-c.p. connections, the total number of units sold for the 12 months being 155,555; for the 10 months ended Jan. 31, 1904, the number of consumers connected was 242, the number of 8-c.p connections 13,457, and the total number of units sold was 154,956 for lighting and 242,643 for trams. Applications for supply continued to come in, and applications from 17 consumers for 700 8-c.p. lamps were in hand. The undertaking since its inception had been exceedingly successful. The revenue for the nine months ended Dec. 31, 1903, has been £4,547. 19s. 9d., whilst the total cost was £2,110. 7s. 9d., which included repairs and maintenance to street arc lamps, and it was estimated from these figures that at the end of the financial year ended March 31, 1904, after paying all interest and sinking fund, there will be at least a surplus of £1,000 to provide for reserve and depreciation. The gross profit for 1903 4 was estimated at about £3 000, which is equal to nearly 9½ per cent. on the total amount of capital expenditure.

## PROVISIONAL PATENTS, 1904.

FEB. 29.

**4918. Improvements in automatic circuit-breaking safety appliances for use in trolley wire systems for electric traction.** James Carter, George Hall, and Arthur Parsons, 17, St. Ann's-square, Manchester.

**4925. Improvements in electric bell pushes.** John Samuel Ross, 95, Bath-street, Glasgow.

**4927. Life-saving appliance or lifeguard for electric tramcars and railway cars.** Robert Greenhalgh and William Alfred Barnes, 10, Irwell-street, Bolton-street, Bury.

**4937. Improvements in arc lamps.** Joseph Devonport Finney Andrews and the Manufacturing Electric Company, Limited, 11, Red Lion-street, Clerkenwell, London.

**4943. Improvements in and relating to electric controllers for use with cranes, winches, transporters, and similar or other machinery.** The Cleveland Bridge and Engineering Company, Limited, and Claude William Hill, 165, Queen Victoria-street, London.

**4944. Improvements in arc lamps and in the carbons therefor.** Charles Russo, 165, Queen Victoria-street, London.

**4953. Improvements relating to apparatus for automatically interrupting electric current.** Aktiebolaget Svenska Elektriska Urfabriken, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 3, 1903, being date of application in Sweden.) (Complete specification.)

MARCH 1.

**5027. Improvements in the synchronisation of clocks by means of etheric, electromagnetic, or electric waves.** Thomas Henry Williams, 4, Southampton-row, London.

**5054. Improvements in electrical switches known as tumbler switches.** George Sperryn and William Cassell, Hospital-street Works, Birmingham.

**5058. Improvements in self-regulating dynamos, being particularly applicable to motorcars and like purposes.** William Ross Harvey, 6, Holborn-viaduct, London.

**5064. Improvements relating to the electrical and automatic working of signals, points, and crossing gates on railways.** Dobraji Merwanji Daboo, 19, Southampton-buildings, Chancery-lane, London.

**5071. Improvements in apparatus for regulating and controlling the voltage of alternating-current circuits.** Harve Reed Stuart, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand. (Date applied for under Patents Act, 1901, March 12, 1903, being date of application in United States of America.) (Complete specification.)

**5084. Improvements relating to electrically-propelled vehicles working on the overhead trolley system.** Edwin Crofton McCracken, 7, Southampton-buildings, Chancery-lane, London.

**5097. Improvements in electric meters.** Frank P. Cox, 83, Cannon-street, London. Date applied for under Patents Act, 1901, March 2, 1903, being date of application in United States.) (Complete specification.)

**5098. Improvements in electric lamps.** Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 6, 1903, being date of application in United States.) (Complete specification.)

**5104. An improved method of increasing the discharge energy of electrical vibration systems.** William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m.-b.-H., Germany.) (Complete specification.)

**5105. An improved method of receiving electrical vibrations utilising electrolytic cells.** William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m.-b.-H., Germany.) (Complete specification.)

**5113. Improvements in transmitters suitable for wireless telegraphy.** Marconi's Wireless Telegraph Company, Limited, and Andrew Gray, 24, Southampton-buildings, Chancery-lane, London.

**5118. Improvements in or relating to electrical radiators.** Herbert John Dowsing, 115, Cannon-street, London.

MARCH 2.

**5146. Improvements in dynamos and electric motors with a view to preventing or lessening sparking at the brushes.** William Armistead, Prince's-shambers, Wolverhampton.

**5147. Improvements in commutators for multiple-cylinder motors.** Ernest Talbot and David Mõndey, Bank-buildings, George-street, Sheffield.

**5164. Improvements in electric arc lamps.** Crompton and Co., Limited, and Arthur John Hodgson, Arc Works, Chelmsford.

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**5173. Improved process and apparatus for the production of metals of the alkali group by electrolysis.** Edgar Arthur Ashcroft, 111, Hatton-garden, London.

**5191. Improvements in electric and other lamps.** John Alfred Stevens, 114A, Chancery-lane, London.

**5193. A device for collecting gases which are driven or given off electrical furnaces.** William Macaulay, 7, St. John's-place, Larne, co. Antrim.

**5213. Improvements in and relating to apparatus for conversion of electrical into mechanical energy.** William Geipel, Frederick Montague Townsend Lange, and George William Mascord, 46, Lincoln's-inn-fields, London.

**5214. Improvements in and relating to apparatus for the conversion of electrical into mechanical energy.** William Geipel and Frederick Montague Townsend Lange, 46, Lincoln's-inn-fields, London.

MARCH 3.

**5227. Improvements in supports and guards for conductor rails of electric railways.** Henry Lewis Doulton and Charles Edward Morris, Lambeth Pottery, Lambeth, London. (Complete specification.)

**5251. Improvements in electric plug connectors.** John Henry Tucker, Sampson-road North, Birmingham.

**5269. Improvements in and relating to electric traction systems.** Horace Field Parshall, Salisbury House, London.

**5294. Improvements in or relating to electric alarms.** Johann Kiewert, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

**5297. Improvements relating to electric accumulators or secondary batteries.** M. I. P. Electrical Syndicate, Limited, and Alfred Blackman, 7, Southampton buildings, Chancery-lane, London.

**5298. Improvements in fuse boxes for electricity supply mains.** John Llewellyn Davies, 40, Chancery-lane, London.

**5307. Improvements in or relating to fuse boxes.** Ernest Roberts and Percy Good, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**5308. Improvements in and relating to electric contact devices.** Peter Oluf Pedersen, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**26442a/03. Improvements in controlling vehicles propelled electrically from a distance.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The United Telpherage Company, United States.) (Date applied for under Patents Rule 9, Dec. 1, 1903.)

MARCH 4.

**5321. Improved apparatus for regulating electric voltage or temperature.** Albert Campbell, "Oaklands," Park-road, Teddington.

**5374. Improvements in electric gear for controlling lifts or hoists.** Jörgen Björnstad, 47, Lincoln's-inn-fields, London.

MARCH 5.

**5483. A clip with clamps and a combined book of reference and writing slate for general office use, but more particularly for use on telephones and the like instruments.** Mrs. Charles Plowman, 5, Beresford-terrace, Canonbury, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 24, 1904.*

1902.

**26190. Electric signalling apparatus for railways.** Beer.

1903.

**1855. Wireless telegraphy.** Justice. (Hogg.)

**1995. Electric lamps of the character known as "vapour lamps."** Bastian and Salisbury.

**4533. Method of regulating the voltage of alternating and continuous current generators by means of alternate-current excitation.** Crompton and Co., Limited, and Goldschmidt.

**4781. Bobbins or formers and the like used for electrical purposes.** Appleyard.

**5046. Electric arc lamps.** Oliver.

**6016. Electrical fuse boards.** Moores and Ashton.

**6998. Manufacture of standard electrical conductors.** Claremont and Stratton.

**7137. Selective transmitting systems for electric signalling and other purposes.** Carolan. (General Electric Company.)

**7459. Electric arc lamps.** Carolan. (General Electric Company.)

**7899. Prepayment electric meters.** British Westinghouse Electric and Manufacturing Company, Limited. (Tilden.)

**8028. Arrangement and construction of electric arc lamps.** Oliver.

**8195. Electricity meters.** Plisson.

**9311. Alternating-current meter.** Isabella Christina Clark, Alfred John Davies, and William Livingstone Russell, executrix and executors of the estate of Alexander Melville Clark, deceased. (Hartmann and Braun.)

**8555. System of electric light wiring and casing for internal work.** Read.

**9590. Exhausting and sealing incandescent electric lamps.** Carolan. (General Electric Company.)

**9728. Electric connecting devices applicable to lampholders, wall plugs, and the like.** Menges.

**9832. Electric lamps.** Boehm.

**10096. Electric ignition apparatus for gas and like engines.** Guyon.

**10646. Electric switches.** Somerville and Howard and Bullough, Limited.

**11088. Electrical arc lamps.** Guest, Keen, and Nettlefolds, Limited, and Wakeman.

**11276. Manufacture of electrodes for secondary batteries.** Roderbourg.

**21637. Electrical alarm clock.** Peters.

**26274. Means for ventilating dynamo-electric machines.** Aktiengesellschaft Brown, Boveri, et Cie. (Date applied for under International Convention, Dec. 16, 1902.)

**27213. Method of winding moving coils for electrical measuring instruments.** Heinrich.

**27392. Electricity meter.** Revilliod. (Date applied for under International Convention, Dec. 15, 1903.)

**28291. Receivers for electromagnetic waves.** Fessenden. (Date applied for under International Convention, April 9, 1903.)

**28355. Trolley arms for electric traction.** Robertson.

1904.

**1848. Apparatus for covering of electric cables.** Seymour and Claremont.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 xd |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3¾-4¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 84-89 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 5 | .. | 1¾-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 98-103 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | .. | ¼ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1¼-1⅜ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¼-9¾ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 12-13 |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 106-110 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 18¼-18¾ |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | .. | 34-37 |
| —— 5 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 115-118 |
| Bournemouth and Poole, Ordinary | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10-10¼ |
| —— 7 per cent. Preference | 5 | .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 6-7 |
| —— Nos. 20,001-30,000 | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 14¼ |
| —— " " " £10 Ord. | 6 | .. | 10¾ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7¼-7¾ |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5¾ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 101-103 |
| Chelsea Electricity Supply | 5 | .. | 5¼-6 |
| —— 4½ per cent. Debentures | 100 | .. | 106-109 |
| City of London, Ordinary | 10 | .. | 10¼-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 3-4 |
| —— 5 per cent. Debenture Stock, Red. | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¾-6¾ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 10¼-11¼ |
| —— per cent. Debenture Stock Red. | 100 | .. | 103-106 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | — | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | — | 9¾-10¼ |
| London Electric, Ordinary | 3 | — | 1¼-1½ |
| —— 5 per cent. Pref. | 5 | .. | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | — | 17½-18½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs ,Nos. 1-500 (Reg.) .. | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | — | 95-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | — | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | — | 95-90 |
| South London, Ordinary | | — | 3¼-3½ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | — | 14-15 |
| —— 7 per cent. Pref. | 5 | — | 8-9 |
| —— 3½ per cent. Deb. | 100 | — | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | — | 4¾-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4¾-5¼ |
| Westminster, Ordinary | 5 | — | 12½-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,351 | 5 | — | 6-6½ |
| **Electric Railways,—** | | | |
| Central London, Ordinary | 100 | — | 92-95 |
| —— 4 per cent. Pref. | 100 | — | 98-101 |
| —— ,, ,, deferred | 100 | — | 86-89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | — | 110-113 |
| City and South London, Consolidated Ordinary | 100 | — | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | — | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | — | 123-126 |
| —— ,, ,, ,, '96 | 100 | — | 119-123 |
| —— ,, ,, ,, '01 | 100 | — | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | — | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | — | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | — | 102-104 |
| Waterloo and City, Ordinary | 100 | — | 88-91 |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 1-260,007 | 5 | — | 4⅝-4¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | .. | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | .. | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | — | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 82-85 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10¼-10⅝ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | — | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | — | 9-10 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | — | 10½-11½ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | — | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | — | 2¾-3¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | — | 5¼-5¾ |
| —— "B" 6 per cent. Cm. Pf., 1-87,500 | 5 | — | 4¾-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | — | 104-107 |
| —— Prov. Cert., all paid | 100 | — | 98-101 |
| Cape Electric Tramways ,Nos. 1-480,000 | 1 | — | 1¾-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | — | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | — | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 102-105 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | — | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | — | 11-12 |
| —— Debentures | 100 | — | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | — | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | — | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | — | 94-97 |
| Imperial Tramways Ordinary | all | — | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | — | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | — | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | — | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | — | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | — | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | .. | 101-103 |
| Metropolitan Electric Trams. ,Deferred, 1,000 001-1,314,016 | 1 | — | 5/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | — | ¾-1¼ |
| New General Traction, Ordinary | 5 | — | ¼ |
| —— 6 per cent. Cum. Pref. | 5 | — | 1¼-2¼ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.). | 100 | .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | — | 10½-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | — | 11½-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | .. | 99-102 |
| Potteries Electric Traction, Ordinary, 90,001-40,000 | 10 | — | 8¼-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | — | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | — | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | — | 1 |
| —— £101,132 6 per cent. Preference | 1 | — | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | — | 100 p.c. |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | — | 99-101 |
| —— Deferred Stock | 100 | — | 73-76 |
| —— 6 per cent. Cum. First Pref. | 10 | — | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | — | 13¼-14½ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | — | 5-5½ |
| —— 5¼ per cent. Deb. Stock, Red. | 100 | — | 96 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | — | 99-101 |
| Oriental Telephone and Electric Company | 1 | — | ¾-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 5 | 1,153 | 836 | + 276 | + 9,559*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 5 | 156 | 162 | − 6 | + 171 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 5 | 279 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 4 | 693 | 679 | + 14 | + 2,119 | 24 | 24 | March 25*a* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 3 | 277 | 312 | − 35 | − 291 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 5 | 200 | 201 | − 1 | − 82 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 6 | 1,531 | 1,615 | − 84 | +88,279 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 2 | 784 | 837 | − 53 | +34,383 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | , 6 | 3,238 | 3,333 | − 95 | +19,698 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 5 | 653 | 734 | − 81 | + 2,518*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 4 | 4,193 | 4,212 | − 14 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 5 | 881 | 667 | + 214 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 6 | 275 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 5 | 1,696 | 1,605 | + 91 | +23,052 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 5 | 157 | 144 | + 13 | + 236 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 5 | 7,248 | 6,978 | + 270 | + 750*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 6 | 3,285 | 3,236 | + 47 | − 539*h* | 6⅜ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 3 | 354 | 394 | − 40 | − 41 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 4 | 189 | 215 | − 26 | − 256 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 5 | 159 | 183 | − 33 | + 104 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 6 | 77 | 82 | − 5 | + 55*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 4 | 3,410 | 3,539 | − 129 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 4 | 660 | 663 | − 3 | | | | | | | | | | | |
| Dundee City Tramways | ,, 2 | 777 | 766 | + 11 | + 2,176 | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 7 | 557 | 480 | + 77 | + 8,655 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 5 | 12,907 | 12,128 | + 779 | +51,178*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | Feb 24 | 2,113 | 2,142 | − 29 | + 6,275 | 31⅔ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | Mar. 5 | 1,078 | 1,044 | + 34 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 5 | 1,954 | 1,685 | + 269 | + 7,548 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 2 | 120 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 2 | 190 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 5 | 4,623 | 4,736 | − 103 | +15,403 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | Feb. 27 | 9,203 | 8,969 | + 234 | + 3,119 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | Mar. 6 | 1,449 | 1,494 | − 45 | + 311*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | Feb. 20 | 9,653 | 8,305 | +1,348 | +83,327 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 132 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Mar. 5 | 89 | — | — | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 5 | 3,395 | 2,995 | + 400 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 5 | 1,285 | 1,310 | − 25 | + 5,533 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 7 | 94 | 109 | − 15 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 3 | 370 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 7 | 3,455 | 3,006 | + 449 | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 6 | 3,938 | — | — | — | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 3 | 784 | 849 | − 65 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 6 | 1,017 | 971 | + 46 | + 2,794 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 5 | 551 | 519 | + 31 | + 3,919 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 3 | 207 | — | — | — | 1⅔ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## A NEW HIGH-SPEED TRIPLE-EXPANSION ENGINE.

A good example of recent progress in this country in the construction of high-speed electrical generating plant for power purposes is shown in Fig. 1, which is prepared from a photograph of a large 580-i.h.p. triple-expansion engine by Messrs. W. H. Allen, Son, and Co., Limited. It is coupled direct to a 375-kw. continuous-current dynamo by the British Westinghouse Company, Limited, of Manchester, to run at 325 revolutions per minute, and has been built to the order of the Fairfield Shipbuilding and Engineering Company, Limited, of Govan, Glasgow. The engine is of Messrs. Allen's standard three-cylinder, double-acting, triple-expansion, vertical, enclosed type, the cylinders driving three cranks set at angles of 120deg., and has been designed throughout with a view to obtaining economical results over widely varying conditions of load when working with dry saturated steam at 150lb. per square inch at the stop valve and exhausting against a maximum absolute pressure of 4in. of mercury, and to be further capable of developing an overload of 25 per cent. for a period of two hours.

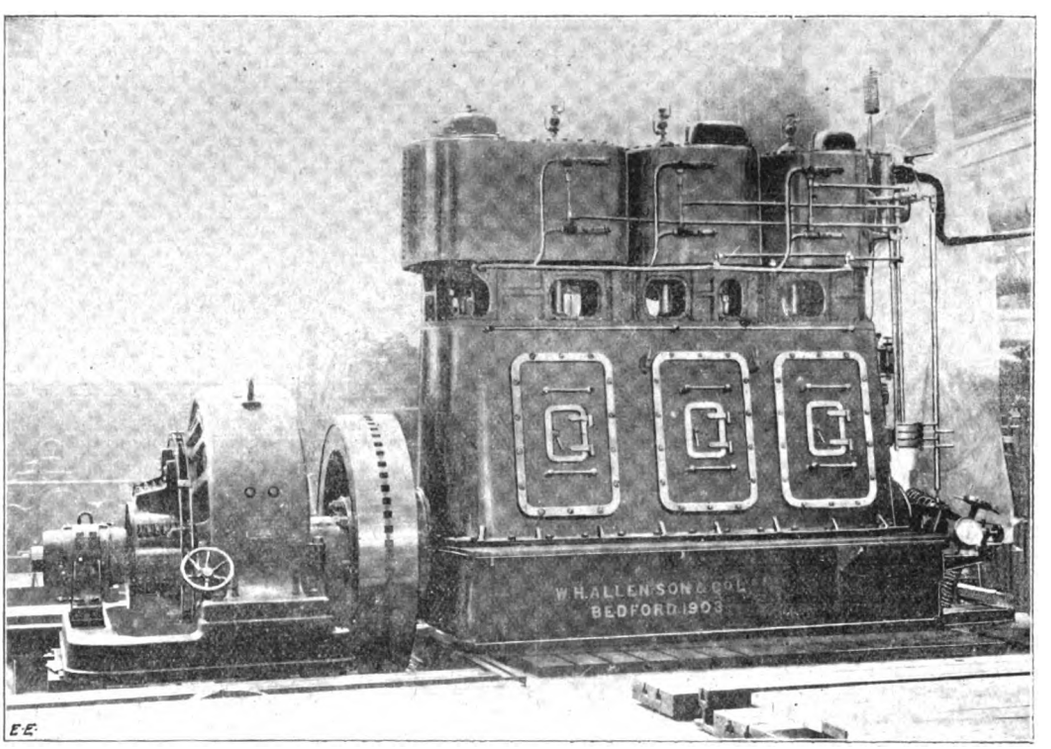


FIG. 1.—580-h.p. Triple-Expansion Engine, by W. H. Allen, Son, and Co., Coupled to British Westinghouse Company's Dynamo.

The dimensions of the cylinders and the successive points of cut-off are so arranged as to produce an equal distribution of power between the three cylinders, thereby ensuring an exceedingly even turning moment throughout the revolution of the engine. The weights of the reciprocating parts on each crank are also equalised in order to eliminate the resultant horizontal and vertical forces due to the inertia of the moving parts; there remain, consequently, only two couples to be balanced respectively in vertical and horizontal planes. As is well known, the complete elimination of these latter couples by any arrangement of revolving weights is a practical impossibility, but in the case under notice they have been reduced to a minimum by a somewhat novel arrangement of balance weights, securely fixed to the crankwebs. These weights are so arranged that the radii of their respective centres of mass are set at a small angle to the crank radius, in order to reduce the unbalanced couples due to the inertia of the valve gear, as well as those of the main reciprocating parts. The success of this system of balancing was a noticeable fact during the trials, and was amply demonstrated by the steadiness of the engine when running without holding-down bolts and standing on a smooth surface plate. The three cylinders are respectively 13in., 20in., and 30in. diameter, and have a stroke of 13in., and are made of a special mixture of hard and tough close-grained cast iron having a tensile strength of from 12 to 15 tons per square inch. They are also provided with the usual accessories in the way of drains, relief valves, and provision for indicating.

The intermediate and low-pressure pistons are of cast steel, and are fitted with Rowan's packing rings, and the high-pressure piston is of cast iron, of solid block type, and is fitted with a solid packing ring of rectangular section, all three pistons being of equal weight for balancing purposes. The valves are all of the solid piston type, and take steam on the inside edges, thereby diminishing the pressure on the glands, as compared with valves taking steam on the outer edges. The whole of the working parts of the engine are enclosed in a neatly designed and substantial cast-iron trunk, the walls of which carry the slides for the main cross-heads. Easy access to the interior of the trunk is provided by three large doors ranged along the front of the engine, each door being furnished with a smaller hinged panel in its centre, which permits of inspection of the working parts. Between the cylinders and the top of the trunk upon which they stand is a distance piece which is cast in one piece with the body of the cylinder, and permits of easy access to the piston-rod and valve-rod glands. The top of the trunk is also fitted with a special form of bush which effectively prevents oil being carried up from the crank chamber to the cylinder, and also prevents the water from entering the crank chamber. Each cylinder with its distance piece is completely isolated from each of the other cylinders, this design having been adopted by the makers for all their standard types of engines, excepting the smaller two-cylinder types, as it ensures that there shall be no distortion of the frame of the engine under any conditions of varying temperature, consequently the working parts are always correctly "in line" and work freely. The whole trunk and cylinders complete are mounted upon a massive cast-iron bed-plate, which forms a reservoir into which the oil drains, and from which the oil is supplied at a pressure of about 15lb. per square inch to all the working parts by means of a small valveless force pump driven from one of the eccentrics of the engine.

The crankshaft, piston rods, valve rods, connecting rods, and eccentric rods are all of Siemens-Martin steel, having a tensile strength of 28 to 32 tons per square inch, and giving under test an elongation of 27 per cent. in a length of 2in. The eccentrics are all of solid forged steel, the high-pressure valve eccentric being securely keyed on to the shaft, and the remaining two eccentrics being forged in one piece with the shaft. The whole of the bearings

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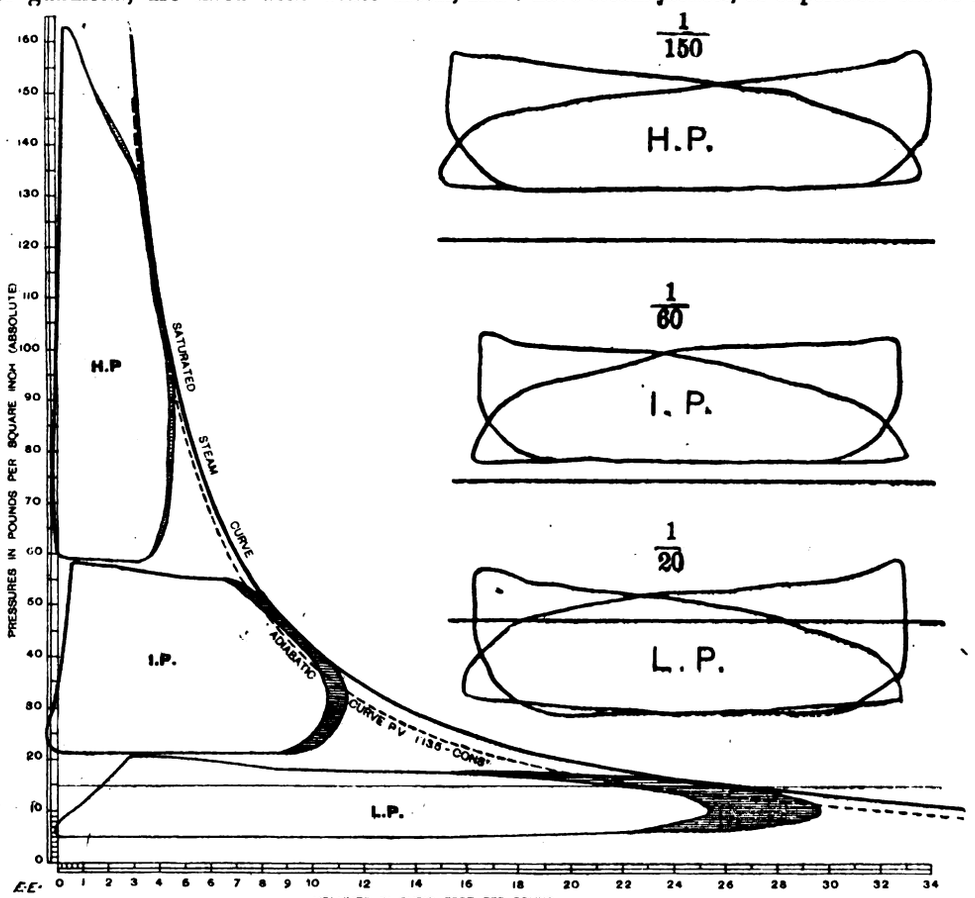
throughout, with the exception of the cross-head bearings, which are of gunmetal, are lined with white metal, and




FIGS. 2 AND 3. Indicator Diagrams from the Allen Engine, and a Combined Diagram prepared from them.

receive oil under pressure from the force pump described above.

The governor is of the company's standard crankshaft type, and can be regulated by hand whilst the engine is running to give a speed variation of at least 5 per cent. above and below the normal, and operates a compound double-beat valve of special design placed between the stop-valve and the engine, and so arranged that at overload steam is by-passed direct to the low-pressure cylinder. It was specified that the steady speed variation from no load to full load should not exceed 3 per cent., and the momentary variation in speed when the whole load is thrown off or on should not exceed 10 per cent. On the official trial, however, the tests of the governor showed a steady speed variation from no load to full load of 1·9 per cent., and a momentary variation when the whole load was thrown off or on of 5 per cent., being thus well within the specified maximum variation. The flywheel is of the solid disc pattern, being forced on to the end of the crankshaft and securely keyed. The dynamo side of the flywheel is accurately faced up to form the coupling for the armature. The cylinders, steam stop-valve, governor valve, and steam separator are all properly lagged with asbestos non-conducting composition, and are neatly covered with blue planished sheet steel, the whole presenting a very neat appearance.

Appended are a few diagrams and test figures taken from the official trial recently carried out at the Queen's Engineering Works, Bedford:

TRIAL RESULTS (OFFICIAL), 13IN., 20IN., AND 30IN. BY 13IN. TRIPLE-EXPANSION ENGINE.

| | |
|---|---|
| Main steam pressure | 160lb. per sq. inch. |
| Throttled steam pressure | 143lb. ,, |
| Mean I.H.P. | 578lb. ,, |
| Mean B.H.P. | 540lb. ,, |
| Mean R.P.M. | 330lb. ,, |
| Mean vacuum at engine exhaust | 25·35in. mercury. |
| Total pounds of water per hour | 8,190lb. |
| Water per I.H.P. per hour | 14·2lb. |
| Water per B.H.P. per hour | 15·2lb. |
| Mechanical efficiency | 93·5 per cent. |

The indicator cards shown in Fig. 2 are samples of those taken during the official trial, and the order in which the cranks lead and follow is that given. None of the cylinders have steam-jackets, as experience shows that their effect at

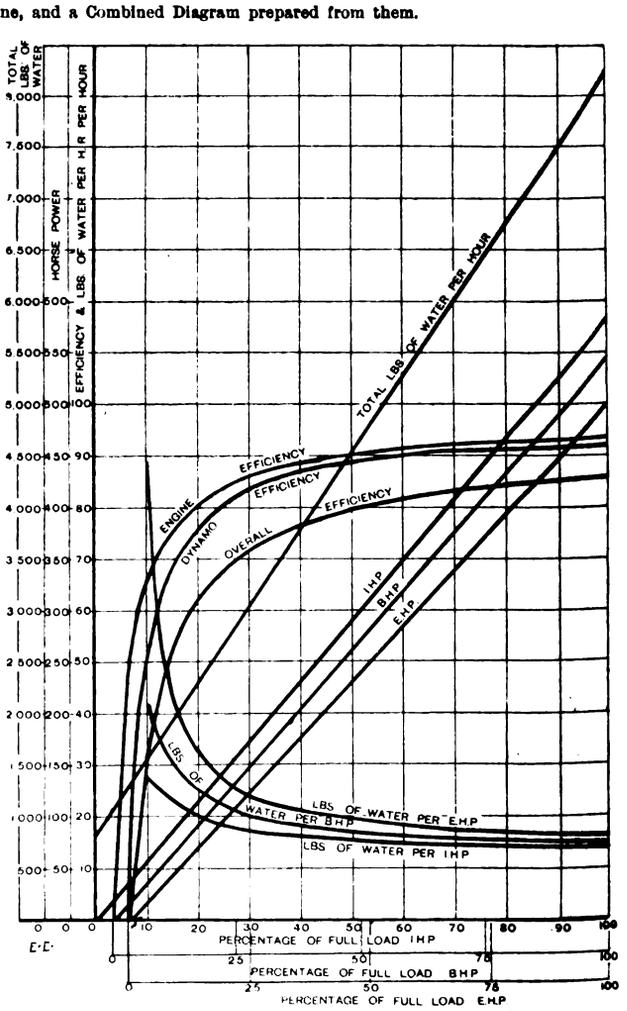



FIG. 4.—Consumption and Efficiency Curves for Engine and Dynamo. Steam pressure, 150lb.; speed, 325 revs.; 25in. vacuum.

such high speeds is so slight as to make it not worth the increased first cost in fitting them. Fig. 3 shows the

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diagrams of Fig. 2 combined under a common saturation curve and an adiabatic curve. The whole diagram is for 1lb. of steam passing through the engine, and to enable the use of a common saturation curve and adiabatic curve for all three cylinders, the cushion steam has been eliminated in each case, as a quantity which does not pass through the engine. The shaded areas indicate the quantity of moisture in the steam during expansion and at release in each cylinder. Fig. 4 gives a number of curves deduced from readings taken during the official trials, and shows the efficiencies and steam consumptions throughout.

## SINGLE-PHASE COMMUTATOR MOTORS AND THEIR REGULATION.*

BY FRIEDRICH EICHBERG.

*(Continued from page 360.)*

[ERRATUM.—For Fig. 12 read Fig. 19 on p. 360—first portion of this article.]

### SERIES AND REPULSION MOTORS.

Before entering into details as to the arrangement of motor and regulator, shown in Fig. 19, the two known classes (series and repulsion) of single-phase commutator motors may be briefly considered, with a view of determining, in the first place, how far they comply with the conditions essential for satisfactory working. My opinion

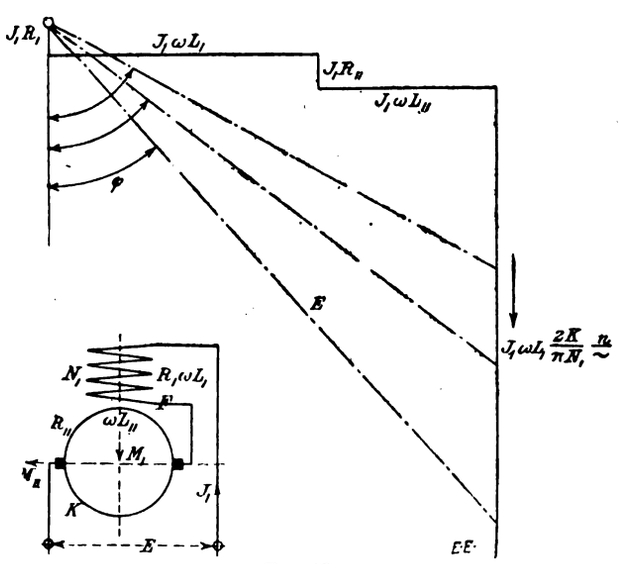


FIG. 12.

on this point is supported by the results of actual experiments. As a matter of fact, the characteristics for the series motor, the repulsion motor, and the motor arranged as in Fig. 19 respectively, given in the following, were established from experiments carried out upon one and the same machine, which was constructed according to my designs by the Union Elektricitäts-Gesellschaft in the summer of 1902. Great credit is due to this company for having rendered possible the elaborate experiments which prove the relative values of the different arrangements.

(*a*) *The Series Motor.*—The series motor not provided with a compensated armature field has to excite both the magnet field, F, and the field due to the so-called armature reaction. The latter produces only harmful self-induction. But the armature reaction can be reduced by modifying the shape of the poles or by employing compensating winding, which with the over-compensation on the Déri system may entirely suppress this reaction. The same result may be attained by providing a short-circuited compensating winding on the stator (see Fig. 13). Lamme seems to have adopted this method. Such a winding was also employed by Déri on a machine constructed by him about six years ago, which started up as a single-phase series motor and continued to run as an induction machine. Then, however, there must be considered the total leakage flux which occurs at the slots and face of the armature and

* Translated from the *Electrotechnische Zeitschrift*.

compensating winding. The diagram for the series motor without compensation is shown in Fig. 12. The diagram for the series motor provided with compensating winding or a short-circuited winding on the stator differs only in that $J\ \omega\ L_{,,}$ and $J\ R_{,,}$ represent the total inductive loss due to the ohmic loss is in the armature and compensating circuit. Generally speaking, $J\ R_{,,}$ will then be somewhat greater and $J\ \omega\ L_{,,}$ smaller. The magnet field in the series motor is given by the relation

$$F = \frac{4\pi}{10}\ \frac{J\ N_{,}}{M};$$

$$F_{max.} = \frac{4\pi}{10}\ \frac{J_{max.}\ N_{,}}{M},$$

M representing the magnetic resistances in the direction of the field. $\omega\ L_{,}$ is the inductance of the field winding.

$$\omega\ L_{,} = 2\pi \sim \frac{4\pi}{10} \cdot \frac{N_{,}^2}{M}.$$

According to equation (1), the counter F.M.F. is, however, given by

$$E_R = 2\ n\ K\ \frac{F_{max.}}{\sqrt{2}}.$$

By introducing the value for $F_{max.}$, and allowing for $\omega\ L_{,,}$ we obtain for the counter E.M.F. the expression

$$E_R = J\ \omega\ L_{,} \cdot \frac{1}{\pi}\ \frac{K}{N_{,}} \cdot \frac{n}{\sim} \quad . \quad . \quad . \quad (7)$$

This equation (7) is the characteristic equation for the series motor. It tells us that for $\frac{1}{\pi} \cdot \frac{K}{N} = 1$ the phase distortion may, under favourable conditions, reach $\frac{1}{\sqrt{2}}$ at synchronous speed—that is to say, when a balance exists between the number of active turns in the armature and

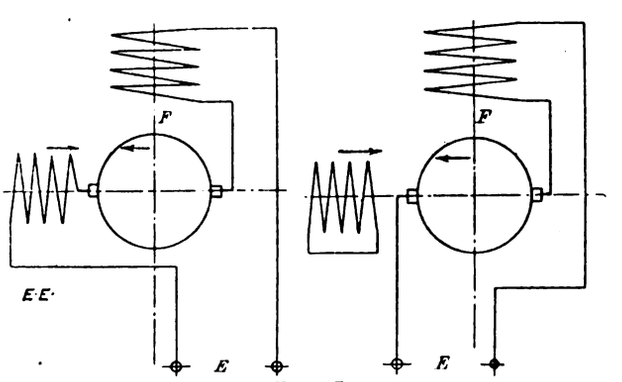


FIG. 13.

field winding, or when in the uncompensated motor there is equal inductance.

The most favourable value for cosine $\phi$, *i.e.*, $\frac{2}{\sqrt{5}} = 0{\cdot}89$, would correspond to double synchronous speed. It is, however, just as impossible to attain this value as that of cosine $\phi = 0{\cdot}7$ for synchronous speeds, since they presume that the magnitude for the armature stray field corresponds to the ohmic resistance. It would, therefore, be to the interest of the manufacturer to increase K—*i.e.*, the number of armature windings. That would effect an increase of the value

$$\omega\ L_{,,} = 2\pi \sim \cdot \frac{4\pi \left(\frac{K\ 2}{2\ \pi}\right)^2}{10\ \ M_{,,}}$$

where $M_{,,}$ represents the magnetic resistance for the armature's cross field. This increase would again reduce cosine $\phi$. It is obvious, however, that the compensating of the armature's cross field will help us very much here. In fact, we may choose a value for K which is fairly large relative to $N_{,}$ and thereby favourably affect cosine $\phi$ without unduly increasing $J\ \omega\ L_{,,}$ which now represents the equivalent self-induction due to stray fields on the armature and compensating winding. Characteristic curves of a compensated series motor are shown in Fig. 14.

But the characteristic cross field, $\Phi$, is absent in such a

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series motor. The short-circuit E.M.F. cannot be counteracted. It naturally decreases with decreasing currents (hence also decreasing F) as the square of the current.

But, in order to fully utilise commutator motors, we must be able to entirely suppress the magnet field at any speed; hence the series motor, due to the absence of means for preventing sparking at the brushes, is far less suited to

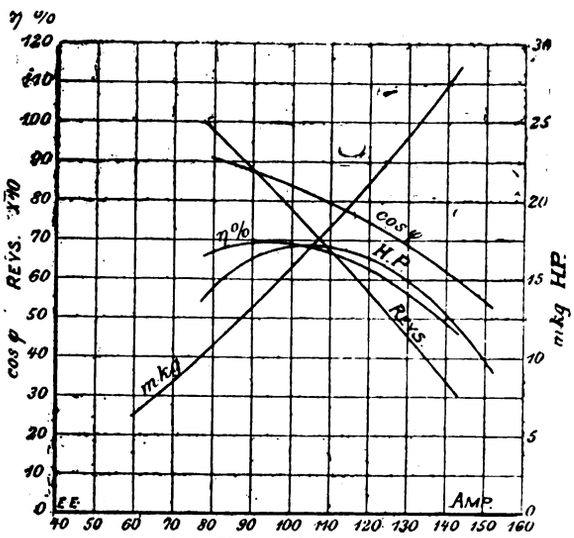


FIG. 14.—Series Motor with Compensating Winding.

the purpose in question than motors which possess a cross field, Φ.

So far as its practical value is concerned, the series motor suffers from the further great disadvantage that it can be constructed only for low tensions—100 to 200 volts, the latter value for very big machines. Besides the field winding a compensating winding is absolutely necessary in

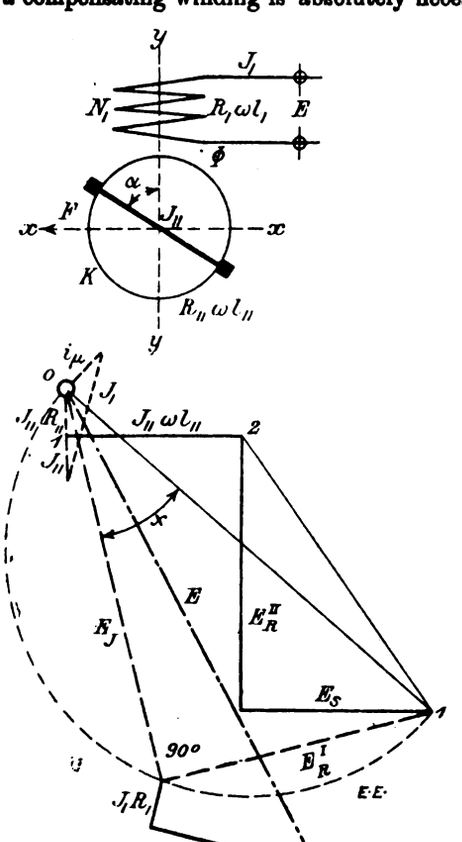


FIG. 15.

rationally constructed motors. To obtain good cosine $\phi$ without running the motor at a speed higher than 1·5 to 1·8 times synchronism, the compensating and armature windings are each allowed two to three times the amount of copper allotted to the field.

(*b*) *The Repulsion Motor.*—The phenomena which occur in the repulsion motor may best be observed in the following manner (see Fig. 15). Let $R_{,}$ and $\omega l_{,}$ denote respectively the ohmic and the inductive resistance (due to the stray field) of the stator winding. $R_{,,}$ and $\omega l_{,,}$ are the similar quantities for the rotor. $a$ is the angle enclosed between the axis of the brushes and that of the field. K is again the number of rotor conductors in series. The field Φ, or its maximum, $\phi_{max.}$, corresponds to an internal E.M.F., $E_J$, of the stator winding, which is equal to the total applied E.M.F., E, less the ohmic and inductive loss. Hence

$$E_J = 2 \sim K \cdot \cos a \frac{\Phi_{max.}}{\sqrt{2}} \quad . \quad . \quad (8A)$$

In the armature there will flow a current, $J_{,,}$ due to transformer action and the E.M.F. induced in the rotor by rotation. All these E.M.F.'s have the full periodicity, $\sim$ (see equations (1) and (2). The armature ampere-turns may be split into two components—firstly, into that component whose influence is exerted along the axis of the stator winding, and which is given by the expression

$$\frac{2}{\pi}\frac{K}{2} \cdot J_{,,} \cos a.$$

These are compensated by the primary ampere-turns, $J_{,} N_{,}$, in the stator winding. The other component is expressed

$$\frac{2}{\pi} \cdot \frac{K}{2} \cdot J_{,,} \sin a,$$

and generates in the direction $x\,x$ at right angles to the field, Φ, a flux, F, as follows:

$$F_{max.} = \frac{4\pi}{10} \cdot \frac{\frac{2}{\pi}\frac{K}{2} J_{,,max.} \sin a}{M_{F\,a}} \quad . \quad . \quad (8E)$$

$M_{Fa}$ is the magnetic resistance in the direction $x\,x$ for the position $a$ of the brushes. The inductance of the armature corresponding to this alternating field gives an E.M.F. as follows:

$$E_S = 2 \cdot \sim K \sin a \frac{F_{max.}}{\sqrt{2}} \quad . \quad . \quad . \quad (8B)$$

The repulsion motor excites the magnet field, F, by means of its armature. Thus we have two fields, Φ and F. Owing to the oblique position of the brushes, a double E.M.F. of rotation ($E_R^I$ and $E_R^{II}$) is generated with increasing speed. If $E_R^I$ be the E.M.F. generated by rotation in the field Φ,

$$E_R^I = 2\,n\,K \sin a \frac{\Phi_{max.}}{\sqrt{2}} \quad . \quad . \quad . \quad (8C)$$

And if $E_R^{II}$ be the E.M.F. generated by rotation in the field F

$$E_R^{II} = 2\,n\,K \cos a \frac{F_{max.}}{\sqrt{2}} \quad . \quad . \quad . \quad (8D)$$

Now $E_R^I$ is in phase with Φ; $E_J$ in the armature lags 90deg. behind Φ. Further, $E_R^{II}$ is in phase with $J''$; $E_S$ lags 90deg. behind $J_{,,}$.

Let us assume any current, $J_{,,}$ in the armature (see Fig. 15). $J_{,,} R_{,,}$ coincides with $J_{,,} \omega l_{,,}$ (the inductive loss corresponds to the stray field round the armature), and with this $E_R^{II}$, which is in phase with $J_{,,}$ and given by (8D) and (8E).

$$E_R^{II} = 2\,n\,K \cos a \cdot \frac{1}{\sqrt{2}} \frac{4\pi}{10} \cdot \frac{2}{\pi}\frac{K}{2} \frac{J_{,,max.} \cdot \sin a}{M_{F\,a}}.$$

$$E_R^{II} = 2\,\pi\,n\,J_{eff.} \frac{4\pi}{10} \frac{\left(\frac{K}{\pi}\right)^2}{M_{F\,a}} \cdot \sin a \cos a.$$

This $E_R^{II}$ is in phase with J, and proportional to the number of revolutions, $n$. $E_S$, which is distorted 90deg. in phase relative to $J_{,,}$, is at right angles to $E_R^{II}$. The resultant E.M.F. in the short-circuited winding is 0·1, and this maintains the balance between the E.M.F. due to the induction of Φ at rest, or transformer action, and the induction produced by rotation in Φ. These two E.M.F.'s, $E_J$ and $E_R^I$ are superimposed. We now have to describe a circle about 0·1, and $E_J$ and $E_R^I$ form a right-angle triangle upon the diameter 0·1. The angle $x$ (see Fig. 15) is determined from the equation

$$\tan x = \frac{E_R^I}{E_J} = \tan a \cdot \frac{n}{\sim} \quad . \quad . \quad (8F)$$

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The equations (8A) to (8F) contains all the characteristic relations appertaining to the repulsion motor.

By adding to $E_1$ : $J_1 R_1$ and $J_1 \omega l_1$, $J_1$ resulting from the current triangle $J_\mu i_\mu$ (corresponding to $E_1$) and $J_2$, we obtain the diagram for the ordinary repulsion motor. It would take us too far to deduct all the conclusions derivable from these equations. I shall therefore confine my remarks to the essential points concerning the subject under consideration.

The repulsion motor excites the magnet field through the armature. It possesses a cross field, which serves to suppress sparking at the brushes, and also the characteristic

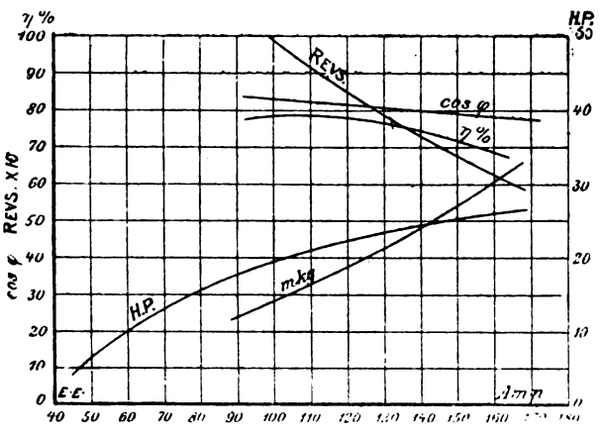


FIG. 16.—Repulsion Motor, 25 ⁓, 220 volts, 2mm. air-gap. Brushes set at an angle of 70deg. to the Stator Winding.

wattless counter E.M.F. The torque corresponds to the product of F and $N_1 J_1$, and is dependent on the phase distortion of both. This distortion is less in proportion as the magnetising current generated by Φ is reduced. The non-inductive resistance of the armature must be kept as low as possible in order to ensure the best possible conditions for starting up and running. If low enough, it can then be neglected without detriment to the result. The greatest consumption of current by the secondary circuit at rest corresponds to an angle α other than of 45deg., which may be determined from the relations already given.

The cross field, F, is its relation to the number of primary ampere-turns, $N_1 J_1$ is given for any angle α. Hence for a given primary potential there is one characteristic only. The ratio of F to the field Φ changes for a given α with the current. The condition (5) for ideal compensation occurs only for a certain current. But the short-circuit

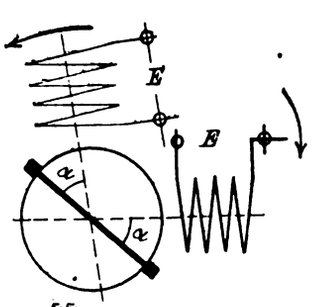


FIG. 17.

energy at the carbon brushes diminishes as the speed increases, thus giving the repulsion motor a considerable advantage over the series machine. From the relation

$$\tan x = \tan \alpha \cdot \frac{n}{\sim}$$

we get $\phi = 1$, for $n = \sim$, if the non-inductive resistances and stray E.M.F.'s in the stator and rotor are negligible quantities, and, further, by neglecting to consider the magnetising current. In reality, this favourable result is not attained, because the assumptions just made do not apply.

Nevertheless, the repulsion motor at synchronous speed has a power factor similar to that of a polyphase motor having the same pole spacing, depth of slot, and equal air-gap (see Fig. 16), the curves in this figure being plotted for an angle of 70deg. relative to the axis of the winding, which corresponds to the position of greatest torque for this motor. At the same time the repulsion motor has only one stator winding, and the primary and secondary potentials are independent of each other. On the other hand, it is of great disadvantage that the repulsion motor can be reversed only by shifting the position of the brushes, or, alternatively, by providing a second set of brushes. Certainly this may be avoided by employing two stator windings, but then we get a serious complication. The one or the other winding must be switched in according to the direction of retation desired (Fig. 17). If we wish to economise copper by splitting up the stator winding into two parts, I. and II. (see Fig. 18),

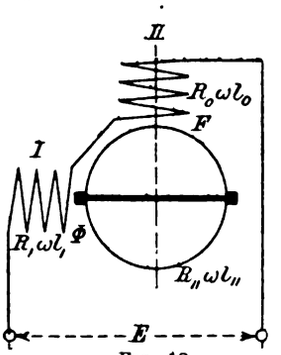


FIG. 18.

the motor at once loses the characteristic of a repulsion machine.* But only the field, F, is now excited by the stator winding. The wattless counter E.M.F. disappears, thereby considerably reducing cosine $\phi$, the other details of the motor being the same.

*(To be continued.)*

## THE ELECTRO-MECHANICAL COMPOUNDING OF GENERATORS.†

An ideal regulator should come into operation at the same instant as the changes of load for which it is to compensate, so that the necessary additional driving power may be supplied as required. If the steam-engine or turbine-driven dynamo is a compound-wound one, the voltage will be constant at all loads, but if shunt wound, the excitation must be altered to suit each load change, and if this alteration is accomplished at the same time as the change in driving power, no voltage variation will occur. The governors employed up to the present on prime movers driving dynamos have the essential drawback that a change of speed must actually occur before they can come into action. It is obvious that in such a case a variation in dynamo voltage must occur, due partly to this change in speed and partly to the strictly electrical change. The regulation, in fact, is carried out at present by letting the governor do its share and then adjusting the excitation by means of a variable resistance.

Recently Mr. Routin, of Lyon, has succeeded in producing regulators which comply with the ideal conditions stated above. It is clear that for every load on the dynamo a particular value of the excitation, as well as a particular amount of steam admission, are necessary, and this naturally suggests that both excitation and admission should be controlled by the same piece of apparatus. Every change of load is followed by a voltage change partly due to ohmic drop and armature reaction—*i.e*, electrical causes—and partly due to speed changes—*i e.*, mechanical causes. The changes due to electrical causes can be counteracted instantly, but those due to mechanical causes are not so quickly dealt with, as they are subject to the law of inertia. Good regulation requires that the steam admission should be increased and the excitation be strengthened at the same

* This method of dividing the stator winding into two parts directly connected in series was made known to me through Herr Déri.

† Translation in abstract of an article by F. Broek in *Elektrotechnische Zeitschrift* for Jan. 14.

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time, whenever either the current increases, the voltage drops, or the speed drops, and *vice versâ*. An apparatus in which the differential action of the current and the voltage is employed may, therefore, be expected to give good results. With Routin's regulator the action may be compared to what would occur if, each time a lamp were switched on, the engineer in charge took the trouble to alter both the steam admission and the excitation of the machines.

The apparatus consists, in principle, of an iron core acted upon by the difference in ampere-turns of a main circuit coil and a shunt coil connected to the terminals (see Fig. 1). The main coil carries the current generated by the machine at each instant. The shunt coil, which is connected in opposition to the main coil, is fed from the generator terminals in series with a regulating resistance, the amount of which is determined by the position of the sliding contact, *a*. At the same time a second sliding contact, *b*, moves over the resistance, R, and alters the excitation of the machine. The dimensions of the two coils are chosen so that the shunt coil normally overpowers the main coil. The iron core of the solenoid is directly connected to the admission gear of the engine and carries a weight, P, producing a permanent downward pull. When the iron core moves downwards the admission is increased, and when it moves upwards increased. Suppose that the speed, voltage, and steam admission are normal, and that the weight, P, is held in a certain definite position by the differential action of the windings. Suppose also that the voltage of the dynamo keeps constant at all loads—*i.e.*, the machine is compound wound. Then any increase in load will correspond to an exactly proportional

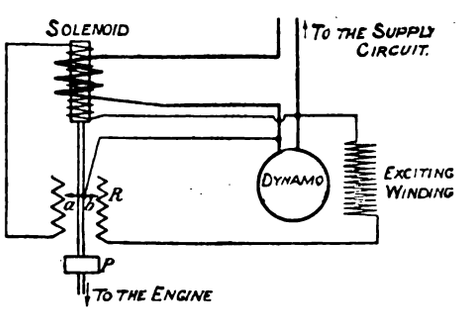


FIG. 1.

increase in the current delivered by the machine, and the ampere-turns of the main coil will increase, so that the overpowering action of the shunt coil will be correspondingly diminished. This will lead to a fall in the iron core, and this produces an increase in steam admission. At the same time, contact *a* will have moved down and reduced the resistance in the shunt coil. As soon as the shunt coil increase becomes equal to the main coil increase in the opposite direction, the iron core will come to rest.

If the dynamo is a shunt-wound one, it is only necessary to make the change of position of contact *b* alter the dynamo exciting current sufficiently to maintain the normal voltage. In the case of a short circuit occurring; the main coil ampere-turns will reach an excessively high value, and will then overpower the shunt coil, reverse the polarity of the iron core, and cause it to rise, thus closing the admission valve. Should a main fuse blow, only the shunt coil on the solenoid will remain in action, and this again will effect the closing of the valve. Should the speed of the machine be altered, due to any external cause, such as a change of head (in the case of turbine-driven sets), etc., the currents in both windings of the solenoid alter proportionately, and their difference becomes greater or smaller according as to whether the speed had increased or diminished. In the former case the iron core is drawn further up, and so closes the admission valve, whilst in the latter case the reverse occurs. The contact on the excitation resistance can be adjusted by hand whilst running, and the degree of compounding can, therefore, be adjusted at will. If both contacts are altered together by hand, the loading of the machine can be adjusted as required, so that when several machines are running in parallel the load on any one of them can be varied in any way desired.

## REGULATING IMPEDANCE COILS: EXPERIMENTS ILLUSTRATING THE IMPORTANCE OF SOME DETAILS IN CONSTRUCTION.*

BY C. FARADAY PROCTOR, MEMBER.

I much doubt whether the substance of this paper is of sufficient interest to compensate for the time you are kindly giving me, but I feel it is the duty of members to assist the society by bringing before it any matter that may be useful, and since I am precluded from touching on the subject with which I am most familiar, I was obliged to either decline to write a paper or make the best of what I hope (if not of sufficient interest in itself) may lead to something useful, and with a view of adding to the interest of the paper, I have, by the kindness of the College authorities, been enabled to show you this apparatus at work.

It is now some years since I was asked to devise a method of regulating a current between the limits of 0·3 to 1·5 of an ampere and 0 to 300 volts, or as near these limits as possible. The method adopted was an alternating current of 375 volts, and a regulating choking coil, such as the one you see here, which consists of about 3,000 turns of ·03in. D.C.C. wire wound into a coil 6in. long and 4in. diameter, and regulates (between 0·2 to 1·0 amperes and 0 to 350 volts), by having a core composed of a bunch of iron wires about 1·5in. diameter and 14in. long drawn in or out of the hollow fibre tube on which the coil has been wound (see Figs. 1, 2, 3, and 4). Some years later more coils

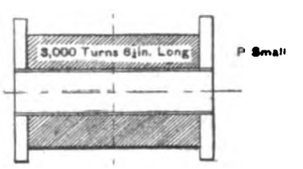


FIG. 1.

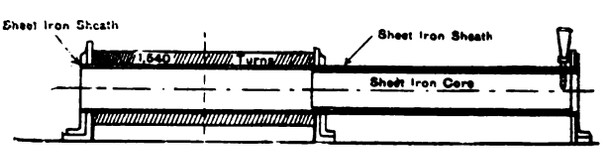


FIG 2.

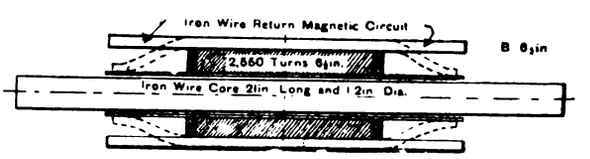


FIG. 3.

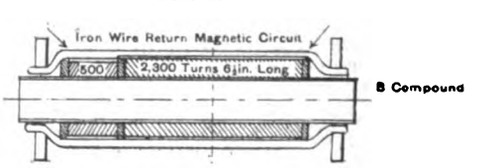


FIG. 4.

were wanted, and were made under the direction of a gentleman of very considerable theoretical experience, but the results were so unsatisfactory that the coils were sent to me to report on and advise how to correct them. This is one of the second batch of coils.

When the first coils were made I questioned the somewhat large diameter of the coil as compared with its length, and also the want of a return magnetic circuit, but the balance of information obtainable seemed to confirm the dimensions as correct, but later on a demand for a coil for heavy currents occurred. I experimented further, and found that by adding a return magnetic circuit the choking effect of the coil could be almost doubled, and later experiments led me to the construction of the coils as shown. Coil $B_1$, I believe, as far as my experiments have gone, is of about the best proportions.

As already mentioned, my experience has always led me to believe that the coils should have been somewhat longer than originally constructed, since the ampere-turns per pound of wire increased more rapidly by adding to the length rather than the diameter. Coils $B_1$ and $B_2$ have exactly the same weight of wire on them, but $B_1$ has 2,550 turns against 2,300 of $B_2$, but any further increase in the length seems to again decrease the efficiency. The weight of wire on these two coils, you will observe by referring to Table I., is just two-thirds of that used in the first coil, P small, and the choking effect is quite as good (in the list it is not shown as being quite as good at minimum

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 29, 1904.

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TABLE No. I.—TABLE OF DIMENSIONS AND RANGES.

| Coils. | Length of coil. | Diam. of coil. | Weight of wire. | Diam. of core in coil. | Diam. of iron core. | Resistance in ohms. | Total turns. | Amperes passing on short-circuiting across 400 volts. Core in. | Amperes passing on short-circuiting across 400 volts. Core out. | On a 400-volt circuit the volts available for regulation at the following amperes are: 1 amp. | 0·75 A. | 0·50 A. | 0·30 A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P small ... | 6·25 | 4·00 | 8lb. 5oz. | 1·625 | 1·20 | 37 | 3,000 | 0·21 A. | 2·90 | 354 V. to 0 V. at ·21 A | 360 V. to 0 V. at ·21 A | 381 V. to 0 V. at ·21 A | 385 V. to 0 V. at ·21 A |
| P large ... | 6·25 | 5·50 | 12lb. | 2·00 | 1·20 | 70 | 5,000 | 0·10 | 1·30 | 225 V. to 0 V. at ·1 A | 310 to 0 V. at 0·1 A | 360 to 0 V. at 0·1 A | — |
| J ..... | 8·00 | 2·25 sq. in. | 2lb. 4oz. | 1·25 sq. in. | 1·20 | 10 | 1540 | Too high for size of wire above 5 A. | Too high for size of wire above 5 A. | 376 to 326 | 380 to 345 | — | 382 to 375 |
| B 6½in. ... | 6·5 | 3·25 | 5lb. 7oz. | 1·625 | 1·20 | 25 | 2,550 | 0·22 | 5·0 A. | 373 to 0 V. at ·22 A. | 379 to 0 V. at ·22 A | — | 391 to 0 V. at ·22 A |
| B 5..... | 5·0 | 3·50 | 5lb. 7oz. | 1·625 | 1·20 | 25 | 2,300 | 0·23 | 5·0 A. | 373 to 0 V. at ·23 A. | 379 to 0 V. at ·23 A | — | 391 to 0 V. at ·23 A |
| B compound | 6·50<br>1·75<br>8·25 | 2·8 | — | 1·75 | 1·20 | 17 plus 5 = 22 total | 2,300<br>500<br>2,800 | 0·3<br>0 22 | Too high for size of wire above 5 A. | — | — | — | — |
| B 100 volts | 5 0 | 1·5 | 1lb. | 0·85 | 0·75 | 5 terminals 0·9 ohm each 4·5 ohms | 1000 | — | — | — | — | — | — |

TABLE II.—COIL J AS CONSTRUCTED, AND AS ALTERED, COMPARED WITH COIL P AND B ON A 400 CIRCUIT.

| Coil J as at first constructed. | Loss in volts by effective resistance at 0·3 A. | 0·75 A. | 1·00 A. | 1·50 A. | Range in volts at various amperes 0·3 A. | 0·75 A. | 1·00 A. | 1·50 A. |
|---|---|---|---|---|---|---|---|---|
| With iron sheath and without iron wire return magnetic circuit ... | 18 | 20 | 24 | 33 | 7 | 35 | 50 | 90 |
| J without sheath and with return magnetic circuit ..... | 3 | 9 | 10 | 18 | 25 | 85 | 110 | 150 |
| Coil P small ..... | 15 | 40 | 46 | — | 385 | 360 | 350 | 344 |
| Coil B 6½ ..... | 9 | 21 | 27 | 36 | 391 | 379 | 373 | 370 |

current, but the ends of the return magnetic circuit are not closed together, which, as you will notice, more than accounts for the difference of ·01) at maximum volts, the coil is, of course, better, the shorter length of wire offering less ohmic resistance, as well as what I have called effective resistance to the current. (The core used in the experiments with the coils P small and P large, also the coils B 6½, B 5, and B compound, consists of a bunch of iron wires 21in. long, 1·20in. in diameter, and weigh 4lb. 10oz. The exterior iron wire return magnetic circuit consists of a number of small bunches of the same sized wires held together with string, making a band 13in. wide and 10in. long, and weighed 3½lb.)

Some of my friends may pull me up for using the term "effective resistance," but I do not know any other term that I can be sure will include all the opposing effects which cause the drop in volts observable, although resistance and self-induction are probably accountable for the chief losses. On referring to Table I., P large, you will notice that the effective resistance is so great that only 1·3 amperes pass with a potential difference of 400 volts, although the actual resistance is only 70 ohms.

Coil J, which is one of the second batch of coils made, you will notice is of very different construction: it is 8in. long, somewhat rectangular in section, is wound on a split sheet-iron sheath, insulated by a mica sleeve, and has only 1,540 turns of wire, and the core is made up of strips of sheet iron, its short-circuiting current is above 5 amperes, and its maximum regulation as at first constructed, and with a current of 1·5 amperes passing and an E.M.F. of 400 volts, is 383 volts to 306 – 77 volts. The difference between the 400 volts and the 383 being loss by effective resistance. At 0·3 ampere its regulation is only 400 volts to 386. Reference to Table II. will show what a very great improvement can be made in this coil by removing the iron sheath and adding an exterior magnetic circuit; at 0·3 ampere the regulation is more than three times what it was, and at the 1·5 amperes more than twice what it was. Of course, the errors in construction of this, and indeed in both coils (when pointed out), are quite obvious, but it is equally obvious that if the constructors knew how important these details were, they would have avoided the errors, and my excuse for bringing this matter before the Institution is the feeling that possibly general knowledge on the subject is not quite complete.

Before referring to the possible uses to which these coils can be put, I think it will be interesting to show how easily they are manipulated, and at the same time it may interest some of the members to know in as brief a manner as possible what the apparatus on the table consists of. Here are the College leads, supplying us with an alternating current of about 20 amperes at 100 volts, which I am using as a primary for this regulating booster transformer. The transformer consists of one circuit only, of 450 turns of Dia. ·054 D.C.C. wire, on which has been placed split sheet-iron rings in the same manner as usually adopted for transformers. The 450 turns of wire are divided thus: Terminal No. 3, then 300 turns, and terminal No. 1, then 70 turns more, and a connection to the first of the switch

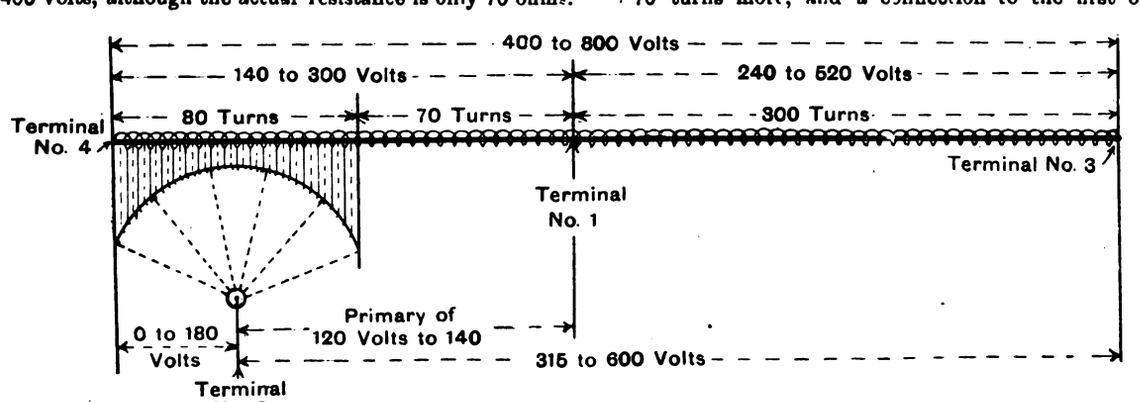


FIG. 5.—Diagram of Regulating Booster Transformer. Windings and Voltages obtainable.

contacts, and at intervals along the last 80 turns there are 20 connections made, one going to each of the switch contacts. The end of the last coil is joined to terminal No. 4. Terminal No. 2 is joined to the switch handle. It will be at once noticed that if I join a primary of 100 volts to terminals Nos. 1 and 2, then between terminals 3 and 4 we will be able to obtain any E.M.F. between approximately 300 volts and 640 volts—*i.e.*, 70 turns into 450 × 100 = 640 volts, or 70 + 80 into 450 × 100 = 300 volts—and by varying the connections of the secondaries, almost any voltage from 0 to 500 or 700 volts can be obtained. Reference to Fig. 5 will, I think, make this clear. To-night I am using 1 and 2 as primaries and 2 and 3 as secondaries, thus giving me the 400 volts I have been using for these experiments. The connections on the table are arranged

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thus: from terminal No. 3 through the two low and high reading ammeters, then through this bank of incandescent lamps (used as resistances), through this series of switches, and back to the transformer; by opening any of the switches I can put into circuit any of these coils. I should also point out that I have a short-circuiting contact on the lamp screen to enable me to short-circuit the lamps out when not required. I should also, perhaps, mention that the lamps are all defective ones. There is also a Weston direct-reading voltmeter, but it only reads to 150 volts. I thus have had to add a resistance box to double or triple the readings as required.

I will now go over a few of the points that I think it will most interest you to see confirmed.

*Coil* P 6½–1. We well note that with an E.M.F. of 400 volts that only about 0·2 of an ampere will pass, although the resistance of the coil is only 25 ohms, and by drawing out the core the current rises to about 1·5 amperes.

2. With the core out, and a current of one to two amperes passing, moving or replacing the exterior magnetic circuit does not affect the current.

3. The addition of the exterior magnetic circuit almost doubles the choking effect.

*Coil* J—1. The point to be checked is the increased choking effect by the addition of the exterior magnetic circuit at low and at full loads.

2. The loss caused by the iron sheath in which the core slides. As regards the uses to which these coils can be put, the first and most obvious is for the regulation of lights in theatres, where often 300 to 400 lamps must be turned up or down without any perceptible jumps. With an impedance coil, 80 to 90 per cent. of the current usually absorbed by the resistances would be saved, and the trouble often experienced with liquid resistances would be avoided; but, of course, alternating currents would have to be used.

The coils might also be used for regulating the illuminosity of an incandescent lamp; for example, a person on a 100-volt circuit may buy 90-volt lamps, and choke down his current to suit. The 10 volts would probably be sufficient to compensate for potential irregularities, and at the same time, as lamps lost their brilliancy, the E.M.F. could be pushed up again by the coil.

I have made coil E to illustrate this point. The loss by the effective resistance of the coil is a drop of 2 volts with a current of 2 amperes passing and a choking effect of 10 to 12 volts. Coil D is practically a regulating booster transformer; it has 2,300 turns of wire, and then a further 500 turns added, in the form of a separate bobbin at one end, and if connected up as shown here may be used for adding on to a 200-volt circuit 10 to 20 volts. Probably it is not quite as economical as the impedance coil, but by having such a coil fitted to rooms in which there is the greatest demand for a good light, lamps of higher efficiencies could be used, and any variations in the E.M.F. of the mains could be taken up by a slight adjustment of the coil, and if the light of the lamp fell by old age, a little extra pressure could be given, and so obtain a bright life rather than a miserable old age.

## COMPANIES' REPORTS.

### YORK TRAMWAYS.

The last half-yearly report states that the gross receipts amount to £2,103, and the working and general expenses to £1,617, showing a balance of £486. It is proposed to pay interest on the 5 per cent. debenture stock; dividend at 4 per cent. per annum on the share capital, leaving to be carried to suspense account, reconstruction of lines, £143. The number of passengers carried during the half-year has been 466,897.

### LONDON ELECTRIC SUPPLY.

The report of the directors for the year ended Dec. 31, 1903, state that the profit on the working for the year is £36,177. 19s. 9d., to which has to be added interest on deposit and amount brought forward, £1,576. 8s. 7d., making a total of £37,754. 8s. 4d. Out of this the interest to Dec. 31—viz., £14,816. 1s. 9d.—has been paid, leaving a balance of £22,938. 6s. 7d. The Board propose to deal with this amount as follows: by payment of a dividend of 6 per cent. (or 6s. per share) on the preference shares, for the year ending Dec. 31, 1903, of which an interim dividend of 3s. per share was paid on Sept. 1, 1903, £14,952; to reserve account, £6,000; to carry forward, £1 986. 6s. 7d. The supply of current has been efficiently maintained during the year, and the cost of production still further reduced. The number of lamps has been increased during the year by 9 per cent., or the equivalent of 17,877 lamps of 8 c.p. The capital expenditure for the year was £36,198. 0s. 10d., necessitated by the expansion of the Company's lighting business and the contract with the London County Council to supply power to their tramways in South London. This power supply commenced on Jan. 17, and is tending, as expected, to reduce the average cost of generation. The Company is now approaching the limits of the capital powers created in 1888. The directors recommend the creation of 20,000 more preference shares, and a resolution will be proposed at the meeting to that effect. The plant and machinery have been maintained out of revenue, and are in efficient condition.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 26,199 | 4 | 10 |
| Distribution of electricity | 5,385 | 19 | 7 |
| Rents, rates, and taxes | 3,914 | 0 | 5 |
| Management expenses | 5,159 | 1 | 5 |
| Law and parliamentary charges | 354 | 2 | 4 |
| | 41,012 | 8 | 7 |
| Balance carried to net revenue account | 36,177 | 19 | 9 |
| | £77,190 | 8 | 4 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter, less discounts | 73,090 | 12 | 9 |
| Rental of meters, transformers, etc. | 3,452 | 11 | 2 |
| Royalties, licenses, etc. | 138 | 11 | 6 |
| Transfer fees | 33 | 19 | 6 |
| Discounts | 260 | 1 | 1 |
| Gross profit on erection of L.C.C. plant and machinery | 214 | 12 | 4 |
| | £77,190 | 8 | 4 |

| Dr. ABSTRACT OF BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 962,095 | 0 | 0 |
| Due from sundry tradesmen and others | 20,270 | 16 | 9 |
| Sundry creditors on open accounts | 10,126 | 7 | 10 |
| Reserve fund account, less discount | 571 | 19 | 6 |
| Balance at credit of net revenue account | 15,462 | 6 | 7 |
| | £1,008,526 | 10 | 8 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 973,392 | 5 | 6 |
| Camberwell provisional order | 208 | 15 | 8 |
| Wandsworth provisional order | 20 | 9 | 0 |
| Cash at bankers and in hand | 1,676 | 12 | 5 |
| Sundry debtors for current supplied | 23,400 | 0 | 6 |
| Other debtors | 2,532 | 18 | 3 |
| Stores on hand | 7,295 | 9 | 4 |
| | £1,008,526 | 10 | 8 |

### BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The report of the directors for the year ended Dec. 31, 1903, states that the revenue account shows a credit balance of £29,233. 18s. 1d., which, with the balance of £888. 8s 3d. brought forward and £335. 7s. 10d. balance of interest received, makes a total of £30,457. 14s. 2d. After deducting £2,424. 3s. for interim dividend on the 7 per cent. cumulative preference shares, and £5.881. 11s. 10d. interim dividend at the rate of 9 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the sum remaining—viz., £22,151. 19s. 4d.—be dealt with as follows: to credit of depreciation account, £7,500; payment of dividend on the preference shares for half-year ended Dec. 31, £2 307. 17s.; payment of dividend on the ordinary shares for half-year ended Dec. 31 at the rate of 11 per cent. per annum, making 10 per cent. for the year, £7,357. 16s. 3d.; directors' additional remuneration, £806. 18s.—leaving to be carried forward a balance of £4,179. 8s. 1d. The additional remuneration referred to in the preceding paragraph is provided for by article 92 of the articles of association. In view of the large sums, amounting to upwards of £10,000, which the Board has in the past waived out of its ordinary fees, and of the fact that the shareholders are now receiving a substantial revenue from the undertaking, the directors feel that this step will meet with approval. The equivalent of 35-watt (8-c.p.) lamps connected is 154,853, the number of customers connected is 3,326, and the net receipts for the year amounted to £29,233. 18s. 1d.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 13,129 | 5 | 6 |
| Distribution of electricity | 1,414 | 13 | 9 |
| Rents, rates, and taxes | 2,982 | 5 | 8 |
| Management expenses | 3,231 | 1 | 6 |
| Law and parliamentary charges | 49 | 0 | 5 |
| Special charges—insurances, etc. | 232 | 13 | 8 |
| | 21,039 | 0 | 6 |
| Balance carried to net revenue account | 29,233 | 18 | 1 |
| | £50,272 | 18 | 7 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of electricity per meter | 47,985 | 1 | 9 |
| Rental of meters | 2,274 | 4 | 4 |
| Transfer fees | 13 | 12 | 6 |
| | £50,272 | 18 | 7 |

| Dr. ABSTRACT OF BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 200,000 | 0 | 0 |
| Sundry creditors on open accounts | 3,994 | 5 | 5 |
| Unclaimed dividends | 4 | 12 | 6 |
| Balance at credit of net revenue account | 14,651 | 19 | 4 |
| | £218,650 | 17 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 189,062 | 2 | 3 |
| Stores on hand at Dec. 31, 1903 | 802 | 5 | 6 |
| Sundry debtors for electricity supplied | 17,639 | 4 | 3 |
| Other debtors and prepaid and suspense charges | 1,073 | 19 | 11 |
| Cash at bankers and in hand | 4,073 | 5 | 4 |
| Loan against securities | 6,000 | 0 | 0 |
| | £218,650 | 17 | 3 |

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## NOTES.

**Institution of Mechanical Engineers.**—The annual dinner of this institution is to be held this year at the Hotel Cecil on Thursday, April 14.

**National Physical Laboratory.** — The annual meeting of the governing body of the National Physical Laboratory will be held at Bushy House, Teddington, on Friday, March 18, under the chairmanship of Lord Rayleigh. After the meeting the laboratory will be open for inspection, and a number of gentlemen interested in the various scientific and general technical tests and researches carried on in the institution have been invited to meet the executive.

**New Books.**—We have received a treatise on "The Indian Electricity Act, 1903," by J. W. Meares (Calcutta: Thacker, Spink, and Co.). 10s. 6d.—"Refuse Disposal and Power Production," by W. F. Goodrich (Westminster: Archibald Constable and Co., Limited). 16s. A comprehensive, well-illustrated survey of the subject.—"Logarithms or Beginners," by C. N. Pickworth. (London: Whittaker and Co.). 1s. In this volume the author gives a practical explanation of the use of logarithms and of the theory of the same. It will be found useful to beginners. The tables at the end of the book are of four-figure logarithms. The author also gives the logarithms of useful factors, and concludes with a few pages of anti-logarithms, which facilitate rapid working.

**Manchester Section.**—The annual general meeting of this section of the Institution of Electrical Engineers will be held on April 12, at 7.30 p.m., in the physical laboratory at Owens College. Nominations for the chairman, vice-chairman, honorary secretary, and 12 members of committee must be sent in by March 29. We also note that this section has arranged a visit to the Mersey Railway works in conjunction with the members of the Liverpool Engineering Society. This visit will take place on March 23, and applications from those who wish to attend it should be sent at once to the secretary, Mr. P. A. Ramage. The meeting of the section arranged for the 29th inst. will not be held, as the author who was to contribute a paper on that date is unable to do so.

**Speed of Tramcars.**—The Liverpool Tramway Committee had before them recently a petition from a number of inhabitants calling attention to an accident that occurred recently by which a girl lost her life in an endeavour to save a dog from being run over by an electric tramcar. In reply to this memorial, the chairman of the committee properly pointed out that they did not exceed the Board of Trade limits as far as speed was concerned. The fact was, that while a tramway accident was made the subject of comment, nothing was heard of ordinary street accidents. He explained that over 50 people were injured last year in Liverpool by other vehicles than trams. We are afraid the daily Press is largely responsible for the undue attention called to tramway accidents.

**Liquid Carbon.**—An experiment performed by Dr. A. Ludwig has demonstrated the possibility of melting carbon and maintaining it in the liquid condition. The heating was effected under great pressure in the electric furnace, and a curious phenomenon noticed at 1,500 atmospheres was that after a brief failure of the arc, the current refused to pass even when the voltage was much increased. It is supposed that as the carbon passed into the liquid and transparent state, it assumed a rare allotropic form, becoming a non-conductor. The test was too brief for a study of this condition, but was made to include a sudden cooling of the molten carbon by a flooding with water of the interior of the pressure vessel. Though minute diamonds were recognised in the grey powder thus obtained, the result was not wholly satisfactory.

**Melting Frozen Water-Pipes Electrically.**—Mr. E. B. Greene, the superintendent of the Edison Electric Lighting Company at Altoona, has made a feature this winter of thawing out frozen water services. This he has carried out at cost price as an advertisement. He uses a transformer with a 50-volt secondary and with a regulating water resistance in the primary circuit. The secondary cables are connected directly to the spigot or to the pipe inside the building, the other one being connected to a fire plug, or, if more convenient, to the pipe in an adjoining house, which then completes the circuit on the iron pipe for the low potential. In this way they have thawed 250ft. of 1in. iron pipe in 20 minutes actual time of current on, using between 18 kw. and 20 kw. The cost of transport of the transformer, etc., is more considerable than the cost of current used.

**Central-Station Vibration.**—In view of the recent action against the St. Pancras Borough Council, by which they were restrained from working a combined electric light station and refuse destructor on the grounds of nuisance, the borough councils in London are taking up the matter with the Board of Trade. They ask that the necessary steps shall be taken to abolish the nuisance clause in provisional orders issued to metropolitan local authorities, and that a clause should be substituted empowering the undertakers to acquire property compulsorily. If this result could be obtained it would frequently be advantageous to buy up property the owners of which complain of nuisance, rather than have large capital expenditure rendered useless. In view, however, of the wide range over which a badly-constructed refuse destructor can be a nuisance, we hardly think the course suggested is a practicable one.

**A Joint Engineering Institution.**—In February last year Mr. Andrew Carnegie offered the large sum of £300,000 to be devoted to the creation of a magnificent engineering home in New York to serve for a number of engineering institutions. The four principal engineering societies to which the offer was made were the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Institute of Electrical Engineers, as well as to the Engineers' Club, a social organisation including members from all bodies. The plan had got so far forward that a site was acquired adjoining the Engineers' Club on which to build the home. Unfortunately, however, the joint working between the four societies above mentioned will not be consummated, as the Society of Civil Engineers have recently decided not to join in the venture. It remains to be seen how far this will affect the success of the scheme, which has so much to recommend it.

**Royal Institution.**—The following are the lecture arrangements at the Royal Institution after Easter: Prof. R. C. Miall, three lectures on "The Transformations of Animals"; Mr. L. Fletcher, three lectures on "Meteorites"; Mr. H. F. Newall, two lectures on "The Solar Corona"; Prof. Dewar, three lectures on "Dissociation"; Mr. H. G. Wells, two lectures on "Literature and the State"; Mr. Cyril Davenport, three lectures on "(1) Mezzotints, (2) Cameos, (3) Jewellery"; Mr. Donald Francis Tovey, three lectures on "The Sonata" (with musical illustrations); and Sir W. Martin Conway, two lectures on "Spitsbergen in the Seventeenth Century." The Friday evening meetings will be resumed on April 15, when Monsignor the Count vay de Vaya and Luskod will deliver a discourse on "Korea and the Koreans." Succeed-

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ing discourses will probably be given by Lieut.-Colonel David Bruce, the Dean of Westminster, Dr. P. Chalmers Mitchell, Mr. M. H. Spielmann, Prof. E. Rutherford, H.S.H. the Prince of Monaco, Prof. S. Arrhenius, and other gentlemen.

**The Bristol Tramways Overcrowding.**—The phenomenal vigilance of the Watch Committee has resulted in the ninetieth prosecution since the Church Congress for overcrowding on the cars of the Bristol Tramways Company. In two cases last week the cars were carrying considerably less than the authorised aggregate of passengers, but, owing to the inclement weather, there was an excess of five inside passengers in each instance. Mr. H. R. Wansborough, representing the company, remarked that the proceedings were instituted under an archaic statute designed to regulate traffic in the days of Mr. Pickwick and Sam Weller. Judge Austin took a sympathetic view, and observed that the excess number of passengers could not have inconvenienced anybody, but on technical grounds he inflicted a fine of 2s. 6d. and costs against each conductor. While excessive overcrowding is to be deprecated from hygienic considerations as well as those of personal comfort, such prosecutions as these evince less regard for the spirit than the letter of the law, and the action of the Watch Committee and the police is decidedly frivolous, besides being arbitrary.

**St. Marylebone Lighting.**—An attempt was made in the House of Commons on Tuesday last to introduce into the St. Marylebone Electric Lighting Bill the Bermondsey clause. After a considerable discussion this was thrown out, and there is no doubt that it would, if passed, have rendered the position of the St. Marylebone Council as electric lighting undertakers a very difficult one for the next few years. With the large capital charges under which the Council will have to work their undertaking, the Bermondsey clause would be exceptionally onerous until the remodelled undertaking had got fairly to work, and we are pleased to find that the proposal was thrown out without a division. The application of the St. Marylebone Council to the London County Council for the large sums which it is hoped will be authorised under the Bill is coming up for discussion in next week's Council. The Finance Committee have recommended that the time is not an advantageous one for granting the large amount asked for, and that in view of the state of the money market the raising of the bulk of money required should be deferred if possible. The new clauses in the Act to empower the Borough Council to enter into an agreement with the Metropolitan Supply Company for the working of the undertaking for a period not exceeding 10 years, have been ruled not to have complied with the Standing Orders. The matter is therefore being considered by the Standing Orders Committee.

**Battersea Polytechnic.**—An illustrated pamphlet has just been issued containing an account of the work accomplished by this institution in the course of its first ten years' existence. When opened in January, 1894, the large total of 2,550 students (male and female) entered for the initial term, and this number has steadily increased, notwithstanding neighbouring competition, until at Christmas last the number had more than doubled itself. The scholarship and examination results afford convincing testimony to the thoroughness of the instruction and the diligence of the students, the latter having distinguished themselves at the universities and in the examinations of the Board of Education and the London County Council, as well as in numerous other directions. The day school has also met with a great measure of success, and now has 433 pupils against 92 ten years ago. Financially, the institution is in an eminently satisfactory condition, despite large outlays on extensions of the premises and admirably-equipped laboratories and workshops. The work is now being specialised to include courses in electrical traction, recent additions to the equipment including a 500-volt generator, pair of traction motors and gearing, controllers, three-phase generators, transformers, polyphase motors, motor-generators, and rotary converters, with some of the latest types of recording and measuring instruments. This electrical department is much appreciated by a large number of students.

**London Traffic Commission.**—At a recent meeting of this Commission Major-General Webber gave evidence as to the need for increased means of communication between North and South London. He particularly referred to a connection by tube between Clapham Junction and Paddington, which would, in his opinion, do much to decrease congestion. The use of tube lines, which were so eminently adapted to the subsoil of London, had been seriously hampered by exaggeration of the cost. Mr. R. Elliott-Cooper also gave evidence, and favoured tubes, except for certain routes on the south side of the Thames, where he considered an overhead railway would be more convenient and cheaper. He was also in favour of through routes, rather than a closed circle, for relieving traffic congestion. The route he suggested as most required was from Hammersmith in the south-west to Piccadilly as its West-end centre, from that point passing down the Strand, Fleet-street, Cannon-street, to the Monument as its City centre, and so forward to the north-east *viâ* Bishopsgate-street. Liverpool-street to Stamford Hill and Tottenham formed a route which was in itself apparently the best, and had already been approved by the joint committee in 1901 and Lord Windsor's Committee of 1902. A complete scheme of that kind would, in his opinion, go far to relieve the present congestion of traffic in London and the suburbs, and it could be extended further out in the future as the requirements of a growing population had to be met.

**Municipal Competition.**—Before the House of Commons last week there was introduced a Bill promoted by the Corporation of Woolwich, under which powers are sought for the construction of an electric railway in a tunnel to connect the north and south sides of the River Thames at Woolwich. The tube line in question was estimated to cost some £233,000, and it would serve as a means of communication in place of the ferries which are now run by the London County Council. Owing to fogs, these ferries are frequently interfered with in the winter, so that the increased means of communication would then be most valuable. The Bill was opposed by the London County Council, who stated that they had contemplated the construction of a free subway to connect the two sides of the river, and that the present scheme would, if sanctioned, prejudice their application to Parliament for the necessary powers. After consideration, the Committee found the preamble of the Bill proved, subject to the insertion of clauses providing that the Woolwich Corporation should not in the future oppose, save on details, the application of the County Council for the construction of a tunnel. Neither would the Woolwich Corporation be entitled to any compensation by reason of the construction of such a tunnel. It will be interesting to see if these clauses will not render the Bill useless to the Woolwich Corporation. In the event of their deciding to go on and construct the electric railway, and the County Council also proceeding with their subway, we shall have a curious case of strong competition between two municipally-controlled undertakings. It seems in this instance that concerted

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action would be much better than such a duplication of tubes under the Thames.

**Electro-Chemistry.**—The second Cantor lecture was delivered on this subject by Mr. Bertram Blount at the Society of Arts on Monday last. The lecturer dealt in the first place with the preparation of metals from fused electrolytes, giving prominence to aluminium, describing the method of obtaining alumina from bauxite, the subsequent getting of aluminium, and the uses of the metal. The latter are extending, and if cost was further reduced might extend more rapidly. About one-third of the total cost is incurred in getting the alumina. The quantity used in 1897 was about 3,394 tons, and had risen in 1901—the last year for which statistics are available—to some 7,500 tons. Compared with the zinc production, it is seen that the aluminium industry is small, but with more extended use better things may be hoped for. Touching on sodium, the lecturer remarked when it was 10s. per pound, then 5s., and now about the price of best fresh butter; but it was not a large industry, because the demand was very small. He indicated that the demand might largely increase if some means could be found for utilising the stored-up energy in a combustion engine. Weight for weight, it had about a quarter the energy of petrol, and could it be used for motor traction the demand would be great, probably leading to its production even more cheaply than at present. Brief reference was made to the obtaining of alkali and bleach, hypochlorites, hydrogen, nitric acid, etc., and stress laid upon the economy in obtaining the heat required for the high temperatures used from the inside of the cell rather than from the outside. The lecture concluded with a few remarks on the present position with regard to the obtaining of organic substances such as iodoform by electrolysis and with notes as to the commercial electrolysis of water.

**Congratulations.**—We have to congratulate our contemporary the *Electrical World and Engineer* of New York on the thirtieth anniversary of its establishment. To be more correct, we should speak of the thirtieth anniversary of the establishment of the electrical journal named the *Operator*, which may justly be looked upon as the parent of the existing journal. In order to commemorate the occasion, our contemporary issues, under date of March 5, a special number containing a quantity of interesting reminiscences by prominent electrical engineers in America. In some instances, too, forecasts are given of what is to be expected in the future. Amongst these there is an article by Mr. Nikola Tesla on "The Transmission of Electrical Energy without Wires." We have looked through this article with interest, and learn definitely that the Canadian Niagara Power Company have called for assistance from Mr. Tesla, and that he proposes to design a transmission of 10,000 h.p. at a voltage of 100 million volts. We should like to have seen figures given by the author as to what he has actually done in this direction. Mr. Thomas A. Edison contributes the article on "The Beginnings of the Incandescent Lamp." The article by Mr. W. J. Hammer on "The First Central Station for Incandescent Lighting," is of special interest to English engineers. In it he describes the plant laid down by him and Mr. E. H. Johnson at the Holborn Viaduct Station in January, 1882. This first central station had machinery for 3,000 lights, and was equipped with the Edison "Jumbo" dynamos. The first two machines used were coupled direct respectively to a Porter-Allen engine and an Armington-Sims engine, and they worked successfully in parallel. The central station in question did not survive the Electric Lighting Act of 1882. Mr. Hammer's other reminiscences of early electric lighting work in England are most interesting. It was in connection with some of this that the first automatic circuit breaker was designed and constructed.

**South African Association of Science.**—The second annual meeting of the South African Association for the Advancement of Science will be held in Johannesburg during Easter week. The function, which will continue until Saturday evening, April 9, will be inaugurated by the High Commissioner at 8 o'clock in the evening of Monday, April 4, when Sir Charles Metcalfe, Bart., M.I.C.E., will deliver his presidential address. The first section of the programme comprises astronomy, chemistry and metallurgy, mathematics, meteorology and physics, and will include papers upon "The Metallurgical Aspect of the Goldmining Industry," by Mr. J. R. Williams, the president of the section, and "Examination of Waters," by Dr. W. C. C. Pakes. In the second section anthropology and ethnology, bacteriology, botany, geography, geology and mineralogy, and zoology will be treated, and amongst the papers promised are "Some Points in the Geology of South Africa," by Dr. Corstorphine, the sectional president, and "Some Rare Minerals found in the Transvaal, with Special Reference to Radium," by Mr. E. P. Rathbone. The third section comprises engineering, architecture, sanitary science, etc., the papers including "Causes of Variations in Diamonds," by Prof. H. Miers; "Lightning Arresters," by Mr. L. A. Wilms; "The Infiltration of Water into the Earth," by Mr. D. C. Leitch; "Mining," by Mr. Ernest Williams; four on "Mechanical Engineering," by Messrs. D. Gilmour, W. G. Holford, H. S. Denny, and G. H. Thurston. The fourth section deals with education, mental science, political economy, and cognate subjects. On April 5 there will be a lecture on "Road Locomotion—Present and Future" (illustrated by models and cinematograph) by Prof. Hele Shaw, F.R.S.; and for the 6th, 7th, 8th, and 9th respectively there is expected to be a drive round Johannesburg and suburbs and a reception by the Mayor and Town Council; a trip to Pretoria, garden party by his Excellency the Lieut.-Governor and Lady Lawley, and a popular lecture; visits to mines and reception by local scientific societies; and a visit to the dynamite factory, Modderfontein. The meeting will, no doubt, discuss in detail the arrangements for the meeting of the British Association in South Africa in 1905.

**Irrigation by Electricity.**—An article in our New York contemporary the *Electrical Review* describes the great success which has attended the introduction of electric power for irrigation purposes in the vast plains of sage bush desert about Los Angeles, California. These plains cover an area of something like 2,500 square miles and from May to November not a drop of rain is to be expected, and during the wet season the rainfall is small. Various attempts were made to obtain an even supply of water by windmills and gasoline engines, but the real solution came when two syndicates put down a hydro-electric plant in the Sierra Madre Mountains, 83 miles east of Los Angeles. To-day these mountain waterfalls are doing work in shops and factories in Los Angeles, and lighting houses and streets, but the most wonderful transformation which they have effected is on the sage plains. The *modus operandi* usually adopted is as follows: A well is driven for each area of from 50 to 75 acres. Over the well is built a little house, and within this is installed a pump and an electric motor. Somewhere in the neighbourhood the high-tension transmission line is tapped, and leads are taken to the pumping station. The transmission voltage is either 15,000 or 30,000 volts, which is reduced by transformers to the voltage of the motors. Troughs and ditches lead from the pumping station to the series of irrigation ditches, with

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flushboards to direct the water to where it is needed. The plant for the pumping station is of the simplest. It is the custom to use small centrifugul pumps driven by small Westinghouse induction motors. Sometimes the motor is mounted upon the top of the pump shaft, and sometimes it is set a few feet away and connected to the pump by a belt. Although irrigation with the aid of electricity was only begun in that part of the country about three years ago, there are already between 500 and 600 electric pumping plants in daily operation. The lands, which were valueless before, are now worth from £60 to £100 an acre. The demand for electric current has become so great that one of the supply companies has gone into the mountains 125 miles to the north of Los Angeles and harnessed up the Kern River. Power from that plant will open up new fields for irrigation as well as supply means for pumping oil, which has been found in large quantities in the district.

**Development of Small Water Powers.**—In a recent issue of the *American Electrician* there appeared an interesting article by Bell on the development of utilisation of water powers having a capacity of less than 500 h.p. The author assumes a stream having a reliable flow of 100 cubic feet per second during the dry months and a working head of 25ft., the maximum flow being 400 cubic feet. The assumed average minimum flow would yield just about 225 h.p. if utilised with a first-class turbine, and the electrical product of this power—a little over 150 kw.—could be sold 24 hours per day, save for a few days at a time in very dry years. For nine months of the year twice this output could be delivered. Since an electric light plant would be the best customer for this power, the author considers how far storage can be brought into play to build up an output big enough to be of some use. With a normal minimum flow of 6,000 cubic feet per minute the working power for a 12-hour run can be developed by storing a little over 4,000,000 cubic feet of water. This would mean drawing down a 100-acre pond 1ft. at night and letting it fill up when the load is substantially off during the day. In a very dry year there may be a further deficit of flow amounting to a little over 2,000,000 cubic feet in every 24 hours, so that the storage pond can be planned for if feasible. The development of the power does not require a large outlay. A well-ballasted timber crib is recommended for the dam. A small penstock is recommended. The number of hydraulic units should be so chosen that the temporary crippling of one will not cause serious inconvenience. The total capacity should be put, say, in four 150-kw. machines. Any more than this would probably lead to increased expense, and any less might cause too severe an overload in case one machine shut down. Regarding the electrical system to be employed, if the power was to be developed for lighting the system is not of much consequence, direct current answering this purpose; if the power is to be transmitted a moderate distance, and loose pulleys are used on all but the smallest motors, a straight single-phase system answers, but where the power is transmitted a long distance and the actual distribution is carried from a sub-station a 10,000-volt transmission line is recommended. A possible supplementary steam plant is suggested in connection with the sub-station.

**Electrical Lift Motors.**—We are indebted to the *Electrical World* of New York for the following abstract of a system of electric hoists in which there is no loss of energy in rheostats. The description is taken from a German contemporary: "The peculiar feature of a hoisting operation is that after a starting period of, say, 20 to 30 seconds immediately a breaking period of 10 to 20 seconds follows. The machine described is a combination of two shunt motors designed in such a way that by varying the field strength the number of revolutions of each motor can be varied in the ratio of 2 to 3. The pole wheel of the first motor is stationary, that of the second motor can revolve, while the armatures of the two motors are so connected as to revolve together. The two fields may first be equally excited, but in reverse sense; then the armature of the first motor revolves with a certain speed and takes the armature of the second motor along. The pole wheel of the second motor tends to revolve in the opposite direction with the difference of the speeds of the two armatures with respect to their fields. The pole wheel of the second motor will, therefore, remain at rest as long as the excitation of both fields is equal. If, now, the excitation of the first motor is diminished, while that of the second motor is kept constant, the relative speed of the first armature with respect to the first pole wheel increases, and the relative speed of the second armature with respect to the second pole wheel decreases. Hence, the second pole wheel will now revolve in space, the first machine working as motor, the second as generator. The first field strength may be so far diminished that the relative speed of the first armature with respect to its field is 50 per cent. above the normal speed; the second pole wheel will, therefore, revolve with one-half the normal speed. To decrease the latter speed again, it is only necessary to increase again the first field excitation. When it is again normal, the second pole wheel is at rest. When the second (movable) field is then decreased, the second pole wheel will begin to revolve in the opposite direction, the first machine now acting as generator and the second as motor; the operation, therefore, corresponds now to an electric brake. It will be seen that the control is very simple, the exciting currents only being varied. After operation has begun, nothing is changed any more in the connections between the armatures and the supply network. The author thinks that this system would be specially suitable for elevators in office buildings and hotels, running at a speed of 1m. to 2m. per second.

**Radium.**—Last week the Rev. Monsignor Molloy, who has taken such an active part in the Dublin branch of the Institution of Electrical Engineers, delivered a lecture on the above subject before the Dublin Royal Society. The theatre in Leinster House was crowded out by those who wished to hear the lecture, in which the whole subject was presented in a concise form. After giving the history of the discovery of radium by M. Curie, Monsignor Molloy illustrated by experiments the properties of radium bromide. These properties led one to the conclusion that radium was continually giving out energy, and the question arose as to where this energy came from. He then described the theories of Prof. Rutherford, of Montreal, that it was due to the atoms continually breaking up, and it was this breaking up which caused the three types of rays now so well identified. This process, however, could not go on for ever, but owing to the immense number of atoms contained even in a small scrap of radium, it might go on for years before the loss of substance would be sufficiently great to be detected by any means now at their disposal. Taking a milligramme of radium bromide, and assuming that the number of atoms that broke off every second was 100,000, the loss could go on for 1,666 years before being detected. The theory presented was generally accepted by the leading scientific men, but it should not be taken as the last word on the subject. It claimed only to be regarded as a tentative hypothesis, which would help them to grasp the facts. Men trained in the highest degree of scientific skill and instinct with knowledge of the laws of Nature were

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engaged everywhere in their investigations, and theories must be moulded into shape, and taken asunder, perhaps, and built up anew as occasion may require, to meet the new discoveries brought to light from day to day. They, as it were, stood on the threshold of a new domain of Nature suddenly unfolded to their view, and all they could do was to search for new facts and in the meantime to wonder and to speculate. Prof. Poynting, addressing a large audience in the Birmingham Town Hall last Sunday, remarked during his lecture, in allusion to Madame Curie's discovery, that, besides, throwing off X-rays, radium emitted negatively electrified atomic particles which travelled at the rate of 100,000 miles a second, and positive atoms which travelled at the rate of 20,000 miles a second. When the positive particles hit certain crystals they gave off a flash, and when they hit neighbouring molecules they gave off heat. Quite recently a new discovery had been made by Prof. Rutherford, of Montreal. He had discovered that the negative fragments not only gave off a flash where they hit, but also when they started.

**Portable Mining Lamps.**—At a recent meeting of the Institution of Mining Engineers the Neu-Catrice portable electric lamp for mining was exhibited and described. This miner's lamp consists of two small accumulators capable of supplying current to a 1-c.p. lamp for 15 hours consecutively. The two accumulator cells are made of celluloid and are then contained in an outer case of sheet lead. Special attention is paid to making the cells acid-tight, so that the lamp may be used in any position. This portable electric lamps is made in two sizes: one, weighing 3lb. 14oz., gives 0·8 c p. during 11 hours, and the other, weighing 5lb., gives 1 c.p. for 15 hours. The respective dimensions are, for the small lamp. 10in. high and 2⅝in. square, and for the big lamp 10in. high and 3in. square. The lamp consumes less than 3·5 watts per candle-power and lasts for 500 hours. The charging plug consists of a block of ebonite, which bears on one of its faces two brass springs, and this arrangement is so devised that any possible error in polarity is obviated. To recharge the lamps a charging table consisting of 20 or 40 compartments is used, according as the available E.M.F. is 110 or 220 volts, and a small switchboard comprising a regulating rheostat, an ammeter, a minimum cut-out, a two-way commutator, and a 32-cp. lamp used as a resistance, absorbing at the commencement of the discharge the excess of voltage which would rapidly deteriorate the small lamps. When the accumulators are recharged, before removing the charging plugs they are discharged for 20 minutes on to the 32-c.p. lamp upon the switchboard. The equivalent resistances are arranged for each department so that any number of cells can be charged. The charging current is usually one ampere kept on for 12 hours. These lamps have been used at the Bruay Collieries, Pas-de Calais, and during April last year the following records were taken: 504 lamps were in regular use, out of which, on an average, 96·73 per cent. completed their shifts without trouble. Of the remaining 3·27 per cent. the failures were due to want of voltage, burnt-out lamps, and other difficulties, but the largest item was due to the lamps giving out, which accounted for 1½ per cent. The communication adds that during the past 15 months 500 of the larger-sized lamps have been used at the pit, and that the average cost of maintenance has been almost exactly ½d. per lamp per day. Mr. W. O. Wood, president of the institution, stated that while he was not familiar with the Neu-Catrice lamp, he had in regular use at Murton colliery some 1,400 Sussmann portable electric lamps. This style of lamp presented considerable advantages, as it was absolutely safe in gaseous atmospheres and very reliable. The bulbs had a life of about 700 hours. The cost was about 3s. per lamp per annum more than that of the ordinary oil-lamp, but he thought it was quite worth while to pay this amount if it was only in the shape of an insurance against explosion, and in fiery mines it was an immense advantage to have a lamp of this description.

**Electricity and Therapeutics.**—At a recent meeting of the Edinburgh Medico-Chirurgical Society, Dr. Alexander Bruce, at the request of the council, gave an interesting demonstration of electrical currents of high frequency, with their mode of production and therapeutic applications. He said that for several reasons electrical treatment had been received by the medical profession with indifference and even contempt. The result had been, however, the discovery by the laity that there was something in such electrical treatment, and consequently all kinds of companies had been started to carry on this treatment, and most of these were run on commercial and unscientific lines. High-frequency currents were periodically alternating currents, and the frequency of this alternation was exceedingly high. Such currents stimulated both nerve and muscle, and the degree of stimulation bore a definite relation to the frequency of the alternation. The slower the alternation (within certain limits) the greater the stimulation—as, for example, from 2,000 to 3,000 per second. With currents of from 5,000 to 10,000 per second there was a gradual diminution in the effect produced, and with alternating currents above 10,000 per second hardly any stimulation was produced. No mechanical means that had been devised enabled them to obtain currents of a greater frequency than 10,000 per second. Having thus described how high-frequency currents were obtained by means of Leyden jar discharges, the lecturer went on to show the use of such high-frequency currents when obtained. He stated that they act as a general tonic to the system, as well as in lessening congestive conditions of the mucous membrane and relieving the pain of neuralgia, neuritis, and locomotor ataxia; in rheumatic anthritis even permanent relief might be obtained. In acute muscular rheumatism the relief might be almost immediate, as in the case of lumbago. In chronic rheumatism benefit also resulted. In neurasthenia the pains were often greatly relieved and a general improvement resulted. In hysteria, however, such a benefit was not obtained—even in some cases the pain had increased in severity. There was also good reason to hope that it might do good in some forms of muscular atrophy, especially if primary. In the treatment of most cases not only a local but a general improvement in health resulted. In alimentary diseases, Dr. Bruce had noted a marked improvement in cases of dilatation of the stomach when due to atony or neurasthenia. In the acute stage hæmorrhoids rapidly improved, as did also fissure of the anus and pruritus ani. Severe cases of cardiac disease with degeneration of the heart muscle did not seem to be benefited. He had not had experience of the treatment in tuberculosis, gout, diabetes, or cancer. We are indebted to the *Lancet* for the above condensation of an interesting lecture, and trust that it will do much to remove the indifference and contempt with which some doctors have received electrical methods of treatment. The same subject has also been treated recently by Sir Oliver Lodge at the Birmingham University, where he has delivered a series of lectures to medical practitioners on physics applied to medicine. These lectures were also accompanied by experiments, and at the conclusion of the last series a vote of thanks was passed to Sir Oliver Lodge for the service he had rendered.

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## THE LIVERPOOL, SOUTHPORT, AND CROSSENS ELECTRIFICATION.

The conversion of the above lines of the Lancashire and Yorkshire Railway Company for electric traction is an accomplished fact. Trains have been run electrically for some time to educate the drivers, and on or about April 3 the public service will be transferred to the 12 new electric

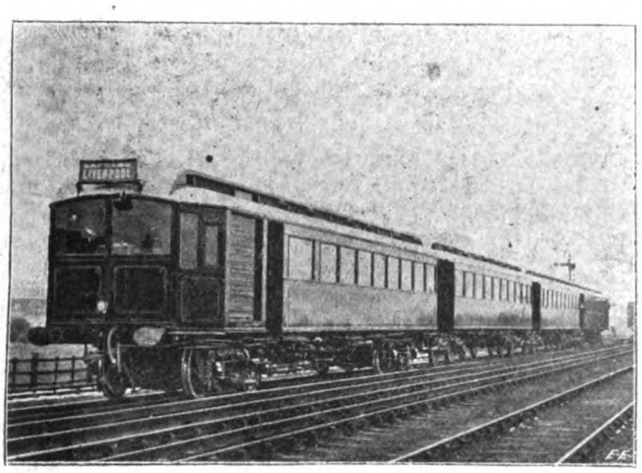

FIG. 1.—The Electric Train on the Liverpool and Southport Line.

trains. New and much improved services between Liverpool, Hall-road, Southport, and Crossens will then be inaugurated, which could not be given economically with the steam locomotives and rolling-stock used up to now. Last week we had an opportunity of examining the line as converted, and of travelling over the route on one of the electric trains. This inspection was well organised to show what could be done, and it is a matter of congratulation that the whole of the electrical plant is of English manufacture. The result is gratifying to all concerned and a great credit to Messrs. Dick, Kerr, and Co, the contractors for the work. It is only by the conversion of suburban lines for electric traction in the way now to be described that railway companies can compete with tramways in suburban traffic. The general fact is that the Lancashire and Yorkshire Railway will now give on the lines in question a much more frequent service with about 30 per cent. increase in accommodation. Thus with smaller trains, more rapid acceleration, and over 80 per cent. increase in train mileage, the company will reap an increased revenue, with, we believe, a decrease in cost.

The scheme for the electrification of the Liverpool and Southport branch was originated by Mr. J. A. F. Aspinall, the general manager of the company, who long ago realised the possibilities of great traffic development in the excellent residential districts which lie between Liverpool and Southport, and on the north side of the latter town. The new service, with its greater facilities, will, no doubt, lead many Liverpool business men to take up their residence on the north side of the city, and particularly in the charming suburbs on the further side of Southport. For the electrified line having been extended to Crossens, enables the district, as regards convenience, to rival the residential neighbourhoods of the Wirral peninsula which lie on the south side of the river. The decision to electrify having been made, no time was lost in putting the work in hand. The complete scheme, with the exception of the rolling-stock, which was made at the Horwich and Newton Heath works of the railway company, was entrusted to Messrs. Dick, Kerr, and Co., Limited, of London, Preston, and Kilmarnock, who may take credit for being the first firm in England to carry out and complete a main-line electrification. It may be interesting to note that the work of electrifying the line has been completed in a remarkably short time. Twelve months ago the work of construction had not been begun, yet on March 1, 1904, a scheme embracing 47 miles of permanent way, a transmission plant of 12,000 h p, and a complete train system had been carried out. It is further to be remembered that this has been achieved without interference with the running of the steam service. These results are mainly due to the untiring energy and organising skill of Mr. Aspinall, ably seconded by the efforts of the contractors.

The distance between Liverpool and Southport is nearly 18½ miles, the total length of track equipped being practically equivalent to 47 miles of single line. The gradients on the road are slight, and there are but few curves, the steepest gradient being a short length of 1 in 85 near Waterloo, and the sharpest curve one of seven chains at Southport; with these exceptions the line is level and straight. There are 14 intermediate stations, which lie at an average distance of about one mile apart on the southernmost portion of the route, but are more widely separated on the northern portion The traffic is almost wholly passenger: business people going to and returning from Liverpool in the morning and evening, with a considerable shopping and miscellaneous traffic during the day. Under steam conditions there are about 36 trains per day in each

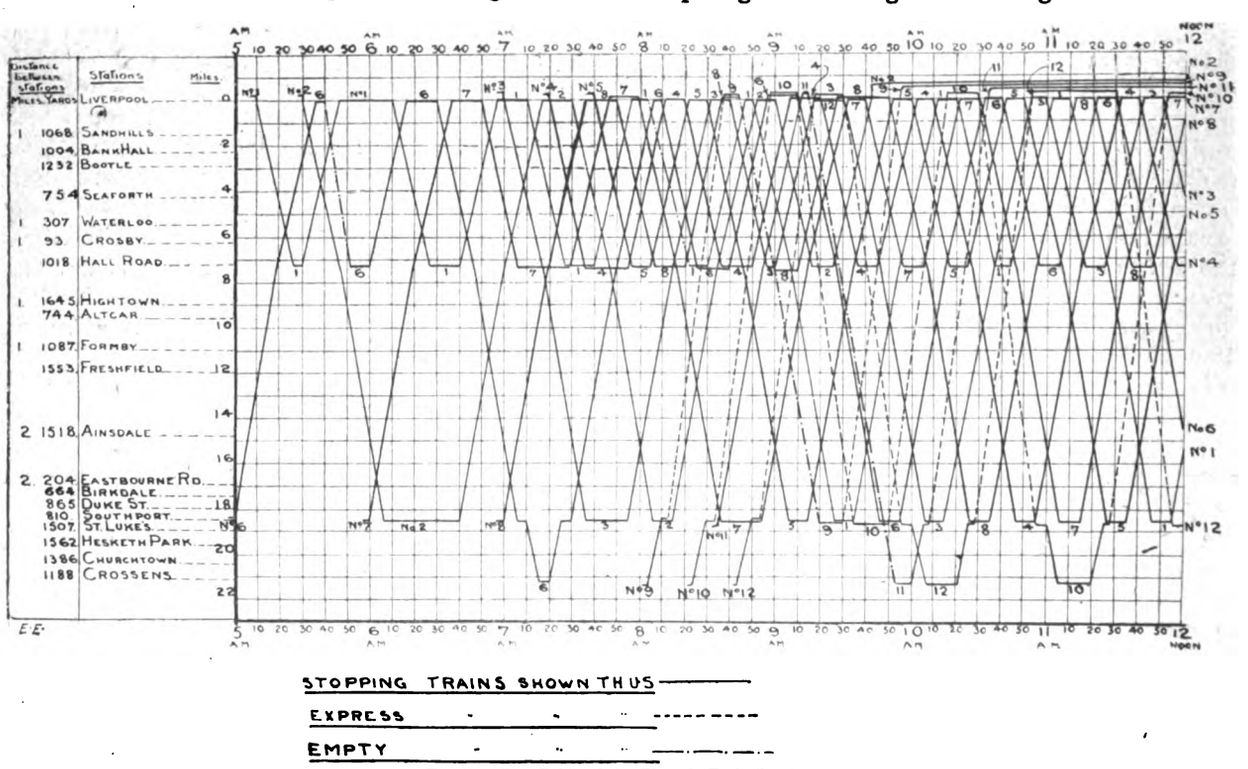


FIG. 2.—Time Table of the Electric Train Service.

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direction between Liverpool and Southport, a similar number running in each direction between Liverpool and Hall-road, a station some seven miles from Liverpool. The majority of these trains stop at every station, a few expresses being run in the morning and evening for the accommodation of the business men. The running times are at present as follows: express trains 25 minutes, stopping trains 54 minutes, Hall-road stopping trains 25 minutes. The total train mileage per diem is about 1,900. With electrified conditions the train mileage will be increased to 3,200 per diem. The number of trains in each direction between Liverpool and Southport will be increased from 36 to 65, and between Liverpool and Hall-road from 38 to 54. Moreover, the running time from Liverpool to Southport will be decreased from 54 minutes

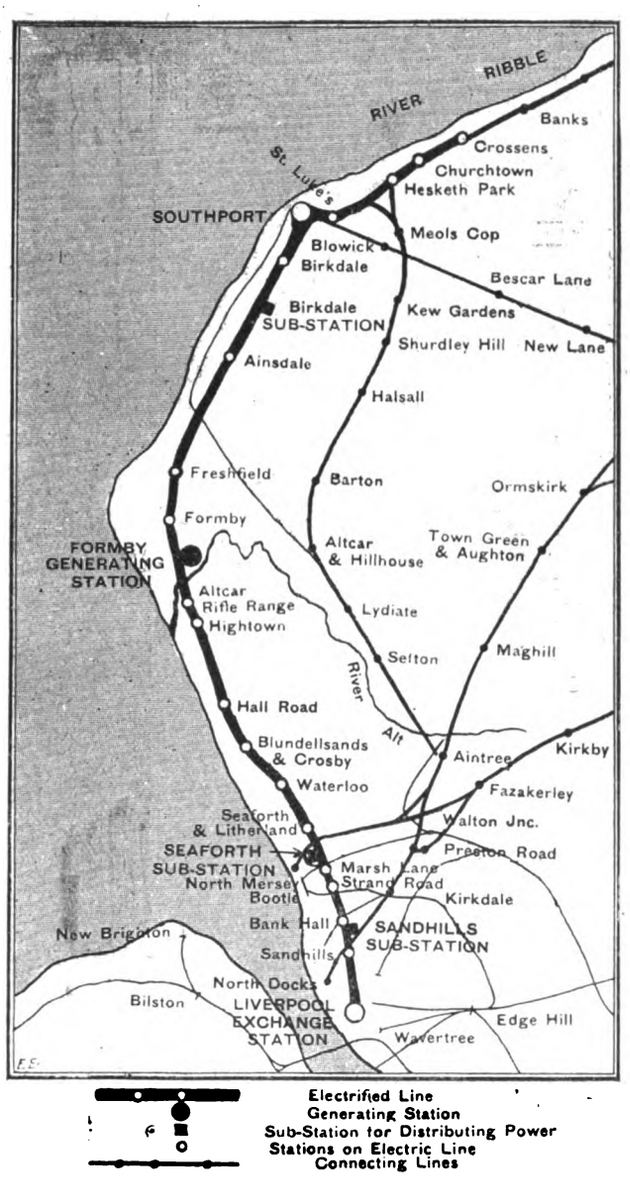


FIG. 3.—Map of the Electrified Portion of the L. and Y. Railway.

at present to 37 minutes, and from Liverpool to Hall-road from 25 minutes to 17 minutes; the schedule time of the fast trains will remain unaltered, but there will be an express in each direction hourly, instead of only rarely. In addition to this, the express trains will run on to Crossens, giving that suburb a service of 17 trains each way during the day. These arrangements, however, do not represent the ultimate capacity of the line, and if the traffic in the course of a year or two were to demand it, there would be no difficulty in running an even more frequent service. It is intended to shorten the stops at the intermediate stations, and as this will make fresh arrangements necessary to deal with heavy luggage and parcels, a special baggage car has been built to deal only with this service. This car will make numerous trips between Liverpool and Southport, and will immensely increase the ease and rapidity with which parcels can be delivered in the residential districts between Liverpool and Southport. In Fig. 2 we reproduce a diagram of the new service with electric trains from 5 a.m. till noon. The time-table thus represented shows clearly how the local trains to Hall-road fit in between the Liverpool and Southport service. It is also indicates how the express trains by starting just before slow trains make the journey in the time mentioned without having to pass the local trains except at Hall-road.

### GENERAL OUTLINE OF SYSTEM.

The portion of the line which has been electrified is shown on the map (Fig 3), and it is obvious that the distance, quite apart from conditions of service, demanded a system of high-tension transmission. The electrical energy is generated as three-phase alternating current at 7,500 volts pressure, and transmitted direct to sub-stations, where the voltage is stepped down by statics and transformed by rotary converters into direct current of 650 volts pressure, the maximum voltage at the train being 600. The power-house is situated approximately about the centre of the line, near Formby, directly on the River Alt, being thus favourably situated as regards economical distribution and a plentiful supply of water. The power-house is utilised at the same time as a sub-station, from whence part of the electrical energy is distributed direct to the adjacent track. In addition to the rotary converters at the main power-house the scheme embraces three sub-stations, the first being at Sandhills, the second at Seaforth, and the third at Birkdale. The distances of these sub-stations from Liverpool are respectively as follows: Sandhills station, 2 miles; Seaforth sub-station, $3\frac{3}{4}$ miles; Formby power-house sub-station, $10\frac{1}{4}$ miles; and Birkdale sub-station, $16\frac{1}{8}$ miles. Near Liverpool it has been necessary to arrange the sub-stations closer together than on other parts of the line, in order to cope with the considerably heavier traffic of the local trains running from Liverpool to Hall-road and *vice versâ*. The extreme ends of the line—from Sandhills sub-station towards Liverpool, and from Birkdale sub-station towards Southport and Crossens—are each fed by one sub-station, whilst for the intermediate sections of the line two sub-stations participate in supplying energy to the trains, the demand of energy supplied from each sub-station depending on the position of the train between the sub-stations. The sub-stations are situated near the track, thus avoiding any low-tension cabling, except a short connecting length. The system is arranged so that any sub-station can be disconnected if required.

### POWER STATION.

The design of the power-house is remarkable from its simplicity, and at a later date the cost per unit generated will, we believe, compare favourably with that obtained at other stations replete with every luxury and refinement. The saving from this simplicity in capital and depreciation charges must be very considerable, and we expect the items for repairs will also prove abnormally small. Figs. 4 and 5 show respectively the plan of the station and a cross-section through the same, which will enable the description to be followed.

The building is a plain and substantial one with no ornamentation, but admirably adapted for the purpose for which it was constructed. It has been erected by Messrs. Thomas Croft and Sons, of Preston, to designs prepared by Messrs. Dick, Kerr, and Co, and upon elaborate foundations which were constructed by Messrs. Monk and Newell, of Bootle, under the immediate supervision of the engineers of the Lancashire and Yorkshire Railway Company. In view of the subsoil being pure sand, the whole station is carried on one large block of concrete. The building is in two divisions—the engine-room, being 280ft. long by 65ft. wide, and the boiler-house, which is 50ft. wide with a similar length of 280ft. The building consists of a steel roof in two bays carried upon steel columns, all of which are independent of the brickwork, and which have been made by Messrs. Head, Wrightson, and Co., of Thornaby-on-Tees. The engine-room is provided with admirable lifting and travelling machinery in the way of overhead cranes, which are capable of dealing with pieces of machinery up to 20 tons, and which are operated electrically. They have been built by Messrs. Jessop and Appleby, of Leicester.

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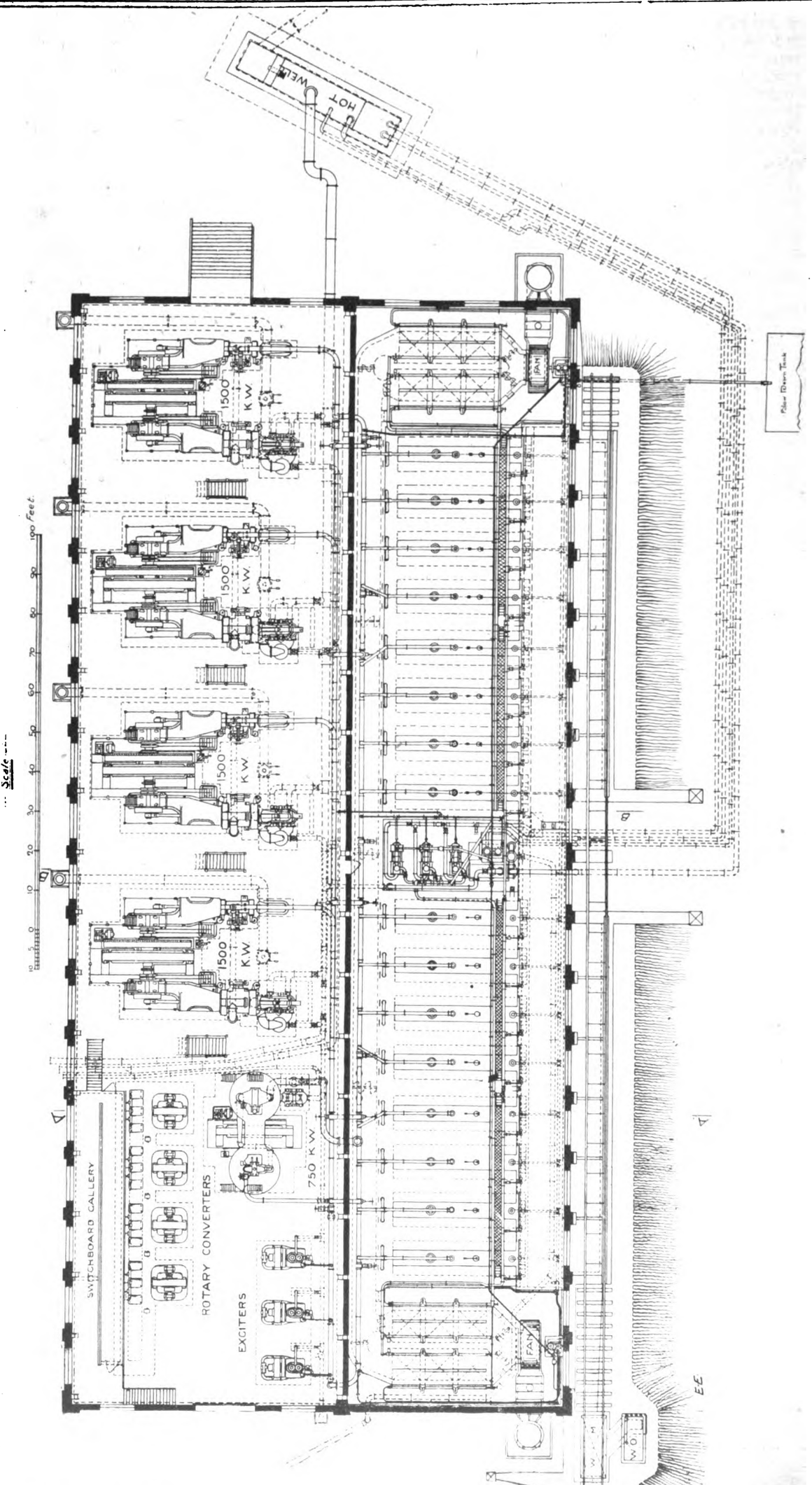


Fig. 4.—Plan of the Formby Power House of the Lancashire and Yorkshire Railway Company.

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For obvious reasons the size of the units is as large as possible compatible with the running of a reduced service with a good load factor.

There are now installed four 1,500-kw. units (Fig. 6), of which three will under normal conditions meet the demands. In addition, there is a fifth unit of 750 kw., which will form a useful link between the larger units, and thus permit considerable flexibility in obtaining a good plant load factor with high efficiency throughout the day. The four main engines are of the horizontal cross-compound type, the fifth engine being a vertical cross-compound. The horizontal engines have cylinders 32in. and 64in. diameter, 4ft. 6in. stroke, and run at 75 revolutions per minute. The normal load of each engine is 2,310 h.p., with a steam pressure of 160lb. per square inch, but they are designed to give an overload of 20 per cent. The main engines, as well as the boilers, were supplied by Messrs Yates and Thom, as sub-contractors to Messrs. Dick, Kerr, and Co., Limited. The cylinders of the main engines are of the built-up type, with separate ends and barrel, the valves, which are of the double-ported type, being placed in the cylinder ends, which thus form the steam boxes. The steam valves are worked by Messrs. Yates and Thom's well-known trip gear, the closing of the valves being accomplished by powerful vacuum dash-pots. The exhaust valves have a plain motion, derived, like the motion for the steam inlet valves, from eccentrics fixed on the crankshaft. The question of governing is an extremely important one in work of this character, and specially powerful and sensitive governors have been fitted to the engine, in connection with which are several devices designed for securing good parallel running and for dealing with greatly varying loads. Each governor is also fitted with a special safety stop arrangement, which will shut off steam in the event of the engine reaching a speed 10 per cent. above the ordinary working speed, and will also shut down the plant in the event of any failure of the governing gear. This is accomplished without interfering with the engine taking excessive overloads, even beyond the full range of the cut-off gear. The massive flywheel, 22ft. in diameter, weighs 70 tons, and is directly attached by strong bolts to the rotor of the alternator. The engines are solidly constructed, and of massive proportion, the weight of each bed frame being 14½ tons. Each crankshaft main bearing weighs about 11 tons, and the crankshaft 17 tons, the cranks weighing five tons each. The pistons are of cast iron fitted with Ramsbottom rings, the low-pressure pistons having also bands of white metal to improve their wearing properties. Each engine is fitted with a condensing apparatus, consisting of two Edwards air-pumps worked from the low-pressure tail-rod by means of links and levers; the condenser, which is of the jet type, being suitably placed relatively to the cylinder and to the air-pumps, and having in connection with it a sluice valve, and an automatic exhaust valve, so that the condensing apparatus can be thrown out of action, and the engines run non-condensing when required. Each engine is provided with a separate exhaust pipe to atmosphere.

The vertical cross-compound engine has cylinders 23in. and 46in. diameter, 3ft. 6in. stroke, and will develop 1,180 h.p. when running at 94 revolutions per minute. The general construction of the cylinders, valve gear, and other parts is similar to that of the horizontal engines described, the main difference being in the framework and staging. A similar arrangement of condensing apparatus has also been adopted, the air-pumps being worked by means of levers from the low-pressure main cross-head. With each engine is also supplied a barring gear driven by a Dick-Kerr electric motor.

The alternators are three-phase, 25 cycles, the larger running at 75 revolutions and the smaller at 94 revolutions per minute, with a pressure of 7,500 volts. These machines, along with the remaining electrical plant, were made at the Preston works of Dick, Kerr, and Co., and the details of their construction were given in our issue for Oct. 30, 1903. Each rotor or magnet wheel is carried between the cranks, the armature ring or stator being erected on its own slide beds, concreted in, and bolted down on the engine foundations. The rotor of the 1,500-kw. generator carries 40 radial cast-steel poles of oval section secured by tap bolts to the outside rim of two finished cast-steel rings of massive T section carried and driven from a central cast-iron spider by 16 axial bolts. The pole tips are of laminated steel with a central air space corresponding to grooves on the pole sides and the clearance between the rotor rings, dovetailed tight into the poles to keep the field coils in position. These are of bare copper strip wound edgewise. The outer surface of the coils is left bare to aid the dissipation of heat, while the central ducts on the poles give ample ventilation to the iron. The cast-iron spider is built in halves and clamped on the shaft by four heavy bolts. The magnet rings are also in halves, but staggered relative to each other and the spider and shrunk together by double-headed keys. The cast-iron slip-rings are of stiff section carried on either side of a cast-iron spider by axial bolts insulated with ebonite. For each slip-ring three carbon brushes are provided. The weight of the magnet wheel complete is about 48,500lb., of which the poles account for 12,800lb. and the spools 6,350lb.

The stator consists of a cast-iron frame carrying the core discs on its inner periphery. The core segments are of annealed iron, punched in sections with their paper insulations. The sections break joint to equalise the reluctance, and are strung true on through bolts that clamp them up between a deep internal flange and a stiff cast-iron end ring built in sections. The complete stator weighs 75 800lb. Each coil is fully insulated, dried, and tested to 15,000 volts before being inserted in the slots, the stator when completed being adequately tested. Special ventilation ducts are provided, the rotating field forcing cool air through these ducts and out at apertures cored in the frame. The winding of each phase is distributed over two slots per pole. The connection used is the star type, with the centre earthed.

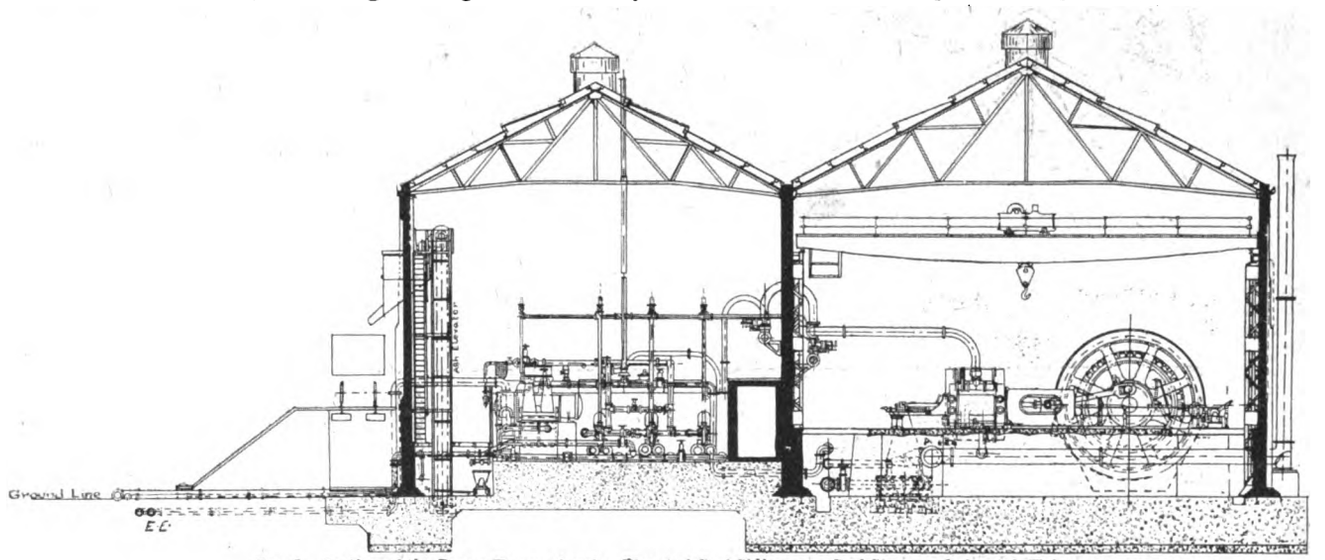


FIG. 5.—Section of the Power House, showing Elevated Coal Siding over Coal Store, and also Ash Hoist.

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The stator terminals consist of three high-tension porcelain pots carried on a bracket at the bottom of the frame and enclosing the bare couplings. In each alternator provision is made for shifting the stator axially by ratchet jacks to clear the rotor and give comfortable access to the windings

to a Willans and Robinson high-speed engine, running at 380 revolutions per minute, the working voltage being 125. They also operate the station lights and ash conveyor and barring motors. The general design of the machine is on the well-known Dick-Kerr lines.

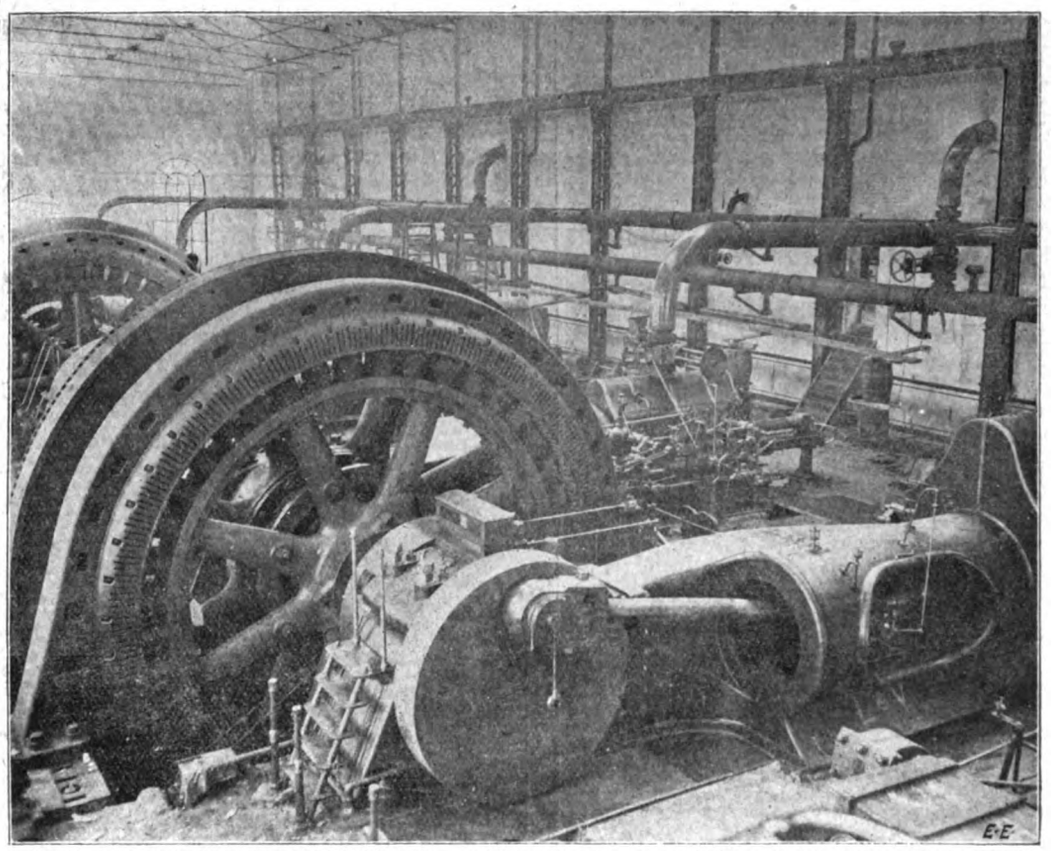

FIG. 6.—The Engine Room, showing 2,310-i.h.p. Yates and Thom Engine coup'ed to 1,500 kw. Dick-Kerr Three-Phase Alternator.

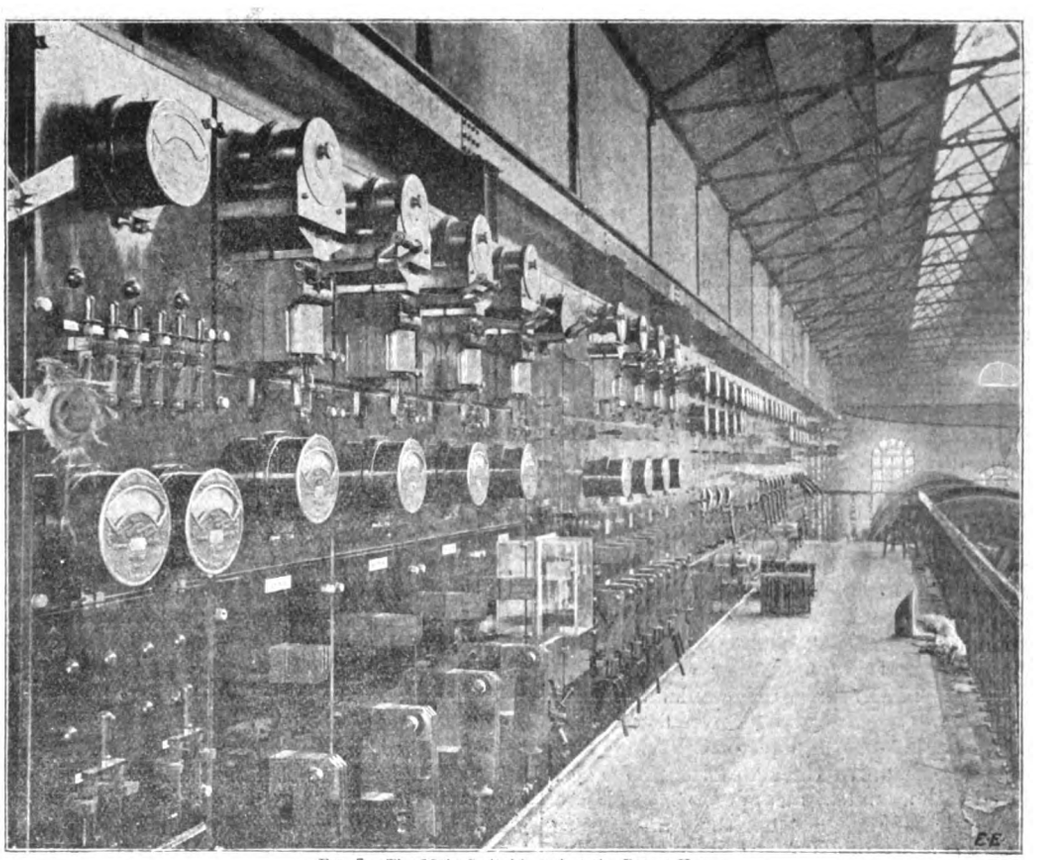

FIG. 7.—The Main Switchboard at the Power House.

The constructional features of the 750-kw. alternator are almost identical with those of the 1,500-kw. sets.

There are three direct-current exciter sets, each consisting of a standard Dick-Kerr four-pole 100-kw. generator coupled

The main switchboard (Fig. 7) is erected on a gallery over a fireproof high-tension chamber, and is built up of 33 2ft. panels of enamelled slate. Starting from the right, there are swing brackets carrying two alternating-current

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'bus bar voltmeters reading to 8,000 volts, synchronising voltmeter 0 to 16,000 volts, and synchronograph with lamps; five main alternator panels, one blank panel, one panel, also comprising one sub-panel switch for starting a rotary converter from direct-current 600-volt 'bus bars; four sub-station feeder panels; lastly, one station lighting

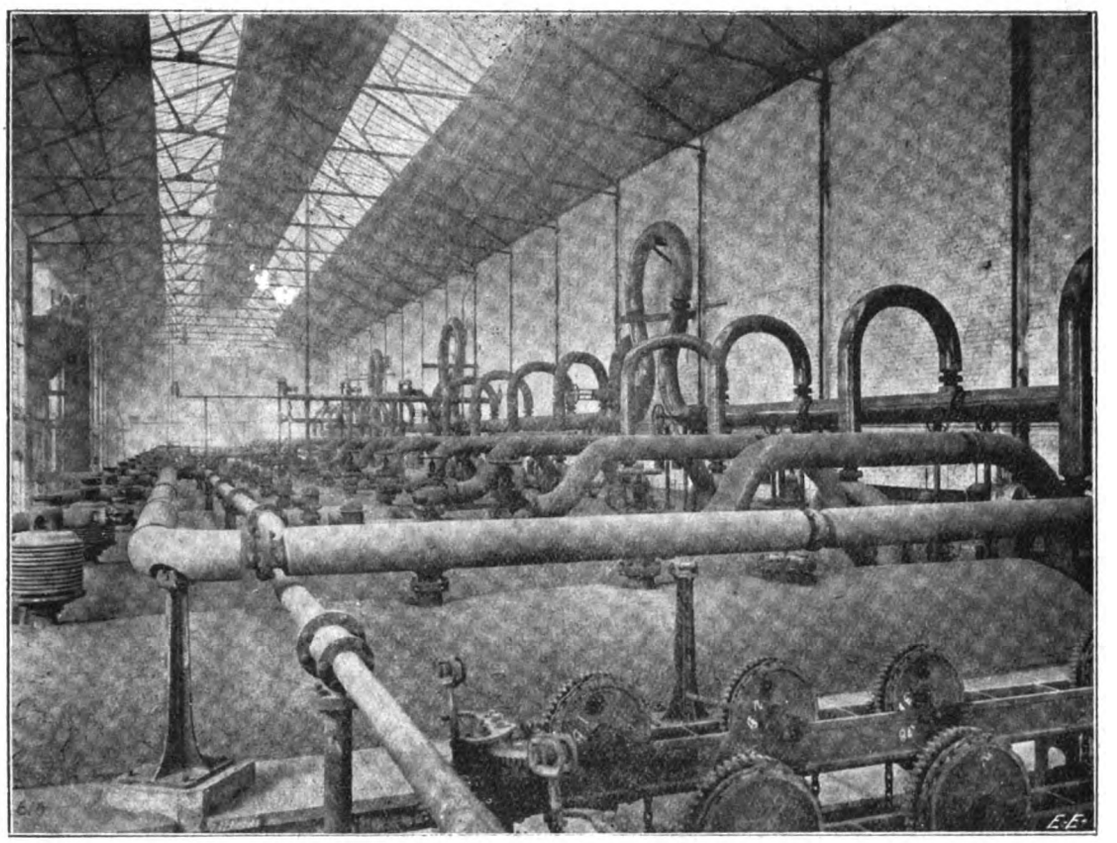

FIG. 8.—View in the Boiler House of the Steam Pipe Connections.

total station power panel, six high-tension feeder panels for the distant sub-stations at Seaforth, Sandhills, and Birkdale; and blower motors' starting panel, and swing bracket with rotary converter' bus bar voltmeter and paralleling voltmeter,

FIG. 9.—One of the Sub-Stations with Static Air-Cooled Transformers and Rotaries.

three exciter panels, one sub-station total power received panel, four high-tension sub-station transformer panels, one blank panel, four rotary converter direct-current panels, one blank panel, one sub-station total power delivered all the sub-station gear being for the local sub-station at Formby. The whole of the high-tension switchgear, oil switches, instrument transformers, and 'bus bars are erected in a fireproof high-tension chamber, the dimensions of

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which are 79ft. by 12ft., and constructed of steel girders and concrete. Connection between the terminals of each stator and its oil switch is made by short leads to a trifurcating box in the pit, thence by a three-core high-tension lead-covered cable passing along an independent duct through the foundation up to the cellar ceiling, along which it is run by ducts through the high-tension chamber floor, where it ends in a second trifurcating box on the wall. The rest of the high-tension wiring is by individual conductors. The three-core high-tension leads are of stranded copper cable, paper insulated and lead covered. The single cables are rubber insulated, taped, and braided. They were designed to pass a flash test of 25,000 volts between the phases and each to earth. The solid copper rod high-tension 'bus bars are insulated in a similar manner, and reduced in section from alternators to local sub-station panels as power is tapped. The 'bus bars and individual leads are carried on corrugated high-tension porcelain pots, connection between oil switch and 'bus bar being made through a high-tension insulating or "hook switch." In the instrument transformers supplied with the ammeters by Messrs. Elliott Bros. the primary is simply a straight length of lead or 'bus bar enclosed by the secondary and iron circuit. In the wattmeter current transformer supplied by the Stanley Wattmeter Company with their meters the forming layers in a vertical stack which open top and bottom for thorough ventilation.

The boiler-house is equipped with 16 boilers of the Lancashire type, 32ft. long and 8ft. 6in. in diameter. These were also made by Messrs. Yates and Thom, and are designed for 160lb. working pressure. They are arranged, as seen in Fig. 4, in two independent batteries of eight boilers. The boilers are connected to a flue, at the two ends of which are placed Green's economisers and an induced-draught fan. Each boiler is equipped with a Galloway superheater, which is arranged to be always in service. The induced-draught arrangement is exceedingly useful in the case of a railway power-house, where the load varies considerably at different times of the day. Each fan in the present instance is able to deal with sufficient air to ensure the consumption of 10,000lb. of coal per hour, with a temperature of the flue gases leaving the economisers of 400deg. F. The fans are driven by independent steam-engines. The Green's economisers at the end of each flue are divided into two sets, so arranged that they can be used independently if needed. The scrapers are driven by direct-geared electric motors. The whole of the pipework was made by Messrs. Dick, Kerr, and Co., at their Kilmarnock works, and it speaks well for the accuracy of the work that the whole of the steam

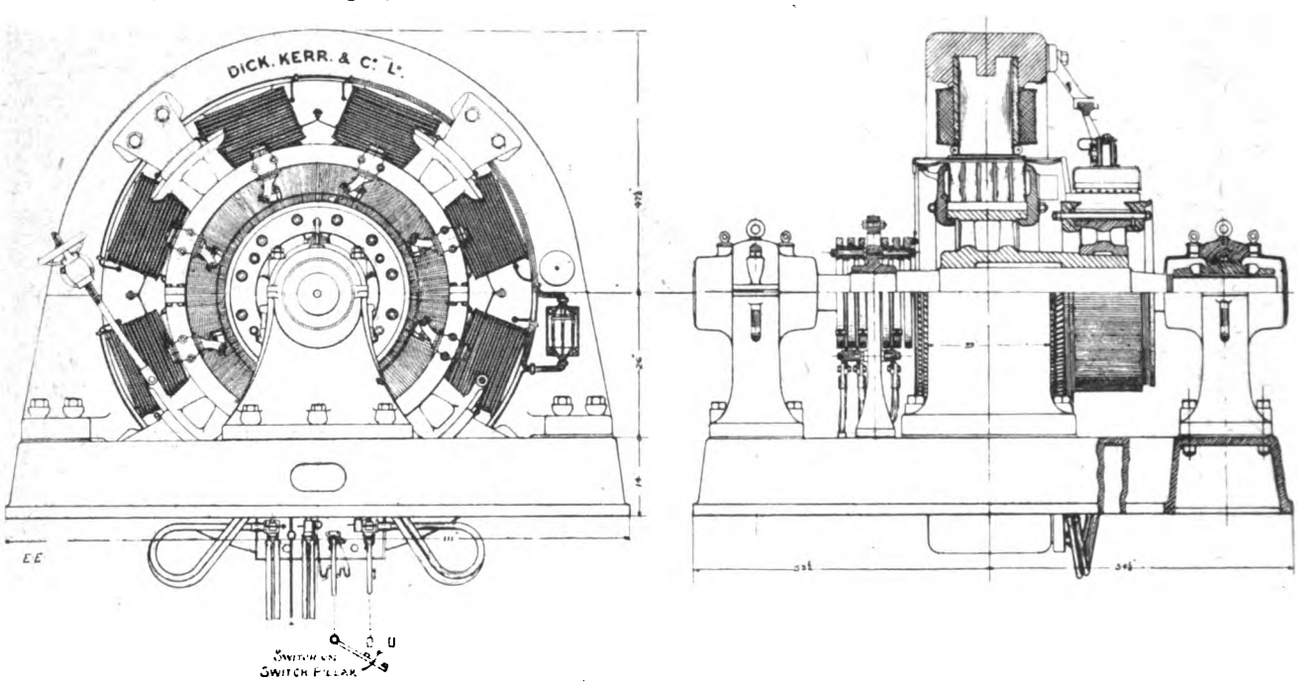


FIG. 10. Elevation and Section of the 600-kw. Rotary Converter.

primary consists of a few turns in series with a 'bus bar. The voltmeter transformers were built by Messrs. Dick, Kerr, and Co., Limited, the voltmeters by Messrs. Elliott Bros., who also supplied the panels for the main board, the switches and circuit breakers being made at the Preston works. In all cases the low-tension secondary leads pass through the ceiling to the switchboard above. The total alternating-current power generated before passing to the sub-station feeders is recorded in an integrating wattmeter. Connection to each triplet of transformers in the sub-station is made through a hook switch, oil switch, and three cast-iron tail-end glands, bushed with corrugated porcelain bobbins, piercing the front wall of the chamber. Each transformer is single-phase, split-phase, and has two independent secondaries, the six of the triplet being grouped in double mesh to afford six phases for operating the rotary converters. Connection between the grouped secondaries and the six rotary slip-rings is made through a pair of three-blade switches carried on a stand, on which is also placed the equaliser switch for the series field. The chief feature of the alternating board is that the high-tension current is confined to the pit below the board, this being effected by the long-arm oil switches which are used throughout the system. Also all the oil switches are encased in iron, which is earthed. The rotor field rheostats are of massive construction, and consist of cast-iron grids insulated with hard micanite, and assembled in frames and exhaust pipes were made to drawing and erected without the use of any make-up pieces. The feed pipes are in duplicate on the ring system.

The main steam-piping, which is 12in. diameter, is a combination of the ring and by-pass systems. The steam is taken from the boilers, passed through superheaters and then into the main ring, or direct through a by-pass to the engines. Fig. 8 shows clearly the steam-pipe arrangements over the boilers, and the pipework in the engine-room can be seen in Fig. 6.

### SUB-STATION EQUIPMENT.

The sub-station equipments, save as regards amount of plant, are identical, and to describe one in detail will give an adequate idea of the whole of them. The three largest—Seaforth (Fig. 9), Sandhills, and Formby—have each four rotary converters, whilst Birkdale has three, provision being made in each case for extensions. Each rotary converter is arranged with its corresponding groups of statics alongside, the high-tension oil switches being placed underground. The rotary converters (Fig. 10) are in appearance and in general design similar to the standard direct-current machines; they are eight-pole machines developing 600 kw. at 600-650 volts at 375 revolutions per minute. The core discs are segmental and dovetail into machined grooves on a cast-iron spider, the rim of which, following standard practice, is sectional to avoid shrinkage strains. On the

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alternating-current side of the machine are six gunmetal slip rings, which tap the armature windings at equidistant points, connection between the radials and the outer rings being effected by insulated bolts carried through the intervening rings. Each slip-ring is equipped with three laminated copper brushes. On the direct-current side carbon brushes are used, which slide in radial brackets and outside. Ample ducts are left between the coils, core, casing, and each other to afford free passage for the blast, which, entering below, may be regulated by a baffle placed above. The core plates are of the best annealed soft iron, coated with a special insulating japan, in two widths as a first approximation to a circular section. The primary leads pass out at a pair of corrugated porcelain bobbins

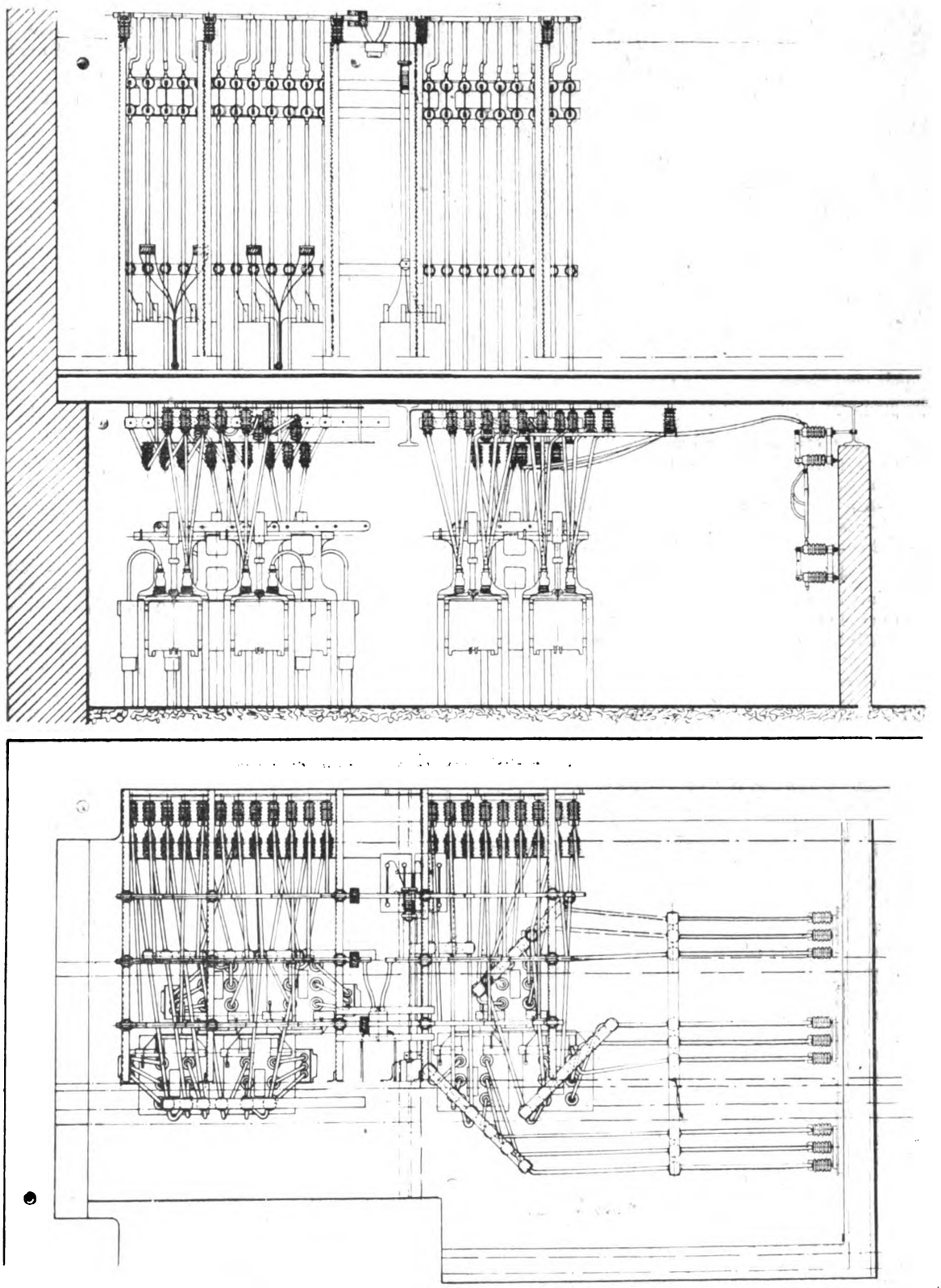

FIG. 11.—Plan and Elevation of High-Tension Switchgear at a Sub-Station.

under the pressure of compensating spring levers. The average finished weights of this rotary are as follows: armatures, 10,380lb.; magnets, 21,100lb.; complete machine, 40,940lb.

The transformers are of the air-blast type, and have each a capacity of 200 kw. They are circular, and are built up of copper strip wound on edge, and insulated with special wrappings repeatedly impregnated and dried. The secondaries are inside next the core, the primaries above sealed into the hood and screw-coupled to the leads emerging from the high-tension chamber through a tail-end gland, ebonite screw sockets encasing the naked connection. The windings may be readily inspected on unscrewing the sheet-iron sides. The secondary leads pass under the floor up the slip-ring stand. The primaries were tested by flashing at 15,000 volts to earth and the secondaries, while the latter were tested at 2,500 volts to earth. Each transformer weighs approximately 5,450lb. The blowers, of

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which there are two in each sub-station, consist of a standard Dick-Kerr-5-h.p. motor, coupled on a combined base to a Davidson Sirocco fan, which is keyed direct on the motor shaft. The capacity of each fan is 8,000 cubic feet of air per minute, at a pressure of 2in. to 3in. of water.

The sub-station switchboards consist of a high-tension and low-tension side, the latter having been supplied by Elliott Bros., the switches and circuit breakers being of the standard Dick-Kerr pattern. On the sub-station "total power received" panel are three alternating-current ammeters, one in each phase, and an integrating wattmeter on the sub-panel. On the transformer panels are an alternating-current ammeter, centre zero rotary-field ammeter, voltmeter synchronising plug, oil switch, operating gear, field-rheostat hand-wheel, field-break switch, and field two-way switch.

The rotary converter panels carry an auto circuit breaker and on the direct-current super-panel is an ammeter, two-way paralleling plug and two single-pole knife switches, with starting bar coupler switch on sub-panel. On the power delivered panel are an ammeter, two-pole change-over switch, two-way voltmeter plug, and integrating wattmeter; on the sub-panel the rotary direct-current starter, a multiple-contact switch connected to a grid resistance behind. On each of the four direct-current feeder panels are an auto circuit breaker on the super-panel, direct-current ammeter and single-pole change-over switch, a Garton lightning arrester and choking coil being behind. The change-over switches are chiefly for burning out a fault in one of the feeders by cutting out the others or for disconnecting a sub-station. Other panels control lighting switches and motors, and a further board carries the Board of Trade instruments. It will be noted that there are no automatic circuit breakers on the alternate-current side. Fig. 11 shows the high-tension switchgear and connections under a sub-station.

### High-Tension Transmission.

The high-tension cables leading from the power-house are arranged in each case in triplicate. Under ordinary working conditions all three cables are used, but in case of breakdown of any one of the cables the two remaining ones can do the work without the drop or the current density exceeding the permissible limit. The whole of the cables were manufactured and laid by Messrs. W. T. Glover and Co., Limited, as sub-contractors to Dick, Kerr, and Co. The extra high-tension cables are of the triple-triangular type, diatrine paper insulated, lead-covered, and armoured, laid on the solid system. Four different sizes of cable were used—*i.e.*, $^{37}/_{15}$, $^{37}/_{16}$, $^{19}/_{15}$, $^{19}/_{16}$—the length of each being respectively 13 miles, 6½ miles, 6½ miles, and 18 miles—a total of 44 miles.

The insulation consists of manila paper impregnated with diatrine by a special process which ensures that the paper is thoroughly impregnated, the surplus compound being removed from the surface of the paper by means of a special apparatus. The thickness of the insulation is ·36in. between conductors and ·26in. between conductors and the lead sheath. This latter lessened thickness is accounted for by reason of the system being earthed at the centre point of the machine winding, the cables being made for a working pressure between conductors of 10,000 volts and a pressure to earth of 5,780 volts. Each of the insulated cores is finished off with a different coloured layer of paper strip, which serves as a distinguishing mark. The lead sheathing varies from ·125in. to ·15in. thick, according to the size of cable. The armouring is of galvanised steel wires ·08in. to ·1in. diameter, which acts as a mechanical protection in addition to making a most satisfactory and efficient earthing conductor. The joints are of the plumbed lead sleeve type, the lead sleeve being filled up with diatrine compound. The troughs are made of stout wood, tarred and creosoted, filled with compound, and covered over with tiles. Specially-prepared impregnated wood bridges support the cables at 18in. intervals. Three cables run in each trough. The cables are laid for the most part in the six-foot way, and where they pass over bridges, or in exposed situations, are laid in stout steel troughs. All cables were tested with 30,000 volts between cores and to earth for one hour before leaving the works.

*(To be continued.)*

## SINGLE-PHASE COMMUTATOR MOTORS AND THEIR REGULATION.*

BY FRIEDRICH EICHBERG.

*(Concluded from page 441.)*

### The W. E Arrangement.

A diagram of the connections to the motor constructed by the Union Elektricitäts-Gesellschaft on the Winter-Eichberg principle is shown in Fig. 19, to which several previous references have been made. Motors thus connected are best adapted for traction work, but will also be found useful wherever the series motor is applicable.

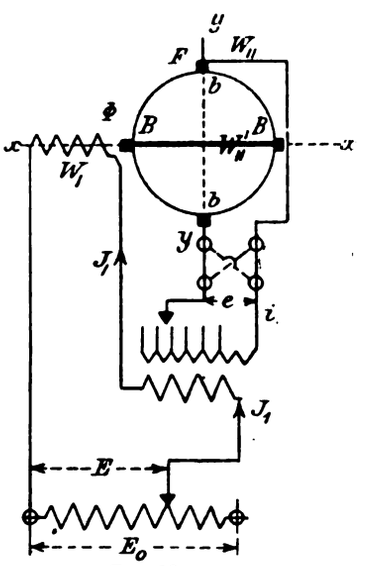


Fig. 19.

In the arrangement in Fig. 19 both the pressure, *e*, of the exciting current and the total pressure, E, are regulated. In the case of motors wound for high tensions, where the regulation of the total pressure is inconvenient, we may be able, for instance, to control *e* only. The motor is provided with a single-phase stator winding, and a rotor resembling the armature of a continuous-current machine.

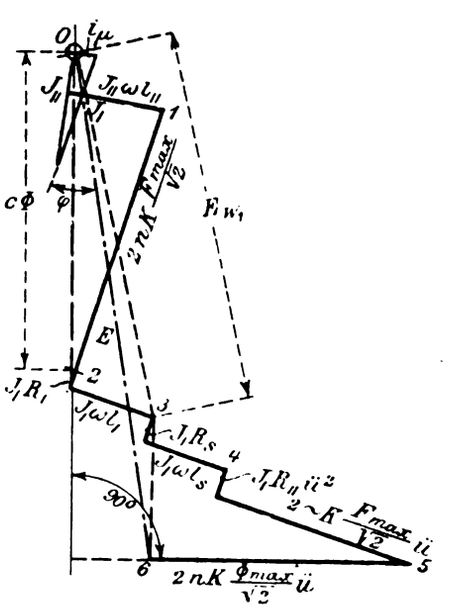


Fig. 20.

The rotor winding serves a double purpose. It is short-circuited across one axis, hence, in a measure, constitutes a short-circuited winding, W'', for the stator winding, W'. The exciting currents are conducted to points (brushes *b b*) at equipotential distances from the short-circuited brushes, B B. Alternatively two separate commutated windings might, of course, be provided. For a two-pole machine four brushes must be used. For series and parallel windings with Mordey end connections and 2 *p* poles, 4 *p* brushes

* Translated from the *Elektrotechnische Zeitschrift*.

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are also needed per pair of poles—*i e.*, 2 *p* short-circuiting and 2 *p* exciting brushes.

The exciting current, *i*, is furnished by a series winding provided with a potential regulator. Hence it is always in phase with the primary current, J,. In starting up W, W,' is essentially a short-circuited transformer presenting a relatively low impedance. With increasing speed an E M.F. is generated in W,'—*i.e.*, between the brushes B B—which is in phase with *i* or J,. Hence with increasing speed the windings W, W,' jointly form a transformer

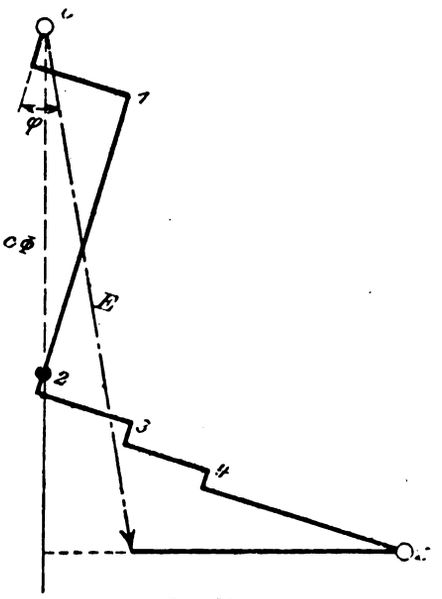


FIG. 21.

with a non-inductive load. In proportion as this load increases with the speed the field Φ also increases. The secondary circuit of the series transformer, and consequently this transformer as a whole, constitutes at first a relatively high impedance, the actual value of the same depending upon the ratio of transformation.

The fewer secondary turns there are on the exciting circuit, *b b* or W″, the greater is the value for the impedance of the series transformer. At the moment of starting a very considerable part of the total potential will consequently be absorbed in the transformer. With increasing speed there will be set up between the brushes *b b* an E.M.F. in phase with Φ. As we have already seen, this E.M.F. will

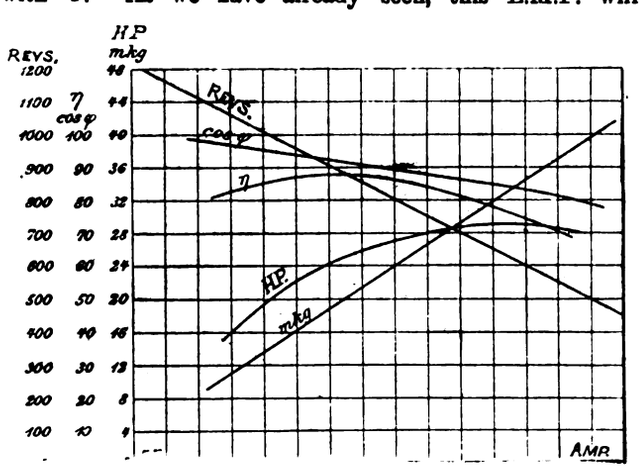


FIG. 22.—W E Arrangement. 25 ⁓ 215 v. 2mm. radial air gap. Regulating transformer *ü* = 32 : 64.

counteract the self-induction in the exciting circuit, and with a sufficiently high speed the secondary circuit of the transformer will be at the very low potential corresponding to the ohmic loss in the winding and the armature leakage. The potential at the series transformer becomes less as the speed increases. Thus, in starting up, the potential E so distributes itself that W, receives only a small proportion, but with increasing speed the potential at W, quickly attains nearly the full value E.

The complete action may be represented as follows: Let J,, be the current in the short-circuited armature winding, W,,'; J, the current in the primary circuit; and *i* that in the exciting circuit. It follows that $i = ü\,J_1$, *ü* being the ratio of the primary turns to the number of secondary turns in the transformer.

$$F = \frac{4\pi}{10}\frac{\pi}{M_y}\,i = \frac{4\pi}{10}\cdot\frac{\pi}{M_y}\,ü\,J_1 = C\,J_1\,ü.$$

$M_y$ is the magnetic resistance in the direction *y y*. $R_{,,}$ is the resistance of the armature between the brushes B B or *b b*; $\omega l_{,,}$ is the inductance, corresponding to the leakage which occurs at the slots and face of the armature; R, and $\omega l_1$ are the analogous values in regard to the stator

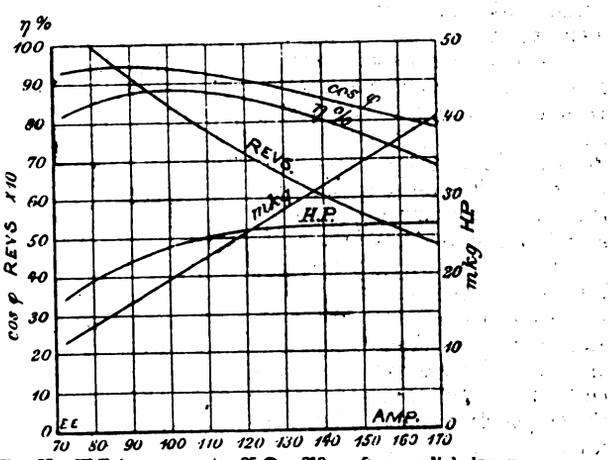


FIG. 23.—W E Arrangement. 25 ⁓ 218 v. 2mm. radial air gap. Regulating transformer *ü* = 40 : 60.

winding; $K_s$ and $\omega l_s$ for the series transformer as a whole. This action is shown diagrammatically in Fig. 20. For a given current $J_{,,}$ 0-1 is the sum of the non-inductive and leakage losses in the armature; 1 2 is the back E.M.F. set up between the brushes B B, being in phase with *i*, or, what amounts to the same thing, J,. According to equation (1) this back E.M.F. is

$$2\,n\,K\,\frac{F_{max.}}{\sqrt{2}}.$$

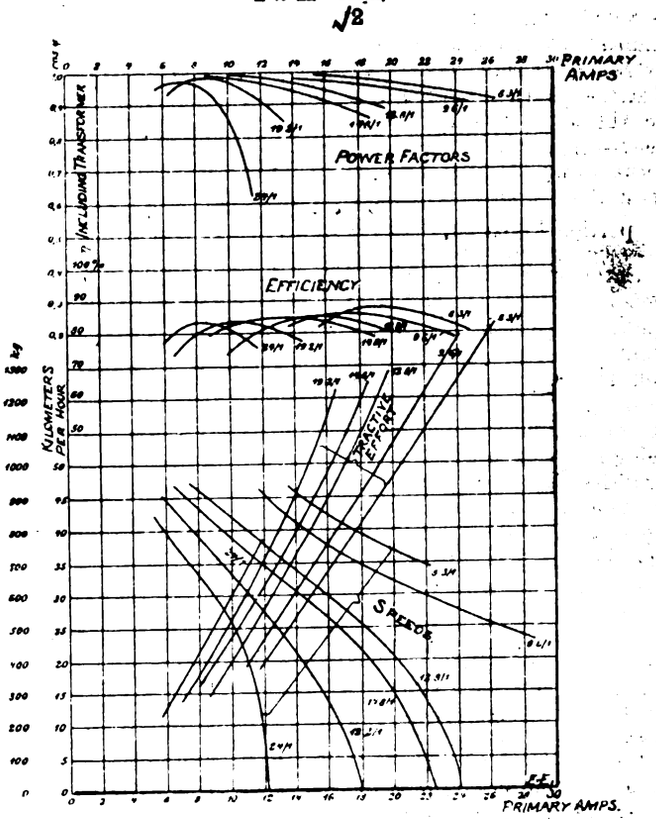


FIG. 24. W E I Motor. 6,000 v. 25 ⁓. Gear ratio 1 : 4·26. Wheel diameter 1,000mm. The figures attached to each curve represent the transforming ratio of the regulating transformer.

0-2 corresponds to the strength of the field Φ in the direction *x x*.

$$0\text{-}2 = 2 \frown K\,\frac{\Phi_{max}}{\sqrt{2}}.$$

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$\Phi_{max}$ corresponds to a certain magnetising current, $i_\mu$. Due to this and $J_{,,}$ we get $J_,$ from the current triangle. This $J_,$ must be parallel to 1-2. This analytical examination is only possible with a polar diagram, which may be developed from the above formula. 0-2 in a measure represents the internal pressure in the stator winding. Added to this are the ohmic and inductive losses in the stator winding, and we get 0-3 = potential at $W_,$. There now has to be added the potential of the series transformer. 3-4 is the equivalent of the non-inductive and leakage losses in the transformer; 4-5 is the impedance of the exciting winding; and 5-6 the wattless back E.M.F. set up between the brushes *b b* by the rotation of the armature in Φ. The

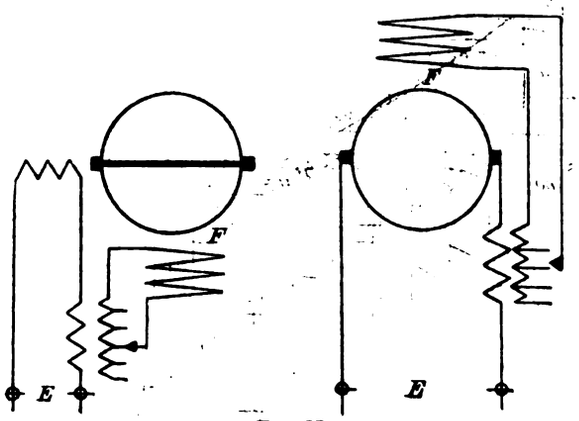


FIG. 25.

potential corresponding to the inductance of $W_{,,}$ is for the most part given by

$$2 \sim\!\!\sim K \frac{F_{max.}}{\sqrt{2}} \ddot{u}$$

so far as concerns the primary circuit. The wattless back E.M.F. is expressed as

$$2 n K \frac{\Phi_{max.}}{\sqrt{2}} \ddot{u}$$

3-6 represents the potential at the series transformer. The electrical conditions obtaining in the motor may be more clearly followed if we assume the magnetising current, $i_\mu$, to be a negligible quantity. We then obtain the simplified diagram (Fig 21). It is apparent, then, in this motor the self-induction of the field will be suppressed by the wattless counter E.M.F. The inductance of the motor will vary as the ratio of transformation, $\ddot{u}$. The greater $\ddot{u}$ is the more effective will be the compensation, which is proportional to $n \cdot \ddot{u}$.

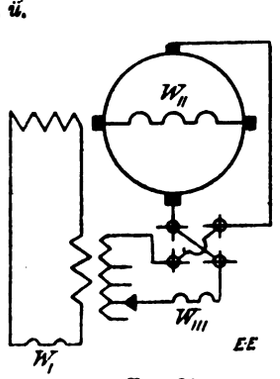


FIG. 26.

The existence of the cross field renders it possible to suppress the short-circuit E.M.F. simultaneously with the inductance of the exciting winding. By the choice of the ratio of transformation, $\ddot{u}$, we may influence F : J at will; hence also F : Φ. Figs. 22 and 23 show the characteristic curves plotted from the observations made with the experimental motor for two different ratios of transformation. The result is far better than that from the series and repulsion motors, notwithstanding that the experimental machine had a radial air-gap of 2mm.

The following further advantages of a practical character come into consideration. The stator winding is quite independent of the rotor winding. This enables the direct application of high-tension currents. Despite the employment of a single stator winding, the motor can be reversed, and, indeed, without opening the stator circuit. The interruption of the exciting circuit stops the motor. The primary winding of the series transformer acts as a choking coil. An increased number of secondary turns corresponds to a higher speed for the same torque, or, in other words, increased torque at constant speed. We can, therefore, start the motor with the full primary

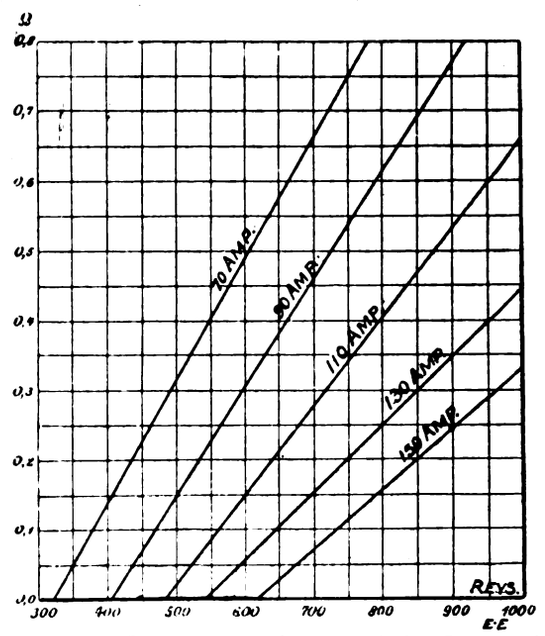


FIG. 27.—W E Arrangement. Short-circuit brake. Resistance in the stator circuit.

potential on the stator by increasing gradually the number of secondary turns. In fact, this arrangement admits of the machine being started, reversed, or stopped without interrupting the high-tension circuit. Fig. 24 shows the curves plotted for a high-tension motor of the W.E.I. type, constructed by the Union Elektricitäts-Gesellschaft, and working in an experimental field. The curves representing the speed and tractive efforts are identical in character with those for series motors. The curves representing cos $\phi$ reveal astonishing values when it is considered that this motor has a radial air-gap of 3mm. The efficiencies given relate to the motor combined with the regulating series transformer. The latter absorbs from 2 to 3 per cent. of the energy, according to the strength of the current. The same tractive effort can be obtained at

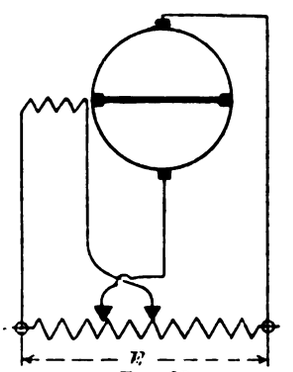


FIG. 28.

different speeds. The efficiency and power-factor curves follow in some measure the curve for the speed, so that it is rational to drive the motor with the controller in any position.

Similar qualities are also shown by the motor constructed by the Union Elektricitäts-Gesellschaft for a frequency of 40. It should be mentioned that the system of regulating by means of series transformers may be readily applied to series or repulsion motors provided with split stator windings (see Fig. 25). Each step in the controller then corresponds to a characteristic. The seeming paradox that the speed is accelerated at constant torque by adding secondary turns again applies,

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In conclusion, brief reference may be made to some further arrangements which help to emphasise the great advantage possessed by the Winter-Eichberg motor over all previous types. In Fig. 26 several alternative arrangements for the short-circuit brake are shown. Brake resistances, it will be seen, are connected not only in the stator circuit, but also in the short-circuit winding and in the exciting coil. Of course, it is necessary to place resistances only in one of these circuits. With the last-mentioned arrangement, the series transformer acts as a transformer for the brake output. The machine excites itself with absolute reliability, and generates an alternating current whose frequency is governed by the number of revolutions

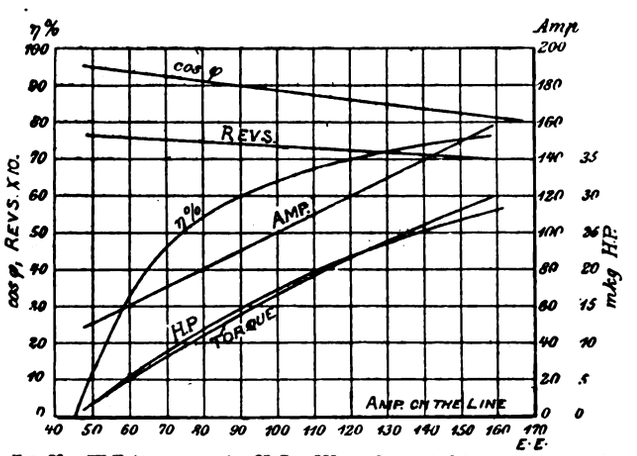


FIG. 29.—W E Arrangement. 25 ⁓ 220 v. Connected for constant speed.

and the magnetic conditions obtaining. With decreasing speed the frequency decreases (see the curves, Fig. 27, in which the braking currents corresponding to different speeds of the motor and different values for the resistance in the short-circuit winding are given). It is possible to so connect the motor that it will yield its full tractive effort in starting and maintain a given speed. It is seen from Figs. 20 and 21 that the potentials of the exciting and stator windings have the same, or approximately the same, phase for nearly all speeds. This is due to the production of E.M.F.'s in both circuits with increasing speed, which forces diminish the phase distortion. The same transformer will, therefore, serve both for the stator and

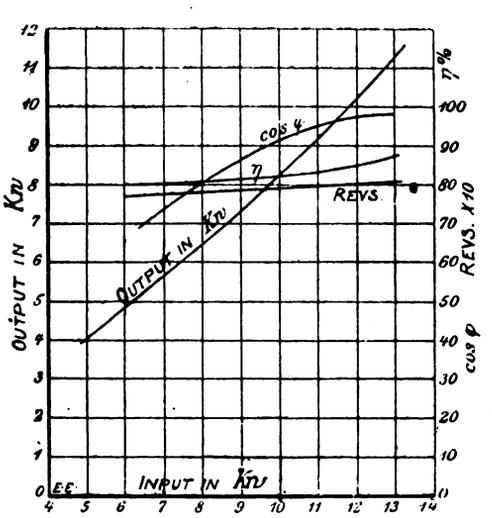


FIG. 30.—W E Arrangement. 25 ⁓ 180 v. Efficiency brake.

exciting circuits, the potential in the stator winding being allowed to increase with increasing speed and the exciting pressure to decrease. At synchronous or approximately synchronous speeds a very low voltage is used in the exciting circuit.

Fig. 28 shows the arrangement. The experimental motor on which the other methods of connection were also tried is capable of developing a torque of 380 foot-pounds even when connected in this manner. The dimensions of the motor are the same as those of a 15-h.p. polyphase machine. The curves shown in Fig. 29 were plotted from observations made with the motor working at approximately synchronous speed, while those in Fig. 30 represent the results obtained by driving the machine at a speed exceeding synchronism. When so connected the motor acts as an efficient brake, returning current to the line. For the rest, this method of connection (see Fig. 28) renders the motor particularly suitable for lift equipments and driving machine tools.

Briefly recapitulated, the progress which this new system marks consists in the provision and independent regulation of two magnetic fields disposed at right angles to each other in the motor, whereby the short-circuit energy under the brushes is suppressed within wide limits of phase distortion.

It further enables the characteristic of the motor to be changed without altering the pressure in the external network. In other words, it admits of any torque being obtained at any speed. It is a most important advantage where high tensions are concerned that the arrangement enables the motor to be started, stopped, and reversed without opening the primary circuit of the machine. The motors combine all the good qualities of the direct-current traction motor, not the least being the good behaviour of the commutators and brushes under all loads.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 18.

**Institution of Mechanical Engineers.**—At 8 p.m., "Compound Locomotives in France," by Mr. Edouard Sauvage.

SATURDAY, MARCH 19.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture V.).

**Institution of Electrical Engineers.**—Glasgow Section: At 7.30 p.m., special smoking concert in the Grand Hotel.

**Junior Institution of Engineers.**—Conversazione at 7 p.m. at the Westminster Palace Hotel.

**Glasgow Technical College Scientific Society.**—At 7.30 p.m., "The Diesel Engine for Marine Purposes," by Mr. A. J. Lawson.

TUESDAY, MARCH 22.

**Institution of Civil Engineers.**—At 8 p.m., "The Use of Cement Grout at the Delta Barrage in Egypt," by Sir Robert Hanbury Brown, K.C.M.G.; "The Barrage across the Nile at Asyut," by Mr. George Henry Stephens, C.M.G.; "Lowering the Sill of the Ramsden Dock, Barrow-in-Furness," by Mr. Leopold Halliday Saville; and "Burntisland Harbour: Construction of the East Dock," by Mr. Robert Henderson.

WEDNESDAY, MARCH 23.

**Institution of Electrical Engineers.**—Manchester Section: at Liverpool, joint meeting with Liverpool Engineering Society.

**Liverpool Engineering Society.**—Royal Institution, Liverpool at 7.30 p.m., joint meeting with the Institution of Electrical Engineers (Manchester Section). Paper by Mr. J. L Hunt, A.M.I.C.E, on "Notes on the Design of Electrical Machinery."

THURSDAY, MARCH 24.

**Institution of Electrical Engineers.**—Ordinary general meeting at 8 p.m., "Direct-Reading Measuring Instruments for Switchboard Use," by Mr. K. Edgcumbe, associate member, and Mr. F. Punga.

FRIDAY, MARCH 25.

**North-East Coast Institution.**—"Automatic Governing of Marine Engines," by Mr. H. M. Wilson.

**Physical Society.**—At 5 p.m., "Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance," by Prof. J. A. Fleming, F.R.S. "A Hot-Wire Ammeter for Measuring Very Small Alternating Currents," by Prof. J. A. Fleming, F.R.S. "The Energy of Secondary Röntgen Radiation," by Mr. C. G. Barkla.

**Institution of Electrical Engineers, Manchester** (Students' Section).—"Photometric Testing," by D. Livingston Sands.

**Royal Institution.**—"Liquid Hydrogen Calorimetry," by Prof. Dewar, M.A., LL.D., D.Sc., M.R.I.

**Institution of Civil Engineers.**—Students' meeting at 8 p.m. "The Relative Advantages of Continuous and Alternating Current for Traction Purposes," by Mr. J. M. Kennedy, Stud.Inst.C.E. Mr. C. H. Wordingham, M.I.C.E., in the chair.

**National Physical Laboratory.**—At 3.30 p.m., inspection by the General Board of the Laboratory.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 25, Newcastle, May 6 and 7; Buxton, May 20 and 21.

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**Brixham.**—The Urban District Council electric lighting scheme is estimated to cost £11,000, exclusive of land.

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THE

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## ELECTRIC RAILWAYS.

The Lancashire and Yorkshire Railway Company, due to the foresight and energy of their general manager, Mr. J. A. F. Aspinall, will have the honour of being the first railway company in the United Kingdon to run an electric train service over a main-line railway. Mr. Aspinall's connection with this company as general manager has been concurrent with the development of the line from a non-paying concern to the prominent position which it enjoys to-day. In the conversion of the Liverpool, Southport, and Crossens section for electric working we see one explanation of this success. It is due to the power of the general manager to rightly see what is required to be done, and to persuade the board of directors to do it before it is too late. For instance, in connection with the electrification, Mr. Aspinall stated at a dinner last week that the company did not expect to save money by it, but to make money. In other words, he proposes by the improvement introduced by electrification to largely extend the traffic on the lines in question. Indirectly, the conversion is also a protection against the severe competition which would otherwise be bound to come from electric tramways. In order to appreciate the advantages to be gained, a few figures are required. The service on these lines with steam locomotives was by no means a bad one, but with the electric trains, with their more rapid acceleration, the time on the journey between Liverpool and Southport will be reduced from fifty-four minutes to thirty-seven minutes for the stopping trains. In other words, the mean speed, including stops, will be increased from twenty miles and a half per hour up to thirty miles per hour. The express trains will continue to do the journey of eighteen and a half miles at the mean speed of forty-five miles per hour, but the number of expresses is to be very largely increased. Quite apart from the saving of time on the journey, there is the other advantage that the number of trains per day between Liverpool and Southport alone will be increased 80 per cent. What the increase will therefore be in the number of passengers carried remains to be proved, but by electrical means only could this more frequent service with the higher accelerations be given commercially. Against this service showing a mean speed of thirty miles per hour on stopping trains, the tramway competition, which has ruined so many steam suburban lines, is not likely to be effective. Turning now from the improved service obtained, we come to the question of how Messrs. Dick, Kerr, and Co. are dealing with the technical side of the question. This consideration is the more pleasing because they are an English firm, and because the problem to be dealt with has been approached on original line, with results which leave nothing to be desired. In the first place, we may remind our readers that the same firm in 1902 remodelled the equipment, as far as rolling-stock is concerned, of the Liverpool Overhead Railway. The problem in this case was not quite the same on account of there being no less than sixteen stations in a length of six and a half miles of route. By placing four 100-h.p. motors on the new trains on this line, the firm succeeded in maintaining an average speed, including stops, of nineteen miles per hour, which was then the highest obtained on any similar electric line. Accelerations as high as 4·2 feet per second per second were reached. The trains weighed fifty-five tons and carried one hundred and fifty-four passengers. On the Liverpool and Southport line the train weight without passengers is one hundred and forty tons, and no less than eight 150-h.p. motors are used. Full details as to the acceleration will be given after more detailed trials

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have been made, but on the trip we made over the line on Saturday last we found the train gained speed remarkably quickly. The problem in this case was also to ensure high speeds on the express service with the same motor, and we observed a speed of fifty-seven miles per hour, and gather that sixty miles per hour is frequently reached. A novel feature as compared with other recently-equipped electric railways is that the whole of the eight motors can be directly controlled from either the front or rear car by means of series-parallel controllers. The details of the control are described in the article of this issue. The interesting feature is that the motors on the rear car are worked either in series or parallel from the controller in the front, only two cables being used for the purpose. For reversing, electric-controlled switches are used for each motor. It is interesting to compare this system with that on the Waterloo and City Railway. The trains on this line also consist of four carriages, and they have two motors on both the front and rear coaches. The number of cables used to connect the front and rear cars are nine. Thus, to quote from Mr. B. Jenkin's paper on the subject: "In order to have complete control, both as to the grouping of the motors and the direction in which they are to run, each motor must have at least four leads, two for the armature and two for the field, carried from one end of the train to the other. For the two motors there are, therefore, eight leads. Besides these there is the lead connecting the collecting shoes." It will be seen, therefore, that Messrs. Dick, Kerr, and Co. have succeeded in controlling four motors from a distance with two cables only, although for safety's sake four cables are employed, connected two in parallel. This direct control has many advantages. The engineering details, both in the power-house and on the track, are worthy of careful study, and are remarkable for simplicity, tending to small charges for repairs. The work of electrification has been carried out in a year from the date of commencement. It now remains to congratulate all concerned on the undertaking, wishing it every success.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### BRIGHTON CORPORATION TELEPHONES.

SIR,—Under the heading "Telephony in Great Britain," your contemporary, the *Electrician*, in its issue of March 11, runs amuck at municipal telephony generally and the Brighton Corporation telephone system in particular. It is good enough to announce that I wish to conceal the character of the Brighton system, and to that end have not allowed the *Electrician* to inspect it. It furthermore is polite enough to say that it supposes that the descriptions of the Brighton system which have appeared have been published under my auspices. In reply to these effusions, I beg to be allowed to state that invitations to inspect the Brighton Corporation telephone system were issued to (1) the *Engineer*, (2) the *Electrical Engineer*, (3) the *Electrical Times*, (4) *Electricity*, (5) the *Scottish Electrician*, (6) the *Municipal Journal*, with an intimation that every possible facility, together with full plans and drawings, would be placed at their disposal. This does not look like concealment. This invitation has already been taken advantage of by several, and a description has appeared in your journal. I trust that you, Sir, will be good enough to add a footnote to this letter describing the reception you met with at Brighton, saying whether your inspection was conducted under my auspices or not, and whether you were influenced in what you did or said by any other person. No invitation was sent to the *Electrician* because, in my opinion, that journal has shown such a want of independence in dealing with municipal telephony as to make it evident that no unbiassed description could be expected at its hands. I can understand the editor feeling annoyed at being left out in the cold, but he must blame the attitude he has assumed towards the corporations, and not myself. In the course of his article he endeavours to enlighten his readers on the subject of the Glasgow and Tunbridge Wells Corporation telephones as well, and in doing so has contrived to illustrate very forcibly his usual style in a manner which completely justifies my action in excluding him from Brighton. He says that when the Tunbridge Wells exchange was opened his representative found* that the wires were brought straight from cable potheads to the switchboard—a statement which is absolutely untrue. He says that a statement was made in the Glasgow Council last week and not disputed, that the capital account of the concern has been debited with wages that should have gone against revenue. This is also inaccurate. The statement was so effectively disputed that the person who made it received only four votes in a very full meeting of the Council. It is also insinuated that the call-wire system at Glasgow was adopted by my advice, whereas I was instructed by the Telephone Committee to prepare plans on the call-wire system. When the *Electrician* can condescend to decent accuracy and put aside the animus which does not permit it to perceive any good in any municipal undertaking, it may rest assured that it will be put on a par on all occasions with its more independent contemporaries.—Yours, etc., A. R. BENNETT.

[We had every facility given to us at Brighton for the complete inspection of the exchange and of the work in the streets. Had anyone attempted to influence our description or to dictate our policy we should have refused to publish a word.—ED. *E. E.*]

### STEWART ARC LAMPS.

SIR,—Our attention has been called to certain misleading advertisements and paragraphs which state or imply that the sale of the "goodwill" of the Stewart Electrical Syndicate, Limited (in liquidation), carried with it rights in the Stewart arc lamps.

As these statements are calculated not only to do us serious injury, but to mislead the public in regard to the channels through which these lamps can be obtained, we shall be grateful if you will allow us to state that some weeks prior to the sale we acquired the sole rights in the Stewart arc lamps, and that no firm is entitled to make or sell Stewart arc lamps not supplied by the original makers or by our agents and customers or ourselves.

As we have received numerous complaints in respect of delays which appear to have occurred in the execution of orders for lamps, spare parts, and repairs prior to our taking over the business of these lamps, we shall be obliged if you will allow us to state that we are executing all such orders promptly on receipt.—Yours, etc.,

J. DEFRIES AND SON, LIMITED.

Houndsditch, E.C., March 16, 1904.

## MUNICIPAL TELEPHONES.—IV.

The late Herbert Spencer thus commences "First Principles":

> "We too often forget that not only is there 'a soul of goodness in things evil,' but, very generally also, a soul of truth in things erroneous. While many admit the abstract probability that a falsity has usually a nucleus of reality, few bear this abstract probability in mind when passing judgment on the opinions of others."

These are weighty words, and if, with these in mind, we are compelled to dissent with almost a direct negative to the conclusions of the criticisms under review, it is because they are almost mathematically demonstrable to be incorrect. In this, our final comment, we shall deal principally

* The exact expression used by our contemporary is: "At Tunbridge Wells we saw no cross connection board, test board, or terminal cable-heads. the wires being brought straight from cable potheads to the switchboard."

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with that burning question—depreciation. We are becoming more and more convinced that the major portion of those who use this term use it with various meanings, and have no very correct view of a rigid definition. It is thus in the case under consideration—the user of the term neither defines it as he uses it, nor as other people use it. He will probably retort, whatever our construction of his words, that his meaning is different. He confuses the question by general references to the Glasgow Corporation and the Postmaster-General, arguing that because they have inaugurated what they call a depreciation fund in addition to a sinking fund, the terms are not synonymous. The adverse critic of Glasgow does not show any difference, and it never seems to have occurred to him that the terms may be as loosely used by others as by himself.

The two funds are identical, giving identical results, and what the *Review* critic imagines is depreciation is nothing of the kind, but something totally and radically different.

Before, however, tackling the main point, there is a question of detail to which we shall refer. The critic refers to 30 years, accepted by Glasgow as the average life of the Glasgow telephone system, as excessive, and, making his own assumption, comes to the conclusion "that the Glasgow Corporation Telephone Department is omitting about £11,000 from its charges against revenue, if depreciation is to be recognised in a safe way." The critic goes the proper way to work in order to get his results. He analyses the system, assuming different lengths of life for the various divisions, the percentage of each division in the system, and then averages the whole. But, surely, the advisers of Glasgow have acted similarly, the difference being that the one conclusion gives a longer life on the average than the other, hence a lower rate of payment. It is the same thing as rules throughout the criticism; but even supposing there was too much optimism by one expert and too much pessimism by the other, what principle against municipal trading is involved?

**Depreciation**, according to the "Century Dictionary," is

1. The act of lessening or bring down price or value.
2. A fall in value; reduction of worth.

In the sense used in accountancy, depreciation is "a fall in value." The depreciation in a balance-sheet is the fall in value, be that fall in securities, plant, or buildings; and a balance-sheet requires that fall to be recognised with the utmost possible exactitude.

It is unfortunately necessary to refer to some very elementary questions in the face of the continuous misstatements made. The final balance-sheet is merely a statement of assets and liabilities. The difference between revenue and expenditure usually forms one item on the one side or the other. Let us for the sake of clearness assume a capital of £100 expended on plant costing £100. We have, say, Jan. 1, 1901:

| Liabilities. | | Assets. |
|---|---|---|
| £100 (capital expended) | ..... ..... | £100 (plant installed) |

Assume 12 months' usage of plant, and a return of £20 of income over expenditure. Then we get, Jan. 1, 1902:

| Liabilities. | | Assets. |
|---|---|---|
| £100 | ..... | £90 (plant depreciated 10 %)<br>£20 cash. |
| | | £110 |

giving a balance of £10 on assets, which can be used to pay 10 per cent. dividend on capital. Or we may do thus:

| Jan. 1, 1902. Liabilities. | | Assets. |
|---|---|---|
| Capital, £100 – £10 paid off = £90 | ..... | £90 (value of plant)<br>£10 cash |
| | | £100 |

Still a difference of £10 in favour of assets with which to pay 10 per cent. on capital.

If these balance-sheets are not correct and not identical, we should like to know in what they differ. In the latter case you eliminate from both sides of the account equally, and the capitalist can invest the capital repaid. In the former the plant owner can invest the capital not repaid; and so in both cases capital stands similarly.

If capital invests at the same rate, it gets for the next year £9 for the £90 and £1 for the £10—that is, £10 for the £100. If plant invests it gets £1 for the £10, and pays £9 for the £90 when £9 + £1 = £10 to be paid to capital.

Now, paying off capital after the manner of municipalities is thus shown to be financially equivalent to depreciation. The only point is what is the correct depreciation; and having settled that, the amount of capital to make the equivalent repayment is settled. So long as depreciation is a constant during constant time, there are no difficulties, but with plant, as with men, accidents arise. These are out of the ordinary course of things, and have to be met by extraordinary methods. Thus one so-called depreciation is really an insurance, as is a reserve fund. It has become customary to class these precautionary financial arrangements with depreciation, and dub them all by one word, which is wrong. Depreciation is one thing, insurance against accident is another, and the two ought never to be combined. There is another phase of the question, and this is the great stumbling block. Even professional accountants agree to differ on the point, but really it is plain. The anti-municipalists would have the municipalities not only depreciate, insure, but put aside an annual fund equal in amount to the real depreciation, which, being cumulative, would be ready to renew the plant when capital and plant are depreciated out of existence. One would have thought the sensible view would be to use fresh capital for fresh requirements. But, no! According to these critics, the original £100 capital is to be paid off, as assumed above, in 10 years, to be paid 10 per cent. interest annually, and to provide a renewal fund at the end of 10 years equal to itself in amount. We all agree that in most municipal works maintenance of plant in efficient working order must be provided out of revenue. This payment can be taken one of two ways—either as largely decreasing depreciation—that is, lengthening the life of the plant—or as equivalent to depreciation, when you again provide for plant in perpetuity. In our own mind, and calling things by their right name, we should say the amounts over and above depreciation allowed at Glasgow and by the Postmaster-General are for insurance of working.

## Limited Life Principle v. Perpetuity.

Councillor Murray, in his address to the Royal Philosophical Society of Glasgow, quoted by Messrs. R. F. Miller and Co. in the *Accountant* of Feb. 20, 1904, says: "They (the Local Government Board experts) do not concern themselves with the question of maintenance or a depreciation or a renewal fund, and *they allow it to be inferred that when the subject is exhausted or obsolete it may be proper to raise a new loan to replace it.*" Take a sample of the Local Government Board's methods. A municipality is allowed to raise a loan for wood paving repayable in 10 years, that period being the expert opinion of the life of such paving. At the end of the 10 years we do not expect to find the municipality provided with a renewal fund, but if repaving is required, they must raise another loan. Further, if the Local Government Board find the expert opinion not borne out by facts, they place fresh conditions on the new loan, say it is to be repaid in seven years. For other purposes the period has been increased.

The maintenance of wood paving and of diverse electrical apparatus is not the same thing. The former must be wholly renewed in due course, the repairs being comparatively simple during the period, and the wear and tear is similar throughout the area covered, while the latter must, to retain working efficiency, be renewed in sections during the average life, so that if the average life is correctly estimated the whole has been renewed once—it may be that certain details are renewed several times—during that period, and this at the cost of revenue—the whole remaining efficient at the end of the period, the plant as it then stands having still an estimated average life equal in length to that of the original plant. It will thus be seen that comparisons between various kinds of municipal work are misleading, and what would be good finance in the one case is not necessarily so in another. Broadly speaking, we gather that capital invested by municipalities in electrical undertakings under the prevailing conditions of repayment is used to provide works, the revenue from which, owing to

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the necessity for efficient maintenance, must (1) repay capital in a given period; (2) maintain the plant in an efficient condition; while the adverse critics require in addition (3) a smaller or larger insurance fund; and (4) a reinstatement fund.

If our contention is correct, we fail to see what is the latter wanted at all for? It is not depreciation, the estimated depreciation being used to repay capital; the real depreciation being met out of revenue by keeping the plant efficient, which implies renewals of detail parts when required. Assuming a perfect example where depreciation or loss of value goes on uniformly, it is easy to show that suggestions to ensure (3) and (4) as above lead to charges upon the early users that are altogether unwarranted.

The latest accounts of the Guernsey undertaking may form a text for discussion. Taking round figures, say £20,000 is used, to be paid back in 20 annual instalments, the life being estimated at 20 years. Some £500 a year is paid or reserved to keep the plant efficient, hence the estimated life will be lengthened—that is, having had £10,000 spent upon it in maintenance, should really last longer than the 20 years. There is still, say, £500 a year paid in interest, and all this with the present revenue. It is readily seen as the instalments are paid off interest lessens, and the amount by which it lessens can be diverted to the maintenance fund. At the end of 20 years the instalments can be also diverted, so that there is then a fund of at least £2,000 a year which can be used for maintenance, or the whole plant can be renewed once every 10 years in perpetuity; and this without any idea of that depreciation fund the critics are so fond of saying is not provided. Thus, contrary to Councillor Murray, we say that the existing practice of municipalities is to create a business, and retain that business in perpetuity, although in a comparatively short period the capital is written or paid off. The same argument will apply to most municipal undertakings, except where they are really carried on to "aid the rates."

The validity of our argument depends very much upon the expert decision as to "length of life"; and probably upon this point no two expert writers on opposite sides of the fence will ever agree.

If the experts estimate the length of life with absolute accuracy, and consider in that estimate the annual maintenance, the whole installation goes in a moment at the expiration of the period. We hold, however, that this has never been done, and that the plant will be efficient at any rate for a time shorter or longer after the end of the estimated period. Then the amounts relieved from repayment and interest come into play. All depends upon the interpretation of efficient maintenance.

Now, finally, these remarks about Glasgow and other telephony have been written because those interesting themselves in municipal telephony complain that they are not receiving fair play. We do not hold with that view; but it is in the interest of truth that both sides of a question be considered, and that criticisms be really directed against the thing they purport to be directed. On this point we contend that an engineer's estimate, be it one thing or be it another, has nothing to do with the principle of municipal trading; neither has the opinion or the fact that apparatus installed is good, bad, or indifferent, or that construction is good, bad, or indifferent. A municipality can change its engineer, its organiser, and its accountant without trenching on principle, and may change over to the exact lines suggested by critics in these things, leaving us no nearer and no further off the real question than before. The problem whether municipalisation is right or wrong is as yet untouched by these critics: they merely cavil at financial and other details. Such criticism is of great value, and no one can object to it.

The secondary question, whether the criticisms against the engineer's estimates and work are correct, is another matter, and may be answered by saying that in our opinion neither his estimates nor his work have been criticised, but something totally different, something which has been evolved out of the critic's own imagination. From beginning to end these criticisms have been directed to impugn the ability and experience of an engineer. Generally, the statements made are opposed to facts by critics whose personality is veiled by anonymity, leaving it impossible to put a value upon assumptions and suggestions.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

671. Describe in detail, with sketches, any system for the sterilisation of water by ozone on a large scale, particularly where connected to a town's water supply.—OZONE.

672. Describe the "Heyland" system of winding alternators so that they are self-exciting.—E. V. C.

### ANSWERS.

*Question No.* 663.—How long should a 500-h.p. Lancashire, also a 350-h.p. Babcock and Wilcox boiler, take to run up to full pressure from cold? State how you would calculate the various strains to which they are subjected.

*Best Answer to No.* 663 (*awarded* 10*s.*).—One of the principal advantages about the Babcock boiler, and which has no doubt, together with its other good properties, been the means of its almost universal use in connection with electric lighting stations, is the rapidity with which steam can be raised. In a boiler of the size mentioned in the question steam can be raised from cold water in a little over one hour. When time permits, however, it is well to allow longer, but in lighting stations it often happens that time does not permit, and we then have to take full advantage of the good nature of our plant. The reason we are able to raise steam so much quicker in this type of boiler as compared with the cylindrical shell type is: in the first place, there is not so much water to heat; secondly, there is much better circulation; and, thirdly, owing to the elastic structure of the boiler severe stresses cannot be set up To appreciate what is meant by circulation and why it should be better carried out in a Babcock boiler than a Lancashire, it is well to study its theory. If we take a glass test tube and partly fill it with water and apply heat near the top, the water at the part where the heat is applied can be made to boil, but the water at the bottom of the tube will remain at its original temperature. It is evident, then, that the heat never reached the bottom, for, as is well known, water is an extremely bad conductor of heat, and unless treated in the right manner it is absolutely impossible to heat it at all.

There are three ways of transferring heat, and are known as radiation, conduction, and convection. The heat passes from the fire to the tubes by radiation, and from the tubes to the water by conduction, and is distributed throughout the water by convection. For our present purpose it is only convection that need concern us, and its meaning will be readily understood by another experiment with the test tube. Again fill the test tube with water and apply heat to the bottom. Again the water will boil, but this time its temperature will be practically the same throughout. The reason of this is that the heat reached all parts of the water by convection, but in the first case, where heat was applied to the top, its only chance of getting to the bottom was by conduction, and as water is practically a non-conductor of heat this could not take place. When heat was applied to the bottom the heated lower layers of water expanded, and became lighter, and consequently rose towards the surface, while the cold water, which is heavier, at once rushed to fill the vacant space, and so a practically uniform tempera

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ture is set up; and this is what must take place in a boiler if differences of temperature are going to be avoided, for if we have differences in temperature, we also have unequal expansions, which often brings about serious straining. In the Babcock boiler circulation is carried out in a most efficient manner: the heated and less dense water rises in the front headers, while the colder and therefore denser water flows down the back headers. This arrangement also prevents any interference of the hot and cold currents, and thus forms a safeguard against priming. I think I have now made it clear that since the heat is applied to the bottom of this boiler, great differences in temperature cannot take place.

There are also other important reasons for good circulation, but to discuss them would be going from the question. To consider the effect of unequal expansion in a Babcock boiler, it is only necessary to take a glance at a section and its elastic structure will soon show that nothing serious can happen, but in a Lancashire boiler the state of things is not quite so pleasing. In the first place, owing to the position of the furnace, it is easily seen by referring to the test-tube experiment that it is quite possible to have the water above the furnace at boiling point while below it can be quite cold. The result of this is that when raising steam the internal flue will expand at a greater rate than the outer shell, and unless special precautions are taken this means serious bulging of the end plates. When this happens the boiler is said to "breathe." Again, the Lancashire boiler can hardly be called an elastic structure, although several ingenious methods have been devised for taking up the expansion of the internal flue. These methods consists of making the flue of a number of corrugations, so that when expansion takes place the corrugations yield. In addition to the end plates being forced outwards, as might be expected, the flue is also found to rise in the middle; when this happens the boiler is said to "hog." Lancashire boilers often breathe as much as $\frac{1}{8}$in., and hog as much as $\frac{1}{2}$in.

Now, in raising pressure in a cold Lancashire boiler, every possible precaution should be taken to maintain as near as possible a uniform temperature. A slow fire should be lighted and the water very slowly heated; some hours should elapse before any steam whatever is raised, and then it should be allowed to gradually rise to about 5lb. or 10lb. and from that allowed to rise very slowly to its maximum, taking in all not less than 24 hours. In a station where the writer was engaged, and where some large Lancashire boilers were in use, it was customary to allow 48 hours to raise steam in a cold boiler; perhaps this is rather longer than some people would care to take over the job, but it certainly does no harm. A very good plan when raising steam in these boilers is to start with a good glass of water, and when the water becomes heated occasionally open the blow-down valve. The effect of this is to set the water in motion and so set up a temporary circulation; it also removes the cold water from the bottom, and allows the heated water to get at the cold parts, and thus somewhat equalise expansions. In marine work and sometimes in land work boilers are fitted with appliances for artificially circulating the water; this, of course, considerably lessens the time taken in raising steam. To calculate the straining in a boiler due to expansion, it is necessary to know by how much the various parts expand. This can readily be calculated if we know the rise in temperature and the coefficient of linear expansion for the metal that we are dealing with. Nearly all engineering pocket-books contain coefficients of expansion for different metals, but care should be taken not to use cubical expansions. If cubical expansions are only given, the linear expansion can be arrived at by dividing by 3, the linear expansion being one-third of the cubical expansion. With these particulars the expansion of any part of the boiler may be found by multiplying its length in inches by the coefficient of linear expansion multiplied by the rise in temperature. Suppose a Lancashire boiler is 30ft. long, and the temperature of the flue is 305deg. F, while the shell is only 100deg. F, what will be the difference in lengths of the flue and shell if free to expand? Assuming the flue to be made of iron, the coefficient for wrought iron is ·00000677, and the difference in temperature is 205deg. F. The difference in length will therefore be $205 \times 30 \times 12 \times \cdot00000677 = 5$in. The compressive strain is the increase in length divided by the original length $= \frac{\cdot5}{30 \times 12} = \cdot00139$. The compressive stress is the strain multiplied by the modulus of elasticity for iron, which is about $29 \times 10^{-6}$, $\therefore$ compressive stress $= \cdot00139 \times 29 \times 10^{-6} = 40{,}310$lb. per square inch. If the flue is 30in. in diameter and $\frac{1}{2}$in. thick the total pushing force of the flue will be $30 \times \pi \times \frac{1}{2} = 47$ square inches, and the stress being 40,310 total pushing force $= 40{,}310 \times 47 = 1{,}894{,}570$lb. These calculations can, of course, be applied to any other type of boiler in the same manner. It will be noticed that I have considered the flue to be made of iron, although in modern practice mild steel is more often used, but the coefficients of mild steel and wrought iron being nearly the same, the calculation will serve roughly for both cases.—E. AUSTIN.

*Answer to No.* 663 (*awarded* 7*s.* 6*d.*).—The time to get up steam on a Lancashire or Cornish boiler from cold has been given by a recognised authority as not less than six hours. This is a minimum that should only be taken on emergency. A good practice is to take two or three days, gradually warming the boiler and setting through before raising steam. A good practice, when there are several boilers, is to pump hot water into the cold boiler; this ensures the bottom of the boiler getting well warmed. When a boiler is got under pressure very quickly, there are considerable differences in pressure between its various parts. We may have the gauge showing pressure while the bottom of the boiler feels cold to the hand. This unequal heating is a prolific cause of trouble. One result is that called by engineers "hogging"; owing to the upper parts being so much hotter than the lower, expansion due to rise in temperature causes the flues and shell of the boiler to take the form of a curve. With a more gradual heating this curvature is reduced. Undue alteration in form caused by forced firing tends to set up "grooving." Grooving is a form of deterioration much feared, and is carefully watched for when a boiler is under inspection; faint apparent cracks or lines of corrosion will often be noted near points where the shell of the boiler is fasted to the end plates To prevent hogging, some boilermakers strengthen the flues by means of supports and stays; this method is, however, generally objected to, as it is a case of the cure being worse than the disease. With forced firing there must be unequal temperatures, and consequently unequal expansions; unless allowance is made for this, the stress may easily turn into a strain. The most rational method is to employ as little forced firing as possible. The Babcock and Wilcox boiler may be more readily forced, the parts of this boiler more directly acted on by the furnace being more quickly brought to an approximately equal temperature; steam may be safely got up in a few hours. Quick steam-raising from a cold condition is one of the most valuable qualities of a Babcock and Wilcox boiler; they also stand forced firing admirably. An important point with this type of boiler is that when getting up steam (the various parts of the boiler then being most unequally heated) the circulation is at a maximum. Unless suitable water is used with tubular boilers, frequent cleaning out is necessary, otherwise deposit soon causes leakages. With regard to the calculation of stresses set up by quick steam raising, it is doubtful if any reliable rules can be given; it is exceptionally difficult to take measurements of a boiler when under steam. Different alterations in shape when under hydraulic test are undoubtedly useful as a guide, but a boiler under the water test is not subjected to anything like its working conditions. Lancashire and Cornish boilers are often found with too little "breathing space." The flues, being hotter, expand more than the shell. Arrangement should, therefore, be made so that the end plates may bulge out slightly to allow for the extra expansion of the flues. To enable this breathing to take place the longitudinal stays should have a dip, not screwed up like fiddle strings. With a 30ft. boiler, cold, this dip should be about 1$\frac{1}{2}$in.; the amount given will depend greatly on the construction of the boiler. The horse-power of a boiler is an extremely indefinite quantity,

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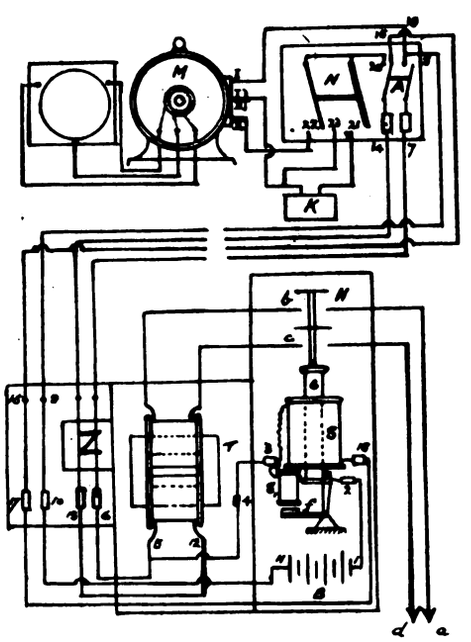
but the boilers mentioned in the query must be fairly large ones. It would have enhanced the interest of the question had the sizes been given.—M. M.

*Question No.* 664.—Describe an automatic switch which will "switch in" extra transformers when the load on the main rises beyond a predetermined point, and "switch out" again when the load falls below that point.

*Answer to No.* 664 (*awarded* 7*s.* 6*d*).—In the accompanying diagrams we observe an apparatus by means of which the no-load running of a transformer can be obviated in a simple manner. The fundamental principle of the apparatus is that, on switching in the current-using apparatus, the transformer is simultaneously connected in the high-tension circuit, and inversely, on switching off the apparatus, motor, etc., the transformer is also again disconnected. Fig. 1 shows an apparatus such that when, for example, the main switch, A, is put in, then a circuit 1 to 11 of the battery, B, is closed through the coil, $S_1$. The iron core of the coil, $S_1$, becomes magnetised, and attracts the armature, *f*. An iron core, *e*, is thereby released, falls by its own weight, and closes at *b* and *c* the circuit breaking points, *a b c d*, of the high-tension side, whereby the transformer, T, is switched in. The transformer can then give current to the low-tension side, from 5 to 8 and 12 to 20. If the change-over switch, N, is closed on the contacts 21 and 22, then the current flows through the main and shunt coils connected in series I.-I., II.-II. respectively; but in addition, through the condenser, K, connected in parallel with the shunt coils II.-II. The torque produced by the resulting phase acceleration of the current brings the motor into operation. After the starter is switched out, and the motor is running at its highest rate of rotation, the switch, N, is put down on position 23, and the shunt circuit, together with the condenser, thereby cut out. Instead of a condenser, a choking coil may be used, but in this case the main and shunt coils of the motor must be connected in parallel.



The motor is brought to rest by turning the starter back, setting in action the switches for changing over and cutting out. On cutting out, a circuit is simultaneously closed by 3, 4, 5, 12 to 15 to 18 through the coil, *s*. The coil is powerfully energised by the alternating current, so that the core, *e*, is again pulled up, and breaks the high-tension circuit at *b* and *c*. The initial condition is thus again reached, and the transformer completely cut out. For three-phase working the high-tension switch receives three contacts, and in place of the single-phase transformer one for three-phase current is used. Further, the condenser, *k*, together with the switch, N, are done away with, but, on the other hand, a three-pole switch, A, is necessary. In time the dry battery runs down and needs to be replaced, otherwise it is impossible for the apparatus to fail. The above apparatus is a German patent, and is used with special preference by the town electricity works at Nuremberg, which supplies single-phase current to the consumers. The accompanying sketch is taken from the German paper, *Helios*.—C. H. L.

[N B.—The above answer does not really apply to the condition of the question, nor do the other answers received.—Ed., *E. E.*]

## TRADE NOTICES AND NOVELTIES.

### Transformers.

From the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., we have a copy of their illustrated price list No. 4B of transformers. Both single-phase and three-phase oil-cooled transformers of different types for primary pressures up to and including 10,000 volts are dealt with in this list, a complete specification being given in each case.

### The Parlyphone.

We have from the Berliner Telephone Manufacturing Company, 200, Upper Thames-street, London, E.C., a pamphlet dealing with their parlyphones or domestic telephones, several patterns of which are offered at very moderate prices; also a leaflet of diagrams showing various methods of connecting the parlyphone.

### Witton Small Motors.

From the General Electric Company, Limited, 71, Queen Victoria-street, E.C., we have received a list dealing with Witton small motors for manufacturers. Hitherto the firm have confined all information regarding motors and dynamos to their plant catalogue, but owing to the increasing demand for small motors up to 10 h.p. they have now issued a separate list of these. We note that a complete range of standard motors from 1 h.p. to 10 h.p. at moderate speeds is now made at Witton for all pressures from 100 to 500 volts, and these motors can be supplied either as open or semi-enclosed machines. In anticipation of large sales at prices which will commend themselves to manufacturers, the company hold a large stock of each size of motor at their Witton works ready for immediate delivery.

### "Perfecta" Resistance Apparatus.

Messrs. Monté-Callow and Co., 6, Ludgate-broadway, London, E.C., inform us that, owing to the great demand for their "Perfecta" starters, regulators, and controllers, it has been found necessary to more than double the size of the works where the apparatus is made, and the addition of the most modern plant facilitating a greatly increased output, has enabled a revision of prices. Hitherto all "Perfecta" starters have been made to start a motor up under full load, allowance being made for a 50 per cent. overload for a period of 60 seconds in all sizes up to and including 20 h.p., and two minutes from that size to 100 h.p. But Messrs. Monté-Callow are now prepared to quote for "light-load" starters—*i.e.*, starters for starting up motors on a line of shafting only—at a considerable reduction.

### The Maxim Patent Lampholder.

A leaflet issued by Sir Hiram Maxim Electrical and Engineering Company, Limited, Maxim Works, Gillingham-street, Victoria, S.W., illustrates and describes the Maxim patent lampholder with bayonet slot shade carrier. These holders were designed, we are told, for the purpose of overcoming the trouble connected with the unscrewing of the old-type shade-carrying ring every time a shade required cleaning—a process which, unless done with a certain amount of care, often leads to broken shades, or, when hanging from a flexible wire, causes short-circuits, owing to the twisting of the wires. With the Maxim holder, after the shade has once been screwed upon the ring, it need never be unscrewed again, as to remove the shade the bayonet joint is unlocked in the same manner as a lamp is taken from the socket.

## PERSONAL.

The Keighley Town Council have increased the salary of the assistant electrical engineer, Mr. Mackintosh, from £109. 4*s.* to £125 per annum.

An honorarium of 250 guineas has been granted to the borough surveyor of Walsall, Mr. R. H. Middleton, and 150 guineas to the borough electrical engineer for the extra work performed by them in connection with the construction and equipment of the tramways.

The salary of Mr. Coveney, tramway manager at Ashton-under-Lyne, has been increased £50 a year.

The Tramways and Electric Lighting Committee of Aberdeen Town Council have resolved to recommend that the salary of Mr. Bell be increased from £500 to £700, in two yearly increments of £100.

Mr. Pilcher, of Birkenhead, has been selected from about 80 candidates for the post of tramway traffic manager at Burton-on-Trent. Mr.

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Pilcher was for some years in the Montreal tramway service, and latterly assistant to the general manager of the Birkenhead tramways.

Mr. F. Thursfield, electrical engineer to Chester Corporation, has resigned in order to accept an appointment with Messrs Preece and Cardew.

## APPOINTMENTS VACANT.

**Engineer or Manager**, with knowledge of tramways construction. Apply to Mr. H. Holloway, contractor, Wolverhampton.

**Engineer** (Malay States) for the Public Works Department, for construction of hydraulic works in connection with the lighting of Kuala Lumpor by electricity. Salary £420 per annum. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to March 26.

**Electrical Engineer**, Radcliffe. Salary, £150 per annum. Applications by March 19. See advertisement in last issue.

**Electrical Engineer**, Singapore. Salary £360 to commence. Applications to Mr. O. C. Lindsay, M.I.C.E., 217, West George-street, Glasgow, by April 19.

**Overhead Electrical Equipment Inspector**, Swansea, during construction of tramways. Wages, £3. 3s. per week. Applications by March 19. See advertisement in former issue.

**West Riding.** The County Council offer four technological scholarships (each of the value of £60), open to residents within the administrative area of the West Riding of Yorkshire, and available for courses of instruction in connection with textiles, dyeing, engineering (mechanical and electrical), metallurgy, or other approved industry. Particulars may be obtained from the Director, Education Department, County Hall, Wakefield. See advertisement in former issue.

## WORCESTER ELECTRICITY ACCOUNTS.

**The accounts of the Worcester electricity department for the year ended Dec. 31, 1903, show a total expenditure on capital account to that date of £120,649. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, etc, are appended.**

| Dr. Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 4,032 | 6 | 2 |
| Distribution of electricity | 166 | 19 | 11 |
| Attending and repairs to public lamps | 408 | 15 | 9 |
| Rents, rates, and taxes | 146 | 4 | 4 |
| Management expenses | 885 | 0 | 5 |
| Special charges | 146 | 10 | 9 |
| | 5,785 | 17 | 4 |
| Balance carried to net revenue account | 7,883 | 11 | 6 |
| | £13,669 | 8 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current, less discounts | 9,519 | 13 | 9 |
| Public lighting | 1,704 | 2 | 7 |
| Tramway company | 1,666 | 0 | 0 |
| Wiring | 219 | 6 | 8 |
| Rental of meters on consumers' premises | 266 | 17 | 5 |
| Alterations, repairs, carbons, lamps, etc. | 23 | 1 | 1 |
| Rents received | 191 | 0 | 6 |
| Damage to mains | 53 | 3 | 1 |
| Sale of scrap iron, miscellaneous, etc. | 26 | 3 | 9 |
| | £13,669 | 8 | 10 |

General Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 118,151 | 12 | 4 |
| Sundry creditors | 2,334 | 18 | 4 |
| Balance at credit of net revenue account | 1,866 | 16 | 1 |
| Sinking fund account | 17,389 | 14 | 2 |
| Reserve fund account | 241 | 5 | 5 |
| Treasurer | 4,430 | 10 | 10 |
| | £144,414 | 17 | 2 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 120,649 | 18 | 10 |
| Stores on hand | 960 | 17 | 6 |
| Sundry debtors for current supplied | 3,107 | 5 | 0 |
| Public lamps | 425 | 13 | 0 |
| Tramway company | 1,666 | 0 | 0 |
| Other debtors | 215 | 8 | 8 |
| Sinking fund account | 17,389 | 14 | 2 |
| | £144,414 | 17 | 2 |

Statement of Electricity Generated, Sold, etc.

| | | |
|---|---|---|
| Quantity generated in B.T.U. | | 923,855 |
| Quantity sold: Public lamps | 147,172 | 685,985 |
| Quantity sold: Private consumers by meter | 538,814 | |
| Quantity used on works | | 50,179 |
| Total quantity accounted for | | 736,165 |
| Quantity not accounted for | | 187,720 |
| Total maximum supply demanded (kilowatts) | | 556 |

Number of public lamps: 57 arcs, 151 incandescents.

# COMPANIES' MEETINGS AND REPORTS

## BRITISH INSULATED AND HELSBY CABLES.

The report of the directors for the year ended Dec. 31, 1903, states that the profit for the year amounts to £129,446. 3s. 4d., to which has to be added the balance brought forward from last year £3,468. 5s. 1d., making a total of £132,914. 8s. 5d. From this have to be deducted directors' and debenture trustees' fees, and remuneration to Works Committee, less directors' fees receivable from other companies, £2,250; interest on debenture stock, £22,500; depreciation on buildings, plant, machinery, etc., £18,500; transfer to special reserve account, £8,500; transfer to debenture stock redemption account, £5,000; dividend on preference shares to Dec. 31, 1903, £30,000; interim dividend on ordinary shares to June 30, 1903, £20,000; leaving available for dividend a balance of £26,164. 8s. 5d. The directors recommend the payment of a further dividend of 4 per cent. on the ordinary shares (£20,000), making with the interim dividend already paid a total of 8 per cent. for the year ended Dec. 31, 1903, and carrying forward to next account a balance of £6,164. 8s. 5d. During the past year the volume of trade has been less and competition more severe. Under these circumstances the directors consider the result of the year's working satisfactory. It will be seen that a further sum of £8,500 has been added to the special reserve account. The increase in freehold and leasehold property, plant, etc. is accounted for by the completion of the instrument factory at Edge-lane, Liverpool, and the telephone cable factory at Prescot, and other extensions, which are now in working order, and which will enable the Company to do an increased business in the future.

## TYNEMOUTH AND DISTRICT ELECTRIC TRACTION.

The directors' report for the year ended Dec. 31, 1903, states that the capital expenditure during the year amounted to £4,157. 19s. 4d., the total capital outlay on the electrical construction and equipment of the lines being £85,314. 6s. 5d. The total revenue for the year amounted to £16,138. 3s. 1d., and the expenditure (including £453. 16s. 10d. for debenture interest) to £10,036. 4s. 3d., leaving a profit of £6,101. 18s. 10d., which, added to the amount of £138. 10s. 3d. brought forward from last account, leaves an available balance of £5,177. 19s. 1d. after deducting £1,062. 10s., the dividend at the rate of 5 per cent. per annum on the cumulative preference shares paid to Sept. 15, 1903. The directors recommend that this sum should be applied as follows: to be placed to depreciation and reserve fund, £1,500; dividend at the rate of 5 per cent. per annum on the cumulative preference shares, £437. 10s; dividend at the rate of 7½ per cent. on the ordinary shares, £3,000; to be carried forward to next account, £240. 9s. 1d. The directors hope to make arrangements for the construction and equipment of the light railway to Whitley Sands during the coming summer season. The directors propose that the capital of the Company be increased by the creation of 4,000 ordinary shares of £5 each in order to provide for increased services, the development of the undertaking, and to replace revenues expended on capital account. Although the weather during the past year has shown little, if any, improvement over that experienced during 1902, the traffic receipts have increased by £759. 19s. 10d. The Bill deposited in Parliament by the Company for the confirmation of agreements entered into with the local authorities received the Royal assent on Aug. 11, 1903.

| Dr. Abstract of Profit and Loss Account. | £ | s. | d. |
|---|---|---|---|
| Power and running expenses | 6,859 | 12 | 7 |
| Repairs and maintenance | 1,041 | 4 | 7 |
| Administration and general expenses | 1,474 | 3 | 3 |
| British Electrical Friendly Society | 23 | 7 | 1 |
| Interest payable | 183 | 19 | 11 |
| Debenture interest | 453 | 16 | 10 |
| Balance carried to balance-sheet | 6,101 | 18 | 10 |
| | £16,138 | 3 | 1 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Traffic receipts | 15,824 | 0 | 5 |
| Advertising receipts | 188 | 6 | 0 |
| Sundry receipts | 125 | 16 | 8 |
| | £16,138 | 3 | 1 |

## OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The directors in their report for the year ended Dec. 31, 1903, state that the total revenue for the year amounts to £30,451. 2s. 10d., and the expenditure (including £1,600 for debenture interest) to £23,566. 15s. 8d., leaving a profit of £6,884. 7s. 2d., which, added to the amount of £123. 12s. 9d. brought forward from the previous account, makes an available balance of £7,007. 19s. 11d., which the directors propose should be applied as follows: amount to be placed to depreciation and reserve fund, £1,000; dividend at the rate of 5 per cent. per annum on the cumulative preference shares, £2,419. 1s. 10d; dividend on the ordinary shares at the rate of 9 per cent. per annum for the six months ended Dec. 31, 1903, making with the interim dividend paid on Aug. 15 last 7 per cent. for the year, £3,418. 16s. 9d.; balance to be carried forward to next account, £170. 1s. 4d. The reduction of the dividend on the ordinary shares by 1 per cent. is due to the distress in the cotton industry, the unfavourable weather experienced throughout last year, and a loss on the joint working by the Company and the Stockport Corporation of the new line from Hyde to Bredbury. The subscribed share and debenture capital of the Company is £140 000. In the course of the year £14,918. 5s. 5d. was expended, mainly on the equipment of the Hyde-Bredbury extension, and the total capital expenditure to Dec. 31, 1903, amounts to £150,327. 7s. The directors

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have power to issue further debentures to the extent of £10,000, but it is not intended to make an issue at present. During the past year 500 ordinary shares and 500 5 per cent. cumulative preference shares of £10 each have been issued to the shareholders and paid for in full. The total premiums received in respect of this issue amounted to £1,250, and after deducting the expenses of issue—viz., £7. 9s. 8d.—the balance of £1,242. 10s. 4d. has been placed to depreciation and reserve fund, which, with the addition of the £1,000 above recommended, will stand at £8,748. 5s. 9d.

| Dr. ABSTRACT OF PROFIT AND LOSS ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Power and running expenses | 15,440 | 13 | 3 |
| Repairs and maintenance | 2,597 | 18 | 8 |
| Administration and general expenses | 2,914 | 15 | 6 |
| British Electrical Friendly Society | 40 | 0 | 11 |
| Expenses of promoting orders and opposing Bills | 401 | 19 | 0 |
| Rent of lines | 538 | 7 | 3 |
| Interest | 33 | 1 | 1 |
| Debenture interest | 1,600 | 0 | 0 |
| Balance carried to balance-sheet | 6,884 | 7 | 2 |
| | £30,451 | 2 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Traffic receipts | 29,704 | 19 | 7 |
| Advertising receipts | 248 | 8 | 9 |
| Sundry receipts | 497 | 14 | 6 |
| | £30,451 | 2 | 10 |

## BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

The directors in their report for the year ended Dec. 31, 1903, state that the Company's business continues to make satisfactory progress. The total applications received at Dec. 31 last amounted to the equivalent of 100,538 8-c.p. lamps, being an increase of 19,542 8-c.p. lamps for the year, as compared with an increase for the previous year of 13,343. The total number of Board of Trade units sold for lighting, power, and traction purposes was 1,520,002, being an increase of 259,736 units for the year. The capital expenditure during the year in respect of the Bournemouth Order, 1890, the Poole and Branksome Order, 1897, the Christchurch and District Order, 1899, and the Pokesdown Order, 1902, amounted to £55,433. 2s. 7d., making the total expenditure to date in respect of these orders £286,889. 11s. 3d. The balance to the credit of net revenue account, including the amount brought forward from last year, and after payment of all interest and other charges, reserve for depreciation and redemption funds, is £12,960. 7s. 3d. Out of this sum the dividends on the 4½ per cent. and on the 6 per cent. preference shares have been paid, and the directors now recommend the payment of a dividend on the ordinary shares of the Company at the rate of 8 per cent., less income tax, for the year ended Dec. 31, 1903. These payments will absorb £9,654. 15s. 8d., and leave a balance of £3,305. 11s. 7d. to be carried forward. To meet the increasing growth of the Company's business, additional generating plant has been erected at the Company's station in the Bourne Valley, and this, the directors anticipate, will be sufficient for the Company's requirements for the next few years. The generating station at Christchurch has been completed during the year, and a supply therefrom was available for both lighting and traction purposes in June last. The Company has secured a contract from the Christchurch Borough Council for the electric lighting of the public streets. The Company's mains have been extended to Pokesdown, under the provisions of the Pokesdown Electric Lighting Order obtained in 1902, and a supply of current was available there early last year.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity—coal and other fuel | 5,776 | 2 | 2 |
| Oil, waste, water, etc. | 863 | 2 | 11 |
| Engineers' salaries | 493 | 15 | 0 |
| Wages | 1,657 | 16 | 8 |
| Stores and works expenses | 175 | 15 | 9 |
| Repairs to buildings and plant | 358 | 17 | 10 |
| Distribution of electricity—engineers' salaries | 237 | 15 | 10 |
| Wages | 271 | 0 | 8 |
| Repairs to mains, transformers, etc. | 359 | 2 | 0 |
| Rents, rates, taxes, and insurance | 1,973 | 2 | 3 |
| Directors' fees | 700 | 0 | 0 |
| Proportion of salaries and wages | 591 | 3 | 5 |
| Stationery and printing | 202 | 16 | 5 |
| General charges, travelling, advertising, etc. | 569 | 8 | 0 |
| Legal charges | 13 | 8 | 8 |
| Debenture trust fee | 52 | 10 | 0 |
| Auditors | 74 | 15 | 0 |
| Depreciation of office furniture | 21 | 0 | 0 |
| Reserve for bad and doubtful debts | 50 | 0 | 0 |
| | 14,440 | 12 | 7 |
| Balance carried to net revenue account | 21,217 | 14 | 0 |
| | £35,658 | 6 | 7 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current | 29,312 | 2 | 11 |
| Rental of meters and indicators | 1,278 | 10 | 11 |
| Interest, discounts, and transfer fees | 314 | 18 | 10 |
| Trading accounts | 21 | 8 | 9 |
| Rents receivable | 137 | 14 | 5 |
| Testing fees | 11 | 8 | 6 |
| Pupils' premium account | 141 | 19 | 11 |
| Interest and dividends receivable, less tax | 4,440 | 2 | 4 |
| | £35,658 | 6 | 7 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | |
|---|---|---|
| Quantity generated in B.T. units | | 1,987,809 |
| Quantity sold { Public lamps | 10,802 | 1,459,399 |
| Quantity sold { Private consumers by meter.. | 1,448,597 | |
| Quantity used on works | | 220,265 |
| Total quantity accounted for | | 1,679,664 |
| Quantity not accounted for | | 308,145 |
| Number of public lamps | | 110 |
| Total maximum supply demanded (kilowatts) | | 1,485 |

## METROPOLITAN ELECTRIC SUPPLY.

The seventeenth annual meeting was held at Winchester House on Tuesday In presenting the report and accounts **Mr. W. Harrison Cripps**, who presided, said their capital account had been increased during the year by £244,000. Out of that sum £33,000 had been spent in Marylebone, and that would be repaid, and the other largest items were £89,000 for machinery, £68,000 for mains, £53,000 for buildings, the great bulk of these sums having been spent at the new generating station at Willesden. It was proposed in future to pay all preference dividend on July 1 and Jan. 1. Negotiations had been entered into to see whether terms could be arranged, after the amount awarded to the Marylebone company had been paid, by which they would supply the Council wholesale from their station at Willesden. They knew that they could do this very much cheaper than the Council could do it for themselves. To obtain their own supply would mean putting up an entirely new station at a cost little short of £500,000, and they would also have to spend many thousands of pounds in disconnecting the present system in Marylebone, which was connected at Willesden all ready for the supply. He contended, moreover, that this money would be expended uselessly, except for the pleasure of doing a little municipal trading—a matter which seemed to him to be unjust. At the present time only about one-fifth—a little more than 20 per cent.—of the ratepayers in Marylebone took the electric light, and the great majority of them were never likely to take it. The Borough Council must lose a considerable sum on the trading, and he maintained that the loss should be made good by charging an extra amount to those who took the electric light. The Council, however, would charge the loss upon the ratepayers who did not take the light; and his view was that this was very hard on a man, for instance, who lived in a back street and who was satisfied with the use of gas or oil. Certain suggestions had been made by the directors for working the concern for the Borough Council, but he did not know whether these suggestions had been considered. According to the newspapers, they had been negotiating not only with this Company but also with others; and, indeed, it seemed to him that they had been casting about over both Europe and America to see what sort of supply they could obtain. Whether the Council would complete the negotiations or not he did not know, but he did know that, being actually connected with them, and having their station at Willesden, the Company could, with fair competition, afford to supply them as cheaply as, if not more cheaply than, anyone else.

The report (which appeared in our last issue) was adopted, and the dividend confirmed.

## COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

The tenth ordinary general meeting was held on Monday.

**Mr. J. B. Braithwaite,** who presided, quoted from the report (which has already appeared in these columns) to show that their record for the past year was one of quiet, steady, and satisfactory progress. He referred at length to the action of the London Electric Supply Corporation in Camberwell, who had been defeated, the Board of Trade not granting the order applied for. Then the Bermondsey Council had made an application, and they had also been defeated, so that he hoped the Company were going to have a few years of peace. A return prepared by the secretary, brought up to that morning, showed that during the current year applications had been received for the equivalent of 26,872 8-c.p. lamps, against applications for 15,040 for the same period of last year. He did not want them to go away with the impression that the Company would more than double their number of lamp connections during the current 12 months. They had not the plant to supply any such additional number. The figures he had given, however, showed that the business had not come to a standstill, but that, on the contrary, it was moving forward at an accelerated pace. Up to the 8th inst. the units sold numbered 1,521,524, as nearly as could be estimated, compared with 1,305,488 in the previous year, and the increase in the number of consumers had also been very satisfactory.

The report was adopted, and the proposed dividend of 4 per cent. on the ordinary shares agreed to.

A resolution changing the name of the Company to "The County of London Electric Supply Company, Limited," was carried.

## CHELSEA ELECTRICITY SUPPLY.

The annual ordinary general meeting of the Company was held on the 11th inst. at Winchester House, E.C.

**Mr. J. I. Courtenay,** who presided, said that a further reduction in the working cost per unit to 1·9d., as against 2·38d. for 1902, had been effected, and this was due to sundry economies which had been facilitated by the increased demand for the supply of electricity. With regard to a scheme for cancelling the founders' shares, no proposal could be put forward now. The directors hoped to meet the founders' committee shortly, and when a basis of agreement was arrived at, such further action as might be deemed advisable would be taken to obtain the approval of the shareholders, and notice of a Bill in Parliament would have to be given in the autumn.

The report (which has appeared in these columns) was adopted.

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## BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

At the sixteenth ordinary general meeting of the Company on the 10th inst., Mr. R. H. Beeton presiding, the report (which has already appeared in our columns) was adopted.

The **Chairman** said that in this the fourteenth completed year of the Company's existence, the increase in the number of lamps connected exceeded that in any previous year, and the growth in net revenue, which was partly due to the further demand for power, had been in spite of less fog. As illustrating the improvements in the Company's position, the number of units sold had advanced in the past 10 years from 400,911 to 2,322,231 units, and the receipts had risen from £6,264 to £29,234, and this notwithstanding that the average price obtained had fallen from 7·35d. per unit to 4·96d. per unit.

## W. T. HENLEY'S TELEGRAPH WORKS.

The ordinary general meeting of the Company was held on Monday at the offices, Bloomfield-street, E.C.

**Mr. Sydney Gedge**, who presided, said that it was something in these bad times to be able to pay 15 per cent. In each of the three preceding years the dividend was 20 per cent., and they were able, besides making that large distribution, to put aside a good deal of money. During the time that the Company had been in existence its dividends had averaged under 6¼ per cent. Municipalities, being unable to borrow money now on such favourable terms as previously, were not launching out into so many luxuries in the way of telephones and traction enterprises. With cheaper money, however, things would unquestionably prosper again. With regard to "retention money" Mr. Gedge said: "We have certain retention money kept back by the municipalities. We hope some day, and in the near future we shall be able to get municipalities to see the error of their ways in keeping back 10 per cent. on the amount of their contracts for six and sometimes 12 months. I think myself where a municipality is dealing with a reputable firm like ours that they should be satisfied as the Government are—the large spending departments of the Government—to pay when the work is completed and not want to retain large sums in hand for so long. To one or two other companies doing a larger business than we are with municipalities this retention of money is becoming a very serious burden. It means that enormous sums of money are outstanding until the termination of the retention time" The report (already noted by us) was carried unanimously, and the proposed dividend was adopted.

## OXFORD ELECTRIC LIGHT.

At the general meeting of the shareholders of the Oxford Electric Light Company, held at the Randolph Hotel on Friday, under the presidency of Sir Henry C. Mance, C.I.E., a satisfactory report was presented and a dividend of 6½ per cent. was declared on the ordinary shares.

## SALISBURY ELECTRIC LIGHT AND SUPPLY.

The annual general meeting was held on Tuesday, the chairman of the directors (Mr. W. M. Hammick) presiding.

The directors' report stated that the progress made by the Company during the year had been very satisfactory. The number of consumers had increased from 369, with 17,657 lamps connected, to 662, with 23,833 lamps connected, the increase being greater than in any previous year. During the year considerable additions had been made to the plant to meet the increased demand. Ten thousand new shares and 56 debentures of £100 each had been issued, bringing the share capital of the Company up to £30,000 and the debenture issues to £26,000. The profit on the year's working, including £116 13s. 10d. brought forward from last account, amounted to £4,489. 5s. 5½d., and after paying an interim dividend at the rate of 4 per cent. for the half-year, amounting to £467. 16s. 4d., £1,199. 8s. 9d. interest on debentures and outstanding accounts, and £35 by which the expenses of issue exceeded the amount of the premium received upon the new shares issued, there remained a balance of £2,787. 0s. 4½d. to be dealt with. The directors recommended that a further dividend be paid, making, with the interim dividend already paid, a total dividend at the rate of 5 per cent. per annum for the whole year, and that £1,600 be placed to reserve, leaving £318. 0s. 4½d. to be carried forward to next account. Of the directors, Mr. Gripper retired by rotation, and being eligible offered himself for re-election.

The report was adopted, and it was agreed that a further dividend be paid to the shareholders, making, with the interim dividend already paid, a total dividend of 5 per cent. per annum for the whole year. Mr. F. E. Gripper was re-elected a director of the Company, and Mr. F. Aston Dawes as auditor. A vote of thanks to the engineer and manager, Mr. Randall, concluded the meeting.

## NEWMARKET ELECTRIC LIGHT.

The annual meeting of the Newmarket Electric Light Company was held on Monday at the Company's Offices (Messrs. A. H. and A. Ruston's)

**Mr. G. H. Verrall, J.P.** (chairman), who presided, moved the adoption of the directors' report, which stated that very satisfactory progress had been made during the year 2,632 8-c p. lamps having been connected, making a total at the end of the year of 16,453 lamps. Applications for a further 887 lamps had been received this year. Additions to the buildings and plant had been completed. The profit on the year's working, added to £126. 13s. 4d. brought forward, amounted to £2,267. 8s. 8d. After paying debenture interest, £669. 3s. 10d., a balance of £1,598. 4s. 10d. remained. It was recommended that a dividend of 4½ per cent. be paid, £500 carried to reserve, and the balance, £312. 18s. 10d., carried forward. The Chairman pointed out that their net earnings during the past year represented a return to shareholders, after payment of debenture interest, of £7. 18s. 6d., as compared with £3. 18s. 3d. in the previous year, though the capital had during the year been increased by the issue of 170 £10 shares and £800 of debenture stocks. The net profits had, therefore, more than doubled in the year. Although the total consuming capacity of the town was being approached, and the increase in the number of lights—2,362—was not so large as in 1902, when the increase—4 230 lights—was abnormal, still the total was larger than in 1901, when the increase was 2,671 lamps.

The report was adopted.

Messrs. F. E. Gripper and H. J. Garrod, the retiring directors, and Mr. A. H. Crow, Westminster, the auditor, were re-elected.

## NEW COMPANIES REGISTERED.

**Otto Electrical Manufacturing Company, Limited.**—Capital, £10,000. Objects: to acquire English and foreign patents and applications therefor in connection with the manufacture of electric arc lamps granted or to be granted to O Gross, and to carry on the business of electricians, mechanical engineers, etc.

**Globe Light, Limited.**—Capital, £5,000. Object: to adopt an agreement with I. Shoob for the acquisition of the benefit of certain existing inventions relating to improvements in incandescent burners, by-passes, etc., for gas and electricity.

### Liens Registered.

**Uxbridge and District Electric Supply Company, Limited.**—Lien registered March 9, for £3.900 debentures, part of £25,000; amount previously issued, £20,000; no trustees; charged on the undertaking and all the property, including the uncalled capital.

**Electro-Voelker Syndicate, Limited (Croydon).**—A debenture, dated March 4, 1904, to secure £215. 15s. 9d., charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. No trustees.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Debreczin.**—The Hungarian Government Tobacco Factory require tenders for a dynamo by March 28.

**Gijon (Spain).**—The Municipality requires tenders for a telephone line between Gijon and Gala de Siero by March 22.

**Retz (Lower Austria).**—The Municipality require tenders for the installation, etc., of an electric light works. Tenders by March 20.

**Paris.**—The Colonial Office, rue Jean-Nicot No. 4B, require tenders for 1,000 iron telegraph poles for Senegambia and Niger by March 29.

**Seville (Spain).**—The Department of Commerce, etc, at Madrid require tenders for installation and working of tramways at Seville by March 21.

**Plasencia (Spain).**—The Municipality require tenders for installing and working an electric lighting undertaking concession. Tenders by March 28.

**Liege.**—The Provincial Government require tenders for the construction of electric tramways and for taking over two lines already existing by April 2.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Edinburgh.**—The City Council invite tenders for 12 months' supply of electricity meters. Specifications from the Resident Electrical Engineer, 5, Dewar-place. Tenders by April 4.

**Dundee.**—The Town Council invite tenders for the supply of electricity meters for Dudhope power station. Specifications from the City Electrical Engineer. Tenders by March 26.

**Aberdeen.**—The Electric Lighting Committee invite tenders for two water-tube boilers and accessories. Specification, etc., may be obtained from the Engineer. Tenders by 31st inst. See advertisement in last issue.

**Glasgow.**—The Corporation invite tenders for the construction of new tramways. Specification, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 11 a.m. on 21st inst.

**Dartford.**—The Urban District Council invite tenders for the construction and working for a term of years of electric railways. Specifications, etc., may be obtained from Mr. W. Kay, Council Offices, Dartford, Kent. Tenders by March 26.

**Sparkhill (near Birmingham).**—The Yardley Rural District Council invite tenders for the maintenance of fire-alarm installation. Particulars from Mr. Arthur W. Smith, Council House, Sparkhill, near Birmingham. Tenders by 19th inst.

**Rugby.**—The Urban District Council invite tenders for the construction and erection of a refuse destructor. Specifications, etc., may be obtained at the office of Mr. D. G. Macdonald, A.M.I.C.E., surveyor to the Council. Tenders by March 28.

**London, W.**—The London County Council invite tenders for a 30-ton electric jib crane for Greenwich electricity generating station. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on 22nd inst.

**Stockport.**—The Electricity Committee invite tenders for the supply of one 500-kw. steam generator. Specifications, etc., may be had on application to Mr. A. J. H. Carter, Electricity Works, Stockport. Tenders by 25th inst. See advertisement in last issue.

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**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Sunderland.**—The Corporation invite tenders for the supply of indiarubber-covered cables from April 1, 1904, to March 31, 1905. Specifications, etc, can be obtained from the Borough Electrical Engineer. Tenders by March 31. See advertisement in former issue.

**Swindon.**—The Corporation invite tenders for the electric lighting installation at the car depot Specifications, etc., may be obtained at the offices of the engineers, Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by 25th inst. See advertisement in last issue.

**Leavesden (near Watford).**—The Metropolitan Asylums Board invite tenders for installations of fire alarms and telephones at the asylum. Specifications, etc., may be obtained at the office of the Board, Embankment, London, E.C. Tenders by 10 a.m. on 22nd inst.

**Swansea.**—The Corporation invite tenders for (Contract No. 16) open-type street arc lamps, including accessories, and (17) converting the existing gas lamps to Nernst lamps, including accessories. Specifications, etc., from the Borough Electrical Engineer. Tenders by noon on April 2.

**St. Annes-on-Sea (Lancs.).**—The Urban District Council invite tenders for the supply, delivery, and erection of surface-condensing plant and natural-draught cooling tower. Specifications, etc., may be obtained from Mr. Jas. H. Clothier, engineer, Electricity Works. Tenders by 26th inst.

**Handsworth (near Birmingham).**—The Urban District Council invite tenders for supply and delivery of permanent way, pavement, roadwork, and overhead equipment. Specifications, etc., can be obtained from Mr. H. Ward, clerk, Council House, Handsworth. Tenders by 30th inst.

**Walthamstow.**—The Urban District Council invite tenders for the extension of their electric generating station. Specifications, etc., may be obtained on application to the Council's engineer, Mr. G. W. Holmes, A.M.I.C.E., Town Hall, Walthamstow. Tenders before 5 p.m. on Friday, April 8.

**Keighley.**—The Corporation invite tenders for rails, overhead equipment, section boxes, bonds, cars, cables, switchboard, and car-shed. Specifications etc., can be obtained on and after the 14th inst. from Mr. Alfred Lister, borough treasurer, Town Hall. Tenders before 10 a.m. on March 25.

**Manchester.**—The Corporation invite tenders for supply, delivery, and erection of synchronous motor-generators at sub-stations and flue-fired superheaters at Dickinson-street station. Specifications may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall. Tenders by noon on April 7.

**Lincoln.**—The Corporation invite tenders for one marine-type water-tube boiler and one high-speed engine coupled to a continuous-current dynamo. Specifications, etc., may be obtained from Mr. Stanley Clegg, Electricity Works, Brayford Side North, Lincoln. Tenders by 21st inst. See advertisement in former issue.

**Newport (Mon.).**—The Corporation invite tenders for boosters, balancers, etc., switchboards, tramway poles and brackets, overhead materials, section pillars, cables, and trolley wire. Specifications may be obtained from Mr H. Collings Bishop, M.I.E.E., Town Hall. Tenders before March 21. See advertisement in former issue.

**Ipswich.**—The Corporation invites tenders for 3,200 yards of 0·06 square inch and 6,000 yards of 0·12 square inch single conductor, paper-insulated and, lead-sheathed cables for extensions to the electric supply mains. Specifications, etc., may be obtained from Mr. Frank Ayton, chief engineer and manager, Constantine-road, Ipswich. Tenders by March 22. See advertisement.

**Bootle.**—The Corporation invite tenders for the supply of a one-horse emergency telescopic tower wagon, to be used for the maintenance of the overhead line equipment of tramways. Also a motor wagon for the same purpose, driven by any form of readily-started motor or engine. Tenders before 10 a.m. on 21st inst. Particulars from the Borough Electrical Engineer, Pine-grove, Bootle.

**Poplar.**—The Council invites tenders for the supply and erection of five three-phase alternating-current motor-generators, three switchboards (three-phase, alternating and direct current), hand travelling cranes. Specifications, etc., may be obtained from Mr. P. N. Hooper, A.M.I.C.E., M.I.E.E., Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 9 a.m. on March 26. See advertisement.

**Swindon.**—The Corporation invite tenders for the supply, delivery, and erection of a continuous water-softening plant, a 60-kw. motor-generator and switchgear; also for supply for one year from 31st inst. of incandescent lamps, cables, lubricating oils, direct-current meters. Specifications, etc., may be obtained on application to Mr. J. G. Griffin, A.M.I.E.E., Electricity Works, Swindon. Tenders by 31st inst.

**Govan.**—The Corporation invite tenders for the purchase of three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery, and balancer, also for three-wire booster by the British Thomson-Houston Company, Limited. Particulars may be obtained from the Burgh Electrical Engineer, Helen-street, Govan. Tenders by March 29. See advertisement in former issue.

**Christiania.**—The Board of Trade have received from H.M. Consul-General at Christiania a dispatch reporting that tenders are invited for the supply to the Norwegian State Railways of 464,450 sole-plates and 123,000 spiral washers. A copy of specification, etc., may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders by 3 p.m. on April 8. Apart from the usual customs duties a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime* The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Ilford.**—The Urban District Council invite tenders for the supply and erection of the following plant: one 1,000-kw. steam dynamo, comprising vertical engine coupled direct to multipolar dynamo; extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, motor-driven pumps, water-cooling tower, and pipework; water-purifying plant; pipework; feeder and pilot cables, feeder pillar, and joint-boxes. Specifications, etc., may be obtained from Mr. John W. Fenton, Town Hall, Ilford, Essex. Tenders by March 22. See advertisement in former issue.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Colne.**—The Council have accepted the tender of Bruce Peebles and Co. for a 400-kw. dynamo direct-coupled to a Belliss engine.

**Ashton.**—The Council have accepted the tender of the British Thomson-Houston Company for a 12 months' supply of motors.

**Walsall.**—The Corporation have accepted the tender of T. Tildesley, Willenhall, at £777, for extension of boiler-house of generating station in Wolverhampton-street.

**Salford and Harpurhey.**—The tender of Messrs. Walker and Hodgetts, Limited, has been accepted for the supply of 110-volt dynamos for lighting and power purposes at the Hippodromes.

**Taunton.**—The Council have accepted the tender of Messrs. Graham Bros. for 2,500 tons of Standard Colliery smokeless coal, at 14s. 6d. per ton, weighed and delivered at the electricity works.

**Radcliffe (Lancs.).**—The Urban District Council have accepted the tender of Messrs. D. Firth and Son, 14, Cannon-street, Manchester, for station lighting and wiring to motors, testing instruments, and accessories.

**Aston.**—The Borough Council have received the following tenders for the supply of a 750-kw. generating set: General Electric Company, Limited, Witton, £5,435 (recommended for acceptance); Dick, Kerr, and Co., £7,414.

**St. Annes-on-Sea (Lancs.).**—The Urban District Council have accepted the tender of Dick, Kerr, and Co. for supply, delivery, and erection of a 220-kw. steam dynamo (Willans engine and Dick, Kerr, and Co.'s dynamo).

**Walton-on-Thames.**—The Urban District Council have accepted the tender of Mr. N. C. Badois, at £99. 14s., for electric fire alarms between Walton and Hersham, and Walton and Oatlands (£48. 19s. for the former and £50. 15s. for the latter).

**Fulham.**—The tender of Messrs. Lancaster has been recommended for acceptance for constructing "rising" electric mains, distributing boards, etc., at the following mansions in Queen's Club-gardens: Vernon, £5; Kingsley, £7; Leighton, £7; Melbourne, £7; Brandon, £12; Chaucer, £12; Owen, £14; Quain, £14; Spencer, £14.

**Hornsey.**—The Council have accepted the following tenders: Babcock and Wilcox, Limited, 30, Farringdon-street, E.C., for water-tube boilers; General Electric Company, Limited, Witton, Birmingham, for engine-house plant; Wallsend Smoke Consumer and Fuel Economiser Syndicate, Limited, 5, Newman's-court, E.C., for smoke consuming apparatus.

**Cowans, Limited.**—Messrs. Cowans, Springfield lane, Salford, report the receipt of the following contracts: Shanghai Municipality, extension to main switchboard and standard high-tension oil-break main switches controlling 4,500 kw., at £668. 10s. Brighton Corporation, two heavy current disconnecting plug switchboards, at £429. Hastings, extension order for Andrews's duplicate mains system, at £126.

**Gwendreath Valleys Anthracite Company.**—The British Westinghouse Company have received a contract including supply

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and erection of generating plant with all accessories and numerous motors, which will be utilised to drive pumps, a 100-h.p. main and tail haulage, and a Waddle fan with a capacity of 50,000 cubic feet per minute, etc. A Belliss compound two-crank engine will be utilised to drive the generator.

**Chatham.**—The Admiralty have accepted the tender of Bruce Peebles and Co. for six 1,000-e.h.p. direct-coupled generating sets, Belliss engines, condensers, etc.; four 1,000-h.p. balancers and boosters, and 4,000 h.p in motors, varying from 5 h.p. to 75 h.p., main switchboard, etc., for the complete electric equipment of the dockyard. The price of the electrical equipment is reported to be between £50,000 and £60,000.

**Canada.**—The Canadian Electric Traction Company, London, have accepted the tender of Bruce Peebles and Co., Limited, Edinburgh, for motorcars and power-house equipment for St. Thomas and Port Stanley Railway, comprising 1,000 h.p. power station equipment, three-phase transformers, etc., 10 250-h.p. three-phase motorcars, each to seat 50 passengers, speed 30 miles an hour. Ganz system; the whole of the plant to be built in Edinburgh. Contract price, £42,250.

**Kilmarnock.**—The Corporation have accepted the following tenders for the various plant in connection with electric lighting and tramways: Oliver and Co., Cambridge-place, Burrage-road, Woolwich, arc lamps and posts, £1,275 2s 9d.; Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London, E.C., mains and feeders, £14,115. 8s. 4d.; and Chamberlain and Hookham, Limited, New Bartholomew-street, Birmingham, electricity meters, £209.

**Ealing.**—The Corporation have received the following tenders for a 750-kw. steam alternator, central surface condenser, etc.:

| | | | |
|---|---|---|---|
| Bertrams, Limited* (condenser plant) | £2,360 | 10 | 0 |
| Siemens Bros. and Co. (Davey-Paxman engine and Siemens alternator) | 5,811 | 10 | 0 |
| Alley and Maclellan (condenser plant only) | 3,430 | 0 | 0 |
| British Westinghouse Company (complete contract) | 9,103 | 0 | 0 |
| Browett, Lindley, and Co. (complete contract) | 10,797 | 0 | 0 |
| Bruce Peebles and Co. (complete contract) | 9,100 | 0 | 0 |
| Couper, Schwarz, and Co. (condenser plant only) | 2,360 | 0 | 0 |
| Crompton and Co. (complete contract) | 9,619 | 0 | 0 |
| Dick, Kerr, and Co. (complete contract) | 10,655 | 0 | 0 |
| Johnson and Phillips (complete contract) | 8,874 | 0 | 0 |
| Kramer and Co (engine and alternator only) | 6,366 | 0 | 0 |
| Masson, Scott, and Co. (condenser plant only) | 3,350 | 0 | 0 |
| J. Storey and Sons (condenser plant only) | 2,800 | 0 | 0 |
| Wheeler and Co. (condenser plant only) | 3,000 | 0 | 0 |
| Mirlees, Watson, and Co. (condenser plant only) | 3,357 | 0 | 0 |

* Acceptance noted in last issue.

**Coventry.**—The New General Traction Company, Limited, have received the following tenders for the construction of about three miles of new tramways and the reconstruction of 5½ miles of tramways:

| | | | |
|---|---|---|---|
| R. W. Blackwell and Co., 59, City-road, E.C. (accepted) | £34,296 | 19 | 1 |
| W. Griffiths and Co., 35, Hamilton House, Bishopsgate-street Without, E.C. | 40,937 | 19 | 10 |
| J. G. White and Co., 22A, College-hill, Cannon-street | 37,656 | 11 | 3 |
| G. Law, Comberton-hill, Kidderminster | 36,747 | 7 | 11 |
| J. Ewart, 21, Old Queen-street, Westminster | 44,280 | 12 | 5 |
| Dick, Kerr, and Co., Abchurch-yard, Cannon-street, E.C. | 41,847 | 13 | 1 |
| Pegg and Bailey, Porter-road, Derby | 37,408 | 16 | 7 |
| Graham and Sons, Springdale, Longroyd Bridge, Huddersfield | 46,628 | 3 | 1 |
| J. and W. S. Briscoe, Longshut-lane East, Stockport | 86,794 | 1 | 4 |
| Underwood, Dukinfield | 36,068 | 7 | 5 |
| Freeman, Hollinwood, Oldham | 38,271 | 3 | 9 |
| Mollett, 41, Finsbury-pavement, E.C. | 36,276 | 1 | 0 |
| H. Holloway and Co., Bilston-road, Wolverhampton | 38,686 | 17 | 10 |

# BUSINESS NOTES.

## TRACTION.

**Ayr.**—It is proposed to spend some £40,000 in the extension of the tramways.

**Holborn.**—The Town Council has decided to notify the Board of Trade that they prefers the overhead system.

**Northampton.**—The Town Council has decided to address the ratepayers individually, by postcard, in regard to a Sunday service.

**Scarborough.**—It is stated that a portion of the Scarborough tramways system will be formally opened by the Mayoress on April 30.

**Great Northern and City Railway.**—The Bill for a three years' extension of time in which to constructt an extension to Lothbury has passed its third reading.

**Stockport.**—The Corporation has resolved that application be made to the Board of Trade for permission to run cars to Gatley as soon as the route is completed.

**Wolverhampton.**—At Monday's meeting of the Town Council it was stated that over 7,000 passengers were carried on the new route on Saturday, more than £30 being taken.

**Gosport.**—The Provincial Tramway Company will commence laying the tramway lines in the High-street in the middle of April, and have undertaken to do the work in three months.

**Rochdale.**—Mr. Graham Harris, the arbitrator appointed in connection with the purchase of the Bury, Rochdale, and Oldham Tramway Company, has commenced his inspection of the system.

**Cardiff.**—Mr. Ellis reports to the Tramway Committee that the cost of generating power at the Roath station during February was only 0·36d. per unit, the lowest recorded during the past two years.

**Burnley.**—The Corporation has now arranged terms with the Brierfield Urban Council regarding the leasing of the tramway in the Council's area, the latter body accepting £860 as annual rental.

**Broughty Ferry.**—The application for a provisional order to construct a tramway will be opposed by the railway companies, but the Dundee Town Council is favourably disposed towards the scheme.

**New Lancashire Railway.**—The Bill authorising the construction of a tramway between Preston and Blackburn has been passed by a committee of the House of Lords. The estimated cost of the line is £150,000.

**Guildford.**—The Town Council has resolved to support the suggestion of the Surrey County Council as to the insertion of a clause in the Stoughton scheme that Wood Bridge should be widened to 30ft. between the parapets.

**Brierfield.**—The Council has agreed to lease its tramways to the Burnley Corporation for seven years for the annual sum of £860. There has been considerable discussion over the matter, as the Council expected a larger sum.

**Keighley.**—The Town Council has approved the recommendation of the Electricity and Tramways Committees that in the construction of the electric tramway to the station a single line should be continued to Victoria Park gates.

**Glasgow.**—Work has been commenced on the new tramway to Potter-hill and also at Carriage-hill. The work is now so forward in the east end of the town that the Glasgow cars should be expected to be running by the end of March.

**Chester.**—The receipts for the past month show a decrease of £52. 9s. 2d. as compared with January, but this is practically accounted for by the fact that there were two days fewer in February, the average takings per day so far being £25. 7s. 4d.

**Kingswood.**—The Urban District Council have rescinded their resolution to oppose the Bristol Tramways Extension Bill this year, and at the same special meeting agreed to the provisions of this Bill. The lines will be extended to Kingswood and Hanham.

**Manchester.**—The Manchester Corporation Tramways Committee have approved a grant of £50,000 to the relief of the city rates, the sum representing the profits on tramway running for 12 months. The sum placed to the relief of the rates last year was £30,000.

**Walton-le-Dale.**—The Walton Council have withdrawn their opposition to the Preston, Chorley, and Horwich Tramway Bill, having come to an agreement with respect to the level crossing at Bamber Bridge. The Bill will now be supported by the Council.

**Yardley.**—The electric tramway extension from the Small Heath steam terminus to the Swan Hotel at Yardley, about 1½ miles in length, will be opened as soon as the sanction of the Board of Trade has been obtained. The plant in the station is driven by a Diesel oil engine.

**Lowestoft.**—The tramways of Lowestoft have now carried over 1½ millions of passengers since their opening. The traffic returns hold up well, even in the winter. Four new cars are now to be ordered, which will cost some £2,105. These will be required for the summer service.

**Wolverhampton.**—Colonel Yorke has inspected the new section of tramways from Snow-hill to the Fighting Cocks on the Dudley-road, which has recently been equipped on the Lorain surface-contact system. The trial runs were satisfactory and the lines were subsequently thrown open for traffic. A 6d. service has been arranged.

**Perth.**—The Perth Corporation are playing with their electric traction scheme in the same way as they did originally with their electric lighting undertaking. With the full reports before them as to the advantage and cost of electric traction they are hanging up the matter until they have experimented with petrol cars.

**Blackpool.**—An enquiry was held on Wednesday into the application of the Corporation for sanction to borrow £3,700 for the provision of a new traction set for the electricity works. The Town Clerk stated that last year the Corporation ran short of electricity and had to borrow some from the Blackpool and Fleetwood Tram Company.

**Hartlepool.**—While the Hartlepool Council at a private meeting decided to extend the lease of the tramway company for 21 years, the West Hartlepool Council are not in favour of this step. They propose to limit the renewal for a period of five to seven years. A committee has been appointed to treat with the company on this basis.

**London County Council Tramways.**—There are a number of rumours in the papers as to what the deficiency of working the London County Council tramway system for the past year is likely to be. In view of the interference due to conversion and troubles when starting up a new system, a deficiency is likely to have been incurred.

**Weston-super-Mare.**—At the last meeting of the Urban District Council the Works Committee reported the receipt of a letter from Mr. S. G. Leech, managing engineer to the tramways company, stating that the exceptionally wet weather had prevented the carrying out of the repairs to the track, which would be taken in hand directly the weather permitted.

**Bath.**—The Corporation have instructed the clerk to obtain the land necessary for the road widening at Odd Down, and to obtain the services of Mr. T. B. Silcock as valuer; and also to negotiate for the purchase of land at the rear of Green Park. The surveyor has been instructed to proceed with the necessary negotiations with the Midland Railway Company.

**Ayr.**—The Town Council has decided to proceed with the proposed provisional order for powers to raise a loan, the sum required being

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estimated at £40,000, the new features contemplated including 10 extra cars, additional feeders and distributors to carry the load required for the extension to Monkton, and the doubling of the line from the grammar school to Chapelpark.

**Bradford.**—The Board of Tradé have sanctioned the transfer to the Corporation of the powers conferred upon the Nidd Valley Light Railway Company by the Nidd Valley Light Railway Order, 1901. Mr. W. B. Woodhead and the chairman and vice-chairman of the Water Committee have been appointed surveyor and bondsmen respectively in connection with certain lands to be acquired.

**Walsall.**—The Town Council has adopted the report of the Tramway Committee, which showed the receipts to be: January, £2,081. 6s. 11½d.; and February, £1,801. 11s. 7d. In presenting same, Councillor Cope said he did not think there would be much to fear at the end of the year. The Council also approved the recommendation to let the advertising on the tramcars by contract.

**Blackburn.**—During the week ending March 4 there were 128,204 passengers, an increase of 5,524, and the receipts were £693. 3s. 9½d., an increase of £13. 15s. 4d. over the corresponding week in the previous year. For the 346 days' running in the year the receipts amounted to £40,902. 2s. 3d., an increase of £2,119. 5s. 4d. over 1903 (345 days' running), and one of £7,206. 7s. 3½d. over 1902.

**Blackburn Proposed Tramway.**—The preamble of the Bill to provide tramways between Preston and Blackburn has been passed in the House of Lords. The gauge of the tramway will be that used in Blackburn, into which the through cars will run. The Preston Corporation, whose trams are of a different gauge, will arrange their service so that there shall be little delay at the meeting point of the line.

**Twickenham.**—The Town Council have authorised the surveyor to formally approve the plans submitted by the L.U.T. Co. in respect of proposed road widenings in London-road and Hampton-road, in accordance with the provisions of the company's Act, 1903, subject to the exact position of the track in the roadway being first set out on the ground, and agreed with the Council's surveyor, before any work is commenced in connection therewith.

**City of Birmingham Trams.**—Out of a disposable balance of £57,873 the directors recommend a dividend on the ordinary shares at the rate of 5 per cent. per annum for the six months ended Dec. 31 last, together with a bonus of 5 per cent., making 10 per cent. for the year, amounting to £6,314, and £31,539 be carried to the reserve fund (thereby increasing that fund to £242,744), to provide for depreciation of assets, redemption of debentures, and for general purposes.

**Southampton.**—The Tramways Committee recommend that the borough engineer be directed to immediately advertise for the necessary materials for the reconstruction of the permanent way from the tramway junction at Prospect-place to the terminus at Shirley; that the work of reconstruction be carried out by direct labour under the supervision of the borough engineer; and that a heavier class of rail be laid at the curves and crossings, and the present rails utilised for the remaining portions of the track.

**Sheffield.**—The new tramway routes came into operation this week. The change on the Midland station route is a decided advantage. By using Commercial-street instead of Blonk-street the cars are brought more readily into the centre of the city, but the service ought to be more frequent. The new Great Central service cars for all parts start at or near Fitzalan-square. They might feed and be fed by the Central Station cars, which should run to and from the square, as nothing is gained by sending them through the city.

**Partick.**—The Partick Town Council have remitted to the convener of the Parliamentary Bills Committee the consideration of the question as to whether any extensions of the Corporation tramways within the burgh are desirable, and to report, it being the desire of Mr. Young, the manager, that the Town Council should make representations to the Tramways Committee rather than private parties and associations of ratepayers. It was agreed that the question of running a line of tramways up Crow-road would be kept in view.

**British Columbia Electric Railway Co.**—The directors state that, in view of the good results of the company's trading for the half-year ended Dec. 31, 1903, they feel justified in increasing the rate of dividend on the deferred ordinary stock to 3 per cent. for the half-year, being at the rate of 6 per annum, free of tax. The earnings of the company for the half-year were £85,286, the working expenses £46,932, and the net profit £38.354, as compared with £29,905 for the corresponding half-year of 1902, and £27,360 for the corresponding half-year of 1901.

**Dunedin.**—The Corporation have issued a very handsome souvenir commemorating the official opening of the electric tramways on Dec. 16, 1903. It shows the three different types of cars—the closed car, the open car, and the combination car—and also an excellent view of the car-house, Market-street, while at the bottom is a photo of one of the old horse cars—"a relic of the past." The names of Thos. Scott, mayor; T. R. Christie, Esq., chairman of the Tramways Committee; and Messrs. Noyes Bros. and W. G. T. Goodman, engineers, are also prominent features.

**Beckenham.**—At the last meeting of the Urban District Council it was reported that the Tramway Committee had just met to consider the question of security by the British Electric Traction Company, Limited, and the claims of occupiers of shops in the High-street, and that the further consideration of both matters had been adjourned. The action of the clerk in giving notice to the company that the Council propose to exercise the option to supply energy for tramways reserved by the agreement between the company and the Council was approved, and the subject was referred to the Electric Lighting Committee for report as to the necessary arrangements for affording the supply in question.

**South Shields.**—A special meeting of the South Shields Tramways Committee was held this week with regard to the construction of tramways within the borough boundaries. There were two tenders, one of which was from the British Electric Traction Company, who had previously been unsuccessful in their negotiations with the Corporation. They now offered more advantageous terms, and asked for a 28 years' lease, but declined to construct. A Manchester syndicate, through a firm of solicitors, suggested a 42 years' lease, and, it is understood, agreed to construct. The meeting was adjourned to allow the Corporation officials to report at an early date.

**Hyde.**—The Town Council on Tuesday considered a letter from the Hyde, Stalybridge, Mossley, and Dukinfield Tramways and Electricity Board, which stated that probably £2,000 would be required from the borough of Hyde to meet the deficiency on the year's accounts. This represented a rate of 4d. in the £ for one year. The chairman of the Finance Committee predicted that though it was probable that for the first two or three years there would be a deficiency, when they had a sufficient number of customers for lighting and power from the generating stations they would at least be able to make both ends meet. It was hoped to commence running on a portion of the system by the end of next month.

**Bristol.**—A special meeting of the Bristol Tramways Company was held last week to consider the Bill to be presented to Parliament for sanction to various extensions. It was mentioned that the proposed extensions at Long Ashton and Kingswood had been abandoned owing to the action which the local authorities had seen fit to take. It remained to be seen whether, so far as Kingswood was concerned, any satisfactory arrangement would be come to in time to include that extension in the scheme. The directors did not anticipate getting any great immediate return from these extensions, but it was in keeping with their policy that they should expand without waiting until a district had developed. A confirmatory resolution was passed.

**New Traction System.**—A committee of the House of Commons yesterday considered a proposal to introduce into this country for the first time the Dolter system of electric traction at Torquay. It was explained that there would be placed between the tramway rails studs, or metal boxes, and an apparatus at the bottom of the car called a skate. When these two came in contact the current would be created, but as soon as the skate had left any particular stud it would cease so far as that was concerned. By this system overhead poles and wires were got rid of. It was claimed that the system was a perfectly safe one, and had worked satisfactorily in Paris. The committee inserted a clause for the protection of the Torquay Gas Company, on the ground that this was an untried system in this country.

**Perth.**—At a meeting of the shareholders of the Perth and District Tramway Company, Limited, last Friday, a special resolution was passed that, as the company had disposed of the whole of their tramway undertaking to the Corporation of Perth, the company be now wound up voluntarily, and that Mr. Thomas Dempster, solicitor, be appointed liquidator. The postal authorities are to pay a sum of £60 in respect of the conveyance of mails and postmen by the tramways. Under the previous contract postmen in uniform were permitted to travel free on the cars, but under the new contract this permission will only be granted to men on duty. It has been agreed, however, to allow the postmen in uniform to travel free on the cars up to May 28 next, irrespective of their being on official duty or not.

**Ashton.**—The Town Council have resolved that, in order to avoid arbitration on the question of the 10 minutes' service between Ashton and Stalybridge, the sum of £1 per week be paid to the Stalybridge, etc., Joint Board, to date from Dec. 13 last. It was also decided that an expert be engaged to report upon the suggested arrangements made by the Stalybridge, etc., Joint Board for running over Scotland-street line if constructed. The Council promised consideration of the request from the Ashton and District Trades and Labour Council for a service of workmen's cars and reduced fares on the Manchester-road section for the miners employed at the New Moss Colliery. The Tramway Committee reported that the referee had stated the dispute with the Manchester Carriage and Tramways Company was a question for the Court to decide.

**Preston and Lytham Tramways.**—The House of Lord Committee found that the preamble of the Preston and Lytham Tramways Bill was not proved. The Chairman stated that the committee did not think the requirements of the district warranted the construction of the tramway. The Preston, Chorley, and Horwich Tramways Bill was also before the committee. Powers were sought to make a deviation of the line at Bamber Bridge so as to take the tramway over the Lancashire and Yorkshire Railway at a point beyond the village instead of at the level crossing over the main road. The Bill was opposed by the Lancashire and Yorkshire Railway Company. The committee decided to accept the proposal of Mr. Balfour Browne, who appeared for the promoters, that the tramway should enter Preston *via* Lostock-hall and Penwortham.

**Kirkcaldy.**—At the monthly meeting of the Town Council the Joint Harbour and Tramways Committees recommended that the Town Council withdraw their opposition to the order applied for by the North British Railway Company for an extension of time for the construction of the railway along the foreshore, and also that they withdraw the clause from the Tramway Bill with regard to the carrying on the tramways of merchandise and minerals except for small parcels not exceeding 112lb. It was also pointed out in the minute that should the Corporation agree to this arrangement, the railway company were prepared to withdraw their petition against the Corporation's order in connection with the extension of the tramways and harbour. A deputation from the Harbour Extension Association having been heard, the committee's recommendation was unanimously agreed to.

**Swansea.**—The Corporation Tramways Committee recommend that the tramway company be informed that the Corporation will supply electrical energy for working the Morriston and Brynhyfryd sections at

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the following prices: for a minimum of 200,000 units per annum, 1½d. per unit; for the next 150,000 units in the same year, 1$\frac{7}{8}$d. per unit; for the next 150,000 units in the same year, 1¼d. per unit; for the next 150,000 units in the same year, 1$\frac{1}{8}$d per unit; for the next 150,000 units in the same year, 1d. per unit. The same committee have, after subtracting 10 per cent. per annum for depreciation, off red the tramway company £4 369 as the price for taking over all mains and works in connection with the Neath-road (Morriston) section. The committee replied to the Board of Trade that the objection of Oxford-street tradesmen was to any line at all, whether single or double, being run through the street, and that no objections have been received by the Corporation as the result of public advertisement.

**Hindley.**—At the last meeting of the District Council, the Tramways Committee reported the receipt of a letter from the town clerk of Wigan as to the reconstruction of the Platt Bridge tramway within the district of Hindley on a 4ft. 8½in. gauge, upon which it was decided that the surveyor prepare a plan showing where land should be acquired by the Wigan Corporation to retain the present width of the footpath, and to leave a space of 9ft. 6in. between the outer rail and the kerb, and also showing the best positions for passing places. Another meeting of the committee was held on March 2, when the chairman verbally reported the result of the conference with the representatives of the South Lancashire Tramways Company on Saturday last, after which the committee again considered the letter of the town clerk of Wigan for consent to construct the Hindley-to-Platt Bridge line on a 4ft. 8½in. gauge. The surveyor submitted a plan of the tramway route, Hindley-to-Platt Bridge line, showing the road widenings required if the same be constructed on a 4ft. 8½in. gauge, and it was resolved that the law clerk be requested to ask for a copy of the terms and conditions finally agreed upon between the Wigan Corporation and the Ince Council.

**Baker-street and Waterloo Railway.**—This Bill came before a House of Commons Committee on Tuesday presided over by the Hon. A. de Tatton Egerton. Mr. Balfour Browne, K.C., who appeared for the promoters, said that the purpose of the Bill was to sanction the borrowing of £384 000 additional capital in order to carry out a number of improvements along the line. It was proposed to build a station at Kennington-road, and another at Regent's Park, and to enlarge the tunnels in Edgware-road for the purpose of making a station. All those were works which were not covered in the original Bill. There were numerous other improvements to be effected. It was proposed to convert every carriage into a separate motor carriage, and that would result in a considerable reduction of vibration. Other improvements were to be introduced so as to render the railways safer in case of fire by using concrete in the construction of many parts which were at present of wood. Sir Benjamin Baker, one of the engineers, explained that the new stations were to be erected because of the feeling that had been expressed before the London Traffic Commission and in similar quarters. There were three petitions against the Bill—from the London County Council and the Lambeth and Southwark Borough Councils; the County Council contending that the original capital ought to suffice to complete the undertaking.

**Aberdeen.**—A carter named John Jaffray was fined 7s. 6d. for having, in Union-street, driven a horse and lorry carelessly and colliding with an electric car. He pleaded not guilty. Evidence for the prosecution went to show that accused had been standing near the pavement on the south side of the street, opposite Rose-street, a little behind another lorry. When the car going westwards approached, accused started his horse, and was going to pass the other lorry. The motorman of the car, observing him start, and seeing that the carter would have to cross the rail, sounded his gong, but the carter paid no heed, and when the car was about a car length from the lorry, he applied his brakes, but the lorry collided with the car before the car could be stopped. The lorry was not damaged, but the car was scratched. It was maintained that had the carter stopped when the gong was sounded, the accident would not have occurred. In answer to the fiscal, accused admitted that he did not care to get out of the way, because he thought the motorman should have stopped, and not he. The fiscal stated that it appeared that there was a certain class of carters who did everything they possibly could to humbug the car drivers, and considered that it was the duty of the carmen to give place to the carters. At the recent meeting of the Aberdeen County Council, the plans of the Aberdeen Suburban Tramways Company were agreed to on certain specified conditions.

**Birmingham.**—At a recent meeting of the Tramways Committee of the City Council a long discussion took place upon the scheme for a comprehensive system of municipal tramways throughout the city. Nothing definite, however, was decided upon. The chairman, Alderman Beale, informed the Press that the matter was one which required very careful consideration, and that it would be some weeks before the committee would be in a position to present any report upon the scheme. In the report of the City of Birmingham Tramways Company, which will be brought before the shareholders at the annual meeting of the shareholders, it is stated that the negotiations for mutual running powers between Steelhouse-lane and Aston Cross were broken off because the Corporation made it a condition that the company should be restricted to running one car only to every four cars of the Corporation. This condition the directors consider most unfair to the company. Enquiries on this point tend to show that four-fifths of the traffic on the Aston line is in Birmingham and only one-fifth in Aston. But when the line is extended to Gravelly Hill and other branches are developed the traffic in Aston will be greater, so that the company will then run more cars. It is possible that in the course of time the company's traffic will become so much greater than in Birmingham that eventually the company may have more cars on the route than the Corporation. Still, at present, the Corporation consider that they have four-fifths of the traffic, and consequently should have four cars to one belonging to the company.

## LIGHTING AND GENERAL.

**General Electric Co.**—The transfer books for the debenture stock will be closed from March 18 to 31 inclusive.

**Stanley.**—The Cleveland and Durham Electric Supply Company are about to commence laying mains in the district.

**Doncaster.**—The Yorkshire Electric Power Company have been empowered to appear in opposition to the Corporation Bill.

**Worcester.**—The electricity accounts for 1903 were discussed at length and adopted at the last meeting of the City Council.

**Poplar.**—The Council have decided on a reduction in price for electricity for power to 1½d. per unit, to take effect from April 1.

**Brockie-Pell Arc Lamp.**—A memorandum of satisfaction in full of a debenture, dated Nov. 30, 1903, securing £1,000, has been filed.

**Pleasley.**—The Parish Council have signed an agreement with the colliery company for supplying electricity for street-lighting to the colliery village.

**Thornhill.**—The District Council have referred to a committee an offer from the Yorkshire Electric Power Company, who are prepared to undertake the street lighting.

**Heywood.**—At a recent meeting of the Electricity and Tramways Committee the consumption of electricity for the month of January, 1904, was stated to be 7,457 units.

**Clitheroe.**—The Board of Trade have issued a provisional order authorising the Corporation to supply electrical energy for public and private purposes within the borough.

**Preesall.**—Mr. Hansom, Fleetwood, will at an early date lay before the Urban District Council his views as to the electric lighting scheme which he has in view for this district.

**Change of Address.**—On Friday, March 25, the Manual of Electrical Undertakings, Limited, will move to 37 and 38, Strand, and 1, Buckingham-street, Strand, W.C. (second floor).

**Kensington.**—A notice from the Brompton and Kensington Electricity Supply Company relative to a proposed extension of their mains in Gaspar-mews, Courtfield-gardens, has been agreed to.

**Glasgow Telephones.**—The Secretary of State for Scotland has granted the Corporation's application for the further telephone loan of £50,000 without demur within four days of application.

**Whitehaven.**—The lighting of the harbour will cost something like £200. The electrical engineer considers that there would be a slight profit per annum for the period on the terms of 3½d. per unit.

**Wakefield.**—The Corporation Electric Lighting Committee have decided to reduce the charge to customers for current for lighting purposes from 4½d. to 4d. per unit, and to abolish meter rents.

**Walmer.**—The Board of Trade have issued a provisional order to the Urban District Council authorising them to supply electrical energy for public and private purposes within the urban district of Walmer.

**Morley.**—The charge for electricity has been reduced from 4½d. to 4d. per Board of Trade unit as from April 1, 1904, and new consumers will be allowed the current free during the months of April, May, June, and July.

**Stock Exchange.**—Application has been made to the committee to allow the Bromley (Kent) Electric Light and Power Company's 14,000 ordinary shares of £5 each, fully paid, to be quoted in the official list.

**Windsor.**—The Windsor Electrical Installation Company have agreed to the terms imposed by the Corporation for the electric lighting contract. The question of stipulating a greater fine for arc lamps going out than for small lamps has been referred to the Lighting Committee.

**Bangor.**—The electrical engineer (Mr. Price White) reports an increase of 11·3 per cent. in the quantity of units of electricity sold during the five weeks ended Feb. 27 as compared with the corresponding period of last year.

**Hindley.**—The South Lancashire Tramways Company are about to supply electricity to Messrs. Unsworth and Cowburn's colliery. The District Council intend to apply for a further extension of the Hindley electric lighting order.

**Lytham.**—A number of suggestions are being made in the local Press with regard to obtaining a supply of electricity for private purposes from St. Annes, as the Council, who own the gasworks, do not intend to move in the matter.

**Swansea.**—The Corporation have decided to exercise their option to purchase from Mr. J. S. Brown the electrical installation in the market on March 21. The maintenance will then be undertaken by the borough electrical department.

**Oswestry.**—The Council have approved of the movement for obtaining an extension of the free areas for telephone calls, and that the authorities be requested to form the present Chester, Wrexham, and Holywell areas into one free area.

**Cheltenham.**—The electric lighting question is to be discussed at a special meeting of the Town Council. The matter was postponed at the last meeting, owing, we regret, to the serious illness of Alderman Norman, the chairman of the committee.

**Middlesbrough.**—The recommendation of the Town Hall Sub-Committee, that the sum of £300 be included in the next estimates for lighting the town hall and the main entrance thereto with electricity, has been referred back for further consideration.

**Electric Lighting of Bakehouses.**—One of the conditions on which the Fulham Borough Council grant certificates for underground bakehouses is that such bakehouses must be lighted by electricity. The question came up in a court of law the other day.

**British Insulated and Helsby Cables.**—The directors recommend a final dividend of 4 per cent., making 8 per cent. for 1903;

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also to place £18,500 to depreciation, £5,000 to debenture redemption, £8,500 to special reserve, carrying forward £6,100.

**Darlington.**—The Streets Committee on Tuesday went on an experimental tour. They tested the electric and incandescent lights on one of the centre trolley poles of the tramways, and came to the conclusion to recommend to the Council the adoption of the latter.

**Maidstone.**—The Corporation have received a report from Mr. E. E. Hoadley, borough electrical engineer, going largely into details, in support of which he quotes the report made by the city engineer of Westminster, showing that for equal light arc lighting is cheaper than incandescent.

**Knaresborough.**—Mr. George Wilkinson, engineer to the Harrogate Corporation, has presented a report and estimate of cost on the question of employing the surplus power of the turbine by means of electrical transmission to the gasworks, and the Council will visit the works at Harrogate.

**Weymouth.**—With the object of bringing to the notice of the public the advantages to be gained by the use of electric energy for lighting, heating, and power, the electrical supply department of the Corporation have issued a series of "notes," which are being circulated amongst the would-be consumers.

**Wallasey.**—With regard to our last note on the profit earned by the Corporation electricity undertaking, we are informed that above the amount of £4,700, or, to be exact, £4,727, which was handed over to the relief of rates, £1,000 was allotted to depreciation and renewal fund account, thereby making a total net profit of £5,727.

**Telephone Users' Protection.**—At a recent meeting of the subscribers of the Telephone Users' Protection Association at Manchester, it was resolved that Mr. George Haworth should be asked to allow himself to be appointed chairman of the association, and those present were constituted the committee, with power to add to their number.

**Ayr.**—Extensions to the plant at the electricity station are to be carried out as follows: steam-engine and generators, with foundations, etc., £2,000; switchboard, instruments, cables, etc., £200; pipe work, £250; extras, £50—total, £2,500. Application is also to be made to increase the borrowing powers by £15,000 in view of other extensions.

**Birmingham.**—An enquiry has been held into the application of the Tame and Rea District Drainage Board for sanction to borrow £14,000 for the construction of steam and electrical generating plant and the equipment of an overhead high-tension power transmission line, extending from Saltley to Minworth Greaves, on lands belonging to the Drainage Board.

**Kingswinford.**—The Clerk reported at the last Council meeting that he had received a communication from the electric lighting company, which he thought the Council would agree was satisfactory. There was something which prevented the lamps giving full power, but the company were prepared within a fortnight to give lamps of 32 c.p. and defray the extra cost.

**Stretford.**—As the result of an outbreak of fire caused by an explosion on the 15th inst. at the works of the Stretford Gas Company, a district containing 70,000 or 80,000 people was suddenly plunged into darkness. It appears that from Withington to Barton Bridge, and from Old Trafford to the Altrincham boundary, not a solitary gas-burner would give light.

**Southwark.**—The St. Olave Guardians have agreed to light their institution by means of electricity. An estimate of the cost of installing 845 lights, which amounted to £1,050, has been adopted. The estimated cost of electricity per year is £456. The electric lighting installation of Tanner-street workhouse is to be taken over from the Salisbury Electrical Engineering Company.

**Edinburgh.**—The Electric Lighting Committee's last report shows that from Feb. 11 to March 3 the number of lamps applied for was 4,617, of which 1,736 were for lighting and 2,881 for power, as compared with 2,871 for lighting and 1,462 for power in the corresponding week last year. The total number of applications for the present year is 98,861, as against 64,162 last year.

**Ludlow.**—The Electric Lighting Committee are considering a letter in which the Local Government Board inform the Town Council that the electric lighting scheme, for which the Board was asked to sanction a loan of £8,250 (including a refuse destructor), was incomplete, and that no evidence had been submitted to show that the scheme would be self-supporting. The Board therefore asked the Council to reconsider the matter.

**Falmouth.**—The Corporation have sealed the agreement for the electric lighting scheme, referred to in our issue of Feb. 26. Messrs. Crompton and Co. undertake to complete the supply within 2½ years, and to erect a refuse destructor, and to destroy refuse at 9d. a ton, the Corporation to collect and deliver the refuse, the company paying £50 a year towards the cost. The company are now only waiting for a suitable site.

**Cardiff.**—Alderman P. W. Carey, chairman of the Electrical and Lighting Committee of the Corporation, has compiled an interesting summary of the last five completed years' working of the Cardiff electric lighting undertaking, in which he gives, *inter alia*, the following figures: net result of five years' working to March, 1903, £1,913. 4s. 9d. surplus; total redemption fund, £12,037. 4s. 6d.; and total reserve fund, £2,210. 6s.

**Horsham.**—Now that the electric light extensions are nearly completed, the Urban Council have amended their charges. A free-wiring scheme has been formulated by the electrical engineer, Mr. Morgan, and will probably be put in force shortly. The amended scale of charges is as follows: (1) for all units in excess of the first hour's daily average use of the maximum demand, 3d. per unit instead of 5d.; (2) for places of worship a uniform rate of 5d. per unit for all units consumed; (3) that no charges be made for the hire of meters.

**Colliery Plant and Bridges.**—Messrs. Graham, Morton, and Co., Limited, Hunslet, Leeds, report the receipt of a large order for a complete coal-screening plant, including the whole of the steel structural buildings, roofing, picking belts, tipplers, etc., having a capacity of 3,000 tons per day. This plant is for the Kilnhurst Pit, Rotherham. They also report contracts for nine bridges for the G.N.R. Co. and of two bridges for the S.E. and C.R. Co.

**Carlisle.**—The Town Council have adopted a resolution to the effect that the present charges for electric current for lighting purposes be continued, but that the Electricity Committee may make special charges in cases where they are of opinion that to do so would be to the advantage of the consumer and the undertaking. The cable is to be extended from its present termination on Irish Gate Brow to Caldcotes, Caldewgate, at an estimated cost of £430.

**Spain.**—The Palacios y Garcia Company and the Marquez y Plá Company have obtained the concession for an appropriation of 15,500 litres of water per second from the River Segre, 370m. above the mouth of the la Femosa River. The concessionaires have to return the water which they take for their industry, in the same state of purity in which they took it, 40m. above the dam established in the municipal boundary of Serós for taking water for the mill of Lladella.

**Bournemouth.**—An electrical exhibition is being held at the Hotel Mont Dore annexe and winter gardens. All the latest novelties in connection with electricity as applied to our daily requirements are on show, embodying the latest ideas in lighting, heating, and motive power. Amongst the special attractions we note representations of apartments on the hospital ship "Maine" and on the "Victoria and Albert." Demonstrations are given of the application of high-frequency currents and X-ray apparatus.

**Swansea Telephones.**—The National Telephone Company claim that their work at Swansea during the past seven months has met with unprecedented success, and that they have received the following orders for new and additional telephones: August, 55; September, 56; October, 96; November, 159; December, 127; January, 921; February, 85. This makes a total of 670 for the seven months, or an average of 96. But is it not a fact that this effect is due to a considerable reduction in the charges?

**Beckenham.**—The following extensions of cable have been agreed to: The Knoll, estimated cost £55; Barnmead-road, estimated cost £30; South Eden-park (the owner having given an undertaking to pay 20 per cent. on the cost of the cable, £550, for five years). The terms on which Mr. R. P. Wilson agreed to carry through the transfer of the Crystal Palace electric lighting district to the Beckenham station, and to act as consulting engineer for the extension of the plant and machinery for tramway purposes have been accepted.

**Wirral.**—At the last Rural District Council meeting the question of opposing the Cheshire Electricity and Power-Gas Bill was discussed. The engineer was of opinion that the company promoting the Bill would not find it worth their while laying down power gas in the Council's district unless a number of small works arose. It was different as to electricity, as small companies might arise and would be supplied by the company, while in houses of moderate size people would require electric lighting if it was possible to obtain it. It was decided to take no action.

**Woking.**—The Sanitary and Lighting Committee reported to the last Urban District Council meeting that Dr. Ri leal had tested the electric light and found the pressure to be: central station, 200 volts; ditto, 100-volt circuit, 101; town sub-station, 202; Sinton's sub-station, 200; Percy-street sub-station, 203. On his report the committee recommended that the electric supply company be called on to erect at their central station a new standard instrument reading to 220 volts, and to place a suitable voltmeter at the town sub-station. A portable voltometer would be used at the other sub-stations, of which there were about 50.

**Wrexham.**—The borough surveyor and the electrical engineer in a recent report recommend that a new hopper, with a capacity of 1,240 cubic feet, as compared with 787 cubic feet in the present form, be purchased. By this means they would be able to dispense with the services of one man during the whole year, and of two men a portion of the year, and so effect a saving of about £70 per annum. The Council decided to have a specification for the hopper prepared and tenders advertised for. The surveyor and electrical engineer have been requested to prepare a joint report on the subject of the fumes emitted by the refuse destructor.

**Electric Lighting Profits.**—In comparing the dividends paid during the last two years by the 13 big electric lighting companies of the Metropolis, we find that seven out of that number have paid increased dividends for the year 1903. The dividends range from 3 to 14½ per cent., and the yield at the present market price works out from 4⅛ to 6½ per cent. As in most cases, the increase in the net profits was comparatively small, the result is obviously satisfactory to the shareholders. Only one company paid a smaller dividend in 1903 than in the preceding year; on the other hand, the increases in several cases amounted to 1½ to 2 per cent.

**Hampton.**—We understand that in consequence of the tender from the Twickenham and Teddington Electric Supply Company for lighting the street lamps, the company have been asked to place electric lights in the lanterns in Burton's-road, in which oil lamps are at present used, for trial purposes, and that the Council will give the Hampton Court Gas Company notice to determine the contract for street-lighting at the end of September. A site of the company's proposed sub-station in this district has been approved. The company have deposited £200 with the Council before proceeding to open the roads in this district for the purpose of laying their mains.

**Portsmouth.**—The recent partial failures in the electric light are said to be due to the insufficiency of the supply of sea-water for the condensers of the engines in the station. The water is pumped through pipes which run from the station past the Camber dry dock to

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the water's edge, where they dip into the sea. At the dead low tides of March and September difficulties have regularly manifested themselves, and now that the station has grown so much, the pumping and delivery power is insufficient to meet the demand of 400,000 gallons an hour that the engines need for efficient working. The "left" registered at dead low tide is very great, while the pipes cannot, it is thought, be put lower owing to the mud in the Camber. Messrs. Kincaid, Waller, Manville, and Dawson, who originally designed the station, are being consulted in the matter.

**London Gazette.**—The first meeting in the estate of Percy James Murley, lately fire-alarm contractor, now electrical engineers' manager, 132, Spencer-place, Leeds, lately of 18, Park-row, Leeds, and 26, Brook-street, Bradford, will be held at 11 a.m. on March 23 at 22, Park-row, Leeds. The Tramways and General Appliance Company, Limited, will be wound up voluntarily, and Mr. H. C. Lewis has been appointed liquidator. A petition presented to the Chancery Court of Liverpool district for confirming special resolutions reducing the capital of the Blackpool Electric Tramways (South), Limited, from £350,000 (of which £250,000 has been issued) to £100,000, will be heard at St. George's Hall, Liverpool, on March 21 at 10.30 a.m. A winding-up order has been made on the 8th in the estate of the Electric Timber Seasoning and Preservation Company, Limited, 65-66, Chancery-lane.

**Lowestoft.**—The matter of the supply of electricity to Oulton Broad has been considered by the Electric Lighting Committee and deferred for the present. The resident electrical engineer has reported that during the past month two new consumers were connected to the mains, representing 121 8-c.p. lamps. There are now connected to the mains 464 consumers, representing 22,819 8-c.p. lamps. Several services have been put in, though not yet connected. A store is to be built at the works at a cost not exceeding £200, and the cost will be equally divided between the electric lighting and tramways undertaking; the proportion to be paid by the electric lighting undertaking is to be paid out of revenue. London-road South from Kirkley Park-road to the borough boundary is to be lighted with 11 32-c.p. electric incandescent lamps at £2. 18s. per lamp per annum, equalling £31. 18s.

**Aberdeen.**—In our last issue we noted that the Council had decided to give the National Telephone Company leave to lay wires underground. The full resolution reads as follows: "That the committee recommend the Town Council to enter into an agreement with the National Telephone Company, under which permission would be granted to the company to lay underground telephone cables and wires in the streets, the lines of the agreement to be similar to those contained in the company's agreement with the Corporation of Edinburgh, subject to such modifications as may be afterwards arranged; the scale of charges to subscribers and the annual payments and rebate to the Town Council to be as specified in the town clerk's letter of Jan. 21, except as regards (*a*) the number of calls under the measured service, which is to be reduced to 1,500; and (*b*) the charge for a four-party line, which is to be reduced to £4 per subscriber per annum for unlimited service."

**Inquest.**—An inquest was held on Tuesday into the death of Edgar Philip Furlonger, aged 15, who was employed as a cleaning boy at the London Electric Supply Company's works. It appears that on March 4 a lineman was disconnecting a transformer in the company's station, when he heard the noise of the current passing. On looking out he saw a flash come from the terminal in the corner of the room, and saw the boy in the midst of the flame. The doctor was at once sent for, and in the meantime artificial respiration was resorted to, and deceased recovered consciousness. He was taken to Guy's Hospital, where he died, after one arm and both legs had been removed, the limbs being already dead. It was shown that the deceased had no right to be where he was, and that all care had been taken. The current was about 10,000 volts. The jury returned a verdict of accidental death, and suggested that, if possible, the terminals on which the boy seemed to have laid his hand should be guarded.

**Lytham.**—At a meeting of the executives of the Lytham Ratepayers' Association, the Ratepayers' Union (No. 2), and the Tradesmen's Association last week, the scheme for the lighting of the town by electricity was discussed. The following resolution was carried: "This meeting considers that the means at present adopted by the Council will get an unfair and inadequate expression of opinion from the town, and is of opinion that it is desirable that a public meeting should be called, at which the Council should give a fair idea of what their scheme would be in order to provide electric lighting for Lytham, the probable cost, and that a poll be afterwards taken if the public meeting so desires." The Council have issued poll-papers containing the two following questions: "Are you in favour of the provisions of the electric light order being carried out? and are you prepared to take a supply?" The cost of the scheme is between £30,000 and £40,000. The action of the Council in not calling a public meeting was adversely commented upon.

**Ryde.**—The Town Council have adopted a report of the Electric Lighting Committee stating that, after the opening of the electric light station, a report was received from the consulting electrical engineer informing them that the works had been practically completed, that he had inspected the same with reference to nuisances, but that he could not detect at the time of his inspection anything which he considered detrimental to health, or in other respects appreciable. The committee quoted the following clause from the agreement with the company: "The company shall indemnify the Corporation against any liability which the Corporation may have under or in connection with the order, and shall strictly observe all the provisions, conditions, and restrictions of the order, and shall be responsible to the Corporation in respect of all liabilities and claims as if the company were the owners of the order." As the appointment of Mr. J. G. W. Aldridge as consulting engineer had terminated, they recommended that they be empowered to consult him from time to time if necessary.

**St. Marylebone Electric Lighting Bill.**—The Electric Lighting Bill promoted by the Borough Council was considered on Tuesday by the Standing Orders Committee of the House of Commons on the question of non-compliance with the Standing Orders in regard to an additional provision which it was sought to introduce into the Bill to enable the Borough Council to enter into working agreements with any company in connection with the electric light undertaking in St. Marylebone. When the matter came before Mr. Jeune, one of the examiners, last week, it was opposed by the Gaslight and Coke Company on the ground that the parliamentary notices in relation to the Bill did not enumerate the proposal contained in the provision as one of the objects of the Bill, or indicate that there was any intention to apply for such a provision. The examiner held that the Standing Orders had not been complied with, and the promoters thereupon appealed to the Standing Orders Committee. The committee decided that the Standing Orders might be dispensed with, so that the additional provision might be incorporated in the Bill.

**Linolite.**—At Mr. Charles Capper's annual musical and dramatic entertainment on Monday at the Caxton Hall (late Westminster Town Hall), we had an ocular demonstration of the advantages of the new patent (A. W. Bentell's) linolite system, which has been used in the footlights and in the hall and passages. The installation was laid down by the Linolite Company, of 47, Victoria-street, S.W. We have described the system before, and can only repeat that the company's claim that the effect is neat, simple, compact, effective, and efficient was fully borne out on Monday. The lights under the balcony were arranged in groups of four, and the light was brilliant in the extreme without being glaring, the soft effect being somewhat as if the rays were shielded by panels of frosted glass. The graceful lightness and the simplicity of the arrangement were well apparent. We are informed that since the recent issue of the second edition of their catalogue the company have delivered 200ft. of linolite to Admiral Fisher, 100ft. to Claridge's Hotel, 130ft. to the Earl of Scarborough, 200ft. to the New Savoy Hotel, and 286ft. to Lewis's, of Liverpool.

**Ashton.**—Lamps are to be fixed on alternate traction poles on Manchester-road and Stalybridge-road. The offer of the Electricity Committee to accept 2d. per unit for current consumed for street-lighting purposes, to date from March 25, has been accepted, and the Electricity Committee have been requested to state what sum per annum per lamp they would be prepared to accept for supplying current, carbons, globes, and all other material and labour required in connection with the lighting of the existing and proposed arc lamps. These lamps are of the enclosed twin-carbon type, each burning direct off the distributing main. They are fixed on alternate poles, or approximately 80 yards apart, but they take 0·72 unit each per hour instead of 0·60, which were reckoned on last year. The Works Sub-Committee have been empowered to dispose of three Ledward ejector condensers, provided the price obtainable is, in their opinion, a reasonable one. The rate for electricity supplied to the theatre, Oldham-road, has been fixed at 3d. per unit after the completion of the present quarter, and the same rate will be offered to other places of amusement.

**King's Lynn.**—The borough electrical engineer in his last report stated that applications from private consumers were received during the month for 369 additional lamps of 8-c.p., making a total of 18,408 lamps and 449 consumers, and that current for one 12-h.p. motor applied for. The engineer also submitted the following statement: units generated, January, 1904, 54,239 (1903, 49,580); units sold to private consumers (light and power, 28,271 (20,211); units sold at power rates, 8,063 (3 587); cost of fuel, stores, repairs, and wages at station, £156. 9s. 10d. (£139. 13s. 8d.); cost of units generated, 0·692d. (0·675d); wages of lamp lighters and outside staff, £22. 10s. 7d. (£24. 14s. 1d.). The committee have placed on record their high appreciation of the services rendered by the town clerk, the electrical engineer, and the borough accountant at the recent Local Government Board enquiry. Mr. T. Brown's motion, "That in order to avoid raising an additional loan of £11,500 for electric lighting purposes, the gas company be invited to tender for lighting such parts of the borough as the Streets Committee may select, and thus liberate for private lighting the current thereby set free," was discussed at the last Council meeting and defeated by 17 to 6.

**Glasgow.**—The financial year of the Corporation electricity department, which began on June 1, has been most successful, and promises well for the remainder of the term. It has therefore been decided to authorise the treasurer to repay to the gas department the sum of £13,895. 6s. 1d., being the deficit on the operations for the year ending May 31, 1903, which was transferred to the gas account, in terms of the Glasgow Corporation Electric Lighting Order, 1890. The large deficit referred to arose in very exceptional circumstances. While the machinery in the original electric lighting station in Waterloo-street was not antiquated, the various engines and dynamos were too small to be of practical use in dealing with the great increase of work which had devolved upon the department. It was, therefore, found to be more profitable to remove that machinery and have power generated in the large new station at Port-Dundas, where there are all the most modern appliances for carrying on the work in the most efficient and economical manner. The abolition of the Waterloo-street machinery involved a loss of about £8 000. Further, the change from the lower voltage of 100 to the higher one of 250 cost the committee during the three years which ended last May the large sum of £20,000. This expenditure will not, of course, occur again, as with very few exceptions the change is now complete to the higher voltage.

**Aston.**—At a specially convened meeting of the Borough Council on the 17th a report of the Electricity Committee recommending an extension of the electric power station was considered. The station was only opened on Sept. 30 last year, and the committee are advised that the present plant is altogether inadequate to cope with the increased demand. The existing plant consists of two 500-kw. and one 200-kw. steam dynamo, six water-tube boilers having a total

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evaporation of 40 000lb. of water per hour, two Boby detartarisers capable of softening 6,800 gallons of water per hour, and four boiler feed pumps capable of delivering to the boilers 6,800 gallons of water per hour. There are 202 services laid (consumers connected), being equivalent to 8,716 8-c.p. lamps connected. The maximum demand up to Feb. 18 was 270 kw. The 200-kw. generator, therefore, is too small for this peak load. The maximum demand for traction is 176 kw., therefore the 200-kw. generator will do the present traction load. The number of applications in hand in excess of those already connected is for 160 consumers, being an equivalent to 10 581 8-c.p. lamps. Assuming an equal load factor to lamps already connected, a total maximum demand of 575 kw. is obtained, and this is a larger current than one of the 500-kw generators will give out. The Council has arranged to supply current to the British Electric Traction Company, Limited, for the running of the Aston trams, and the committee is informed that the company intend to have about 20 cars on circuit regularly and about 40 cars on football and other special days. On the latter occasions two generators will be required on traction. The 200-kw. machine is too small for the present lighting load and placing aside the necessity for stand-by plant, the existing machines will not be sufficient to meet the demand for current which already exists. The committee recommend the extension of the station and plant at a cost of £30,000, as follows: one 750-kw. steam dynamo, £8,000; two water-tube boilers, mechanical stokers, and superheaters, £3,200; extension of coal bunker and conveyor, £1,500; one ejector, condenser, pipework, circulating tank, etc., £1 500; steam piping, £1,050; new generator panel on switchboard and cables to steam dynamo, £650; extension to existing main and 200 extra services, motors, and time switches, £5,600; extension to buildings, £8,500—£30,000.

**Leicester.**—On Tuesday the Town Council adopted a report relating to the electric lighting department, in which it was stated that the capital account stood at £212,450, £9,223 of which was spent during the half-year. Councillor Edwards said that the authorised capital at the end of the year was £164,974, but an application had been made to the Local Government Board for permission for an additional capital of £100,000, and had their permission to raise it. The committee had spent on generation £3,773, an increase of £500; for distribution they had spent £717, for rates and taxes £1,648, an increase of £568; and management £647, an increase of £214—bad debts £15. The total expenditure had been £6,801, an increase of £1,503. On the credit side they had for the sale of current £14,968, an increase of £2,052. They had received £555 for meter rents, and £153 from profit on fittings. The total income was £15,676, from which they took their expenditure, and that left them with a profit to carry to profit and loss of £8,874. Interest was £3,380 and sinking fund £2 545, which left them with a net profit of £2,948, an increase of £262 for the half-year. They had an accumulated profit of £6,801, which, with the profit of the half-year, left them with an accumulated profit of £9,750. But they had spent some of this during the half-year on things they could not raise capital on. They had the misfortune to have the switchboard at the town office burnt, and that cost £1,030, and they had written it off. They had spent £854 on renewal of meters, and £1,358 in the relaying of a trunk cable which was worn out. They had spent £3,242, or some £300 more than the profit, leaving them with a capital to carry forward of £6,507. He thought the Council would agree that the policy of carrying forward their profits was a wise one. They had no idea as to the length of life of machinery and plant, and they would have had to come upon the rates if they had not had the reserve to, for instance, pay the expenses of the past year. The department generally was very successful. The consumption of light was going up by leaps and bounds. The increase was something like 25 per cent. upon the year. Altogether the department was thoroughly sound and successful. During the discussion the chairman pointed out that their profits were comparatively small, and said he did not think that this was the time when the committee could give any further concessions to the consumers of electric light. Seeing, too, that the price of electric light had been reduced they could not give free meters as well.

**Fulham.** — Having received complaints with regard to the insufficiency of the lighting of that part of Avonmore-road at present lighted by gas, the Electric Light Committee recommend that the part of Avonmore-road at present lighted by gas be lighted by electric arc lamps at an average distance apart of 75 yards, and that the borough electrical engineer be instructed to carry out the work of supplying and connecting the lamps and cables at an estimated cost of £190. The committee have also had under consideration a reference from the Works Committee as to lighting the entrance to South Park, Fulham, and the lodge by Peterborough-road by electric light. They consider that to do this will involve the laying of a considerable length of cable, and propose that the opportunity should be taken of lighting Olancarty-road with incandescent electric lamps as part of the trial authorised by the Council. They recommend (*a*) that the borough electrical engineer be instructed to have cable and two-way ducts laid in Olancarty-road at an estimated cost of £202. 10s., and that six of the trial incandescent or "Nernst" electric lamps be fitted in that road in lieu of the present gas lamps; (*b*) that such mains be extended for the purpose of lighting the entrance gates to the South Park, Fulham, and lodge at an estimated cost of £25, and that the borough electrical engineer be instructed to carry out the work. The committee further say: "In October, 1903, the Council decided to have sub-stations constructed in North End-road by Tournay-road, and in the vicinity of the town hall, and entered into a contract with Messrs. Windsor and Co. for the carrying out of the work at a cost of £520. In view of the possibility of the engine-room at the Granville Theatre being leased by the Council, the work in connection with the sub-station in the vicinity of the town hall has not been put in hand, and even if arrangements cannot be made for the use of the engine-room, it is possible that a sub-station in the space outside the London and Provincial Bank will be constructed and render the one by the town hall unnecessary. In connection with the Crabtree-lane extension authorised by the Council, a sub-station exactly similar to the proposed one by the town hall is required, and the borough electrical engineer suggests that Messrs. Windsor and Co. should be requested to construct the sub-station in Crabtree-lane instead of by the town hall. We agree with the borough electrical engineer's suggestion, and recommend that Messrs. Windsor and Co. be requested to construct the second sub-station referred to in their contract (A) with this Council in Crabtree-lane instead of in the vicinity of the town hall." The cost of this work (£260) is already provided for in the estimates.

**Hastings**—Commenting upon some observations made by the chairman of the gas company at last week's meeting of shareholders, the *Hastings Observer* says that the offer made by the Corporation, and by the acceptance of which Dr. Gray contended the ratepayers would have effected a saving of £1,000 a year, was to light by electric light the whole of the existing Corporation electric light lamps by electricity generated by gas The offer was contained in a letter sent to the town clerk in October, 1901, by Mr. Botley, the gas company's manager. In this communication appeared the following: "With a view to extending the use of gas and in order to reduce the cost to the ratepayers (of which we are the largest) I beg to state that I am, on behalf of my company, prepared to guarantee by gas power, and deliver to the heads of the Corporation in the vicinity of these works, electric current of suitable frequency and tension for supplying the arc lamps on the parade, and under agreement at the rate or equivalent of 70 cubic feet of gas per Board of Trade unit, which is equal to, say, 2½d. per unit. The front lamps, I understand, require about 123,000 units of electricity per annum, and this quantity at the price I have named, will cost £1,291. 10s. In the year 1899 I find current for these lamps was charged at £2,377, and last year similar current was charged at £2,443. Under these circumstances my offer shows a clear saving to the Corporation, and therefore to the ratepayers, of practically £1,120 per annum, besides which there are the dues, etc., on coal used to produce the gas. This saving of £1,120 per annum represents, I believe, nearly a ¾d. rate on the borough, and will therefore, I trust, commend my offer to the serious consideration of the Council in the general interest of the public. I need scarcely say I shall be pleased to give any further particulars, and should be quite willing to consider the supplying of energy for all public buildings now using electricity." Our contemporary understands that this letter did come before the Lighting Committee, but that it was never considered publicly by the Council, and says that an authority on the question, in giving some particulars from the point of view of the gas directors, says that since this offer was made the circumstance have materially altered, because at that time there were only 53 public electric arc lamps along the front line. "These," he added, "the Corporation were charging at the rate of £50 each per annum, or a total of £2,650 per annum, as against £25 per lamp per annum (or exactly half) which they formerly paid to the electric light company. It is only fair to remark that the latter price did not pay the company, but on the other hand, when the Corporation had to take these lamps over, the scheme prepared stated that the total cost, including everything and with a special station for the purpose, would be only £35 per lamp per annum. Subsequently 51 additional arc lamps were erected, in consequence of a scheme prepared and passed by the Council, which stated that these lamps would cost £676. 5s. 10d. per annum, in place of gas costing £649. 16s. 4d." Pointing to an account, our informant showed that the fulfilment of the scheme cost the ratepayers £1,482. 16s., instead of the estimated £676. 5s. 10d.! The amount of the estimate was duly given in the *Observer* at the time it was passed by the Council, and the actual cost is recorded in the Corporation year-book. Our informant added: "Last year you will find the cost of public electric lighting for the 104 lamps was £4,029, and there are four miles of streets lighted, so this is over £1,000 per mile, or nearly £40 per lamp per annum, and some of the lamps only burn to midnight along the front line, and others about the town have two incandescents after midnight. I may add that the current was offered at 2½d. per unit, and although, owing to the offer, the charges on the front line lamps have been reduced somewhat, ever since then the current has been charged at an average of more than 2½d. Last year, for instance, it works out at 2·87d., so that there would be a considerable saving even now, apart from the fact that the public buildings lighted by electricity under the offer could have had current at the same rate, whereas, of course, they are now charged as private consumers."

**Islington.**—The Council have authorised the conversion of the mains in High-street from a two-wire, 100 volts, to a three-wire, 100 volt system between Duncan-street and Torrens-street, including new ducts, at a cost of £274: and from St. Paul's-road to Northampton Works, along St. Paul's-place and Northampton-park, at a cost of £214. Complaints having been received from consumers in High-street that the pressure of supply is below the standard, the committee report that investigation has shown that there is some ground for the statements made so far as regards that portion of High-street between the Grand Theatre and the corner opposite the Angel. Owing to the traffic along the frontage and to the congested state of the subsoil below the footway, they consider it not advisable to attempt to place additional boxes or apparatus in connection with electric lighting in the ground, except at the ends of the section—namely, Torrens-street, City-road, and Duncan-street. They say it appears that the most satisfactory mode of dealing with the supply (especially as a considerable portion of it consists of arc lamps) would be to retain the 100 volts declared pressure, but to supply on a three-wire instead of a two-wire system. This will involve the laying of an additional main for balancing purposes, the cable for which can be taken from stock. When the ground is open for the purpose of laying this main we propose to lay ducts into which the whole of the cables can be drawn, thus increasing their durability and making it an easy matter to effect repairs at any future time, should such be necessary, without seriously interfering with the

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paving of the footway. Owing to the increase of motor load in Northampton-park, the pressure at the ends of the distributing mains laid from Essex-road is considerably below the declared value. These mains when laid pursuant to a statutory requisition were of ample size to give the supply required by such requisition, but conduits were provided for extensions to be made as and when required. As the motor load contemplated has now increased more than three times, it is necessary to make arrangements to deal with it; and as high-tension mains have not yet been laid along along St. Paul's-road, the most satisfactory and economical method of increasing the supply will be to convert this section from a 200-volt two-wire system to a 200-volt three-wire system, which can be done by drawing in additional cable taken from stock into existing conduits. On the recommendation of the Lighting Committee, the Council at their last meeting adopted the following recommendation and authorised the necessary expenditure: 'With a view to reducing the time required to ascertain the position of and remove faults on street arc lighting circuits in Upper Holloway-road, Archway-road, Highgate-hill, and Junction-road, and to enable high-tension current to be handled with greater safety than at present, it is desirable that controlling or sectioning pillars be provided at a point where the circuits leave Holloway-road for the roads mentioned, at a cost of £170. This will greatly add to the ease of working the system and reduce the liability of lamps being extinguished." The special committee *re* wages and overtime at the electric lighting station at Eden-grove reported: "We have considered the memorials submitted to the Council on Oct. 2, 1903, by deputations from the Islington Trades and Labour Council, the Amalgamated Society of Carpenters and Joiners, the Operative Bricklayers' Society, and the Gas Workers and General Labourers' Union with reference to the effect of the resolutions of the Council of Aug. 7 last on certain employés at the electric lighting station. The memorials raise the question how far the Council by their resolutions of Aug. 7, 1903, have departed from the requirements of Standing Order 49 as regards the trades union rates of wages, and imply further that the spirit, if not the letter, of the standing order in question has been infringed by the resolutions of the same date abolishing 'dirty money,' the supply of overalls, etc. We recognise the fact that the Council, in adopting the report of the late special committee, and passing the resolutions in question, were mainly actuated by a desire to do away with the abuse of overtime, and were of opinion that, in altering the conditions upon which up to then the men at the electric lighting tation had been engaged, they were giving them more than a *quid pro quo* in the shape of a weekly engagement and other advantages; but we are satisfied that by some inadvertence the rate of pay for carpenters and bricklayers was fixed at ½d. per hour less than the proper rate of wages, and are also of opinion that the 'dirty money' and overalls should be restored to the men concerned." The committee recommended: "(*a*) That the resolutions of the Council of Aug. 7, 1903, in so far as they relate to the payment of 'dirty money,' the supply of overalls, and to the wages, hours, and conditions of labour of carpenters, bricklayers, and labourers engaged at the electric lighting station be rescinded; (*b*) that one hour per day be allowed to men employed in cleaning flues, boilers, heaters, etc., when working out of daylight and in a cramped position; (*c*) that one suit of overalls and one additional pair of trousers be allowed annually to men continuously employed as above; (*d*) that the one carpenter and one bricklayer in the electric lighting department be engaged at the hours and rates of pay as agreed to by the employers' associations and trades unions or as in practice obtain." The recommendations were adopted.

## PROVISIONAL PATENTS, 1904.

MARCH 7.

**519. Improvements in flexible continuous covering for the ploughway of electric conduit system and apparatus on cars for manipulating the said covering.** Thomas Thornton Dewhirst and James Gurney, 8, Coleraine-road, Blackheath.

**5566. Improvements in coils for electrical machines.** Isaac De Kaiser, the Westinghouse Patent Bureau Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 1, 1903, being date of application in United States.) (Complete specification.)

**5566. Improvements in joints or connections for wires or conductors of electrical energy for telephonic and other uses and in apparatus employed therein.** William Heatley, 55, Chancery-lane, London.

**5582. Improvements in connection with electrostatic watt-meters or watt-hour meters.** Ernest Wilson, 64, St. John's-park, Blackheath.

MARCH 8.

**5620. Improvements in junction boxes for electric wiring.** Frank Muirhead, 65, Chancery-lane, London.

**5630. Improvements in gas or electrical fittings.** John Solari, 80, Regent-street, St. Thomas, Exeter.

**5634. Improved switch point and "frog" for the overhead equipment of electrical traction.** James Bonthrone, 10, St. George's-crescent, Liverpool.

**5646. Improvements in electric and other lamps.** Richard Böhm, 5, Boxworth-grove, Richmond-road, Barnsbury, London.

**5649. An improvement in plating aluminium or its alloys with a metal or metallic alloy by electrolysis.** Richard Beauchamp Wheatley, 115, Hungerford-road, London.

**5663. Annunciators for electric bells and the like.** Hans Henning, 55, Chancery-lane, London. (Complete specification.)

**5664. An improved base or wall block to facilitate the erection of electric light fixture and provide better insulation at their bases.** John William Ewart, Surrey House, Chiltern-road, Wendover, Bucks.

**5670. Improvements in holders for electric incandescent lamps.** Ernest Bristow Skinner, St. Olave's Workhouse, Ladywell, London.

**5678. Improvements relating to electric conductors or cables.** Sidney George Brown, 7, Southampton-buildings, Chancery-lane, London.

**5688. Improvements in apparatus for producing reactions in gases by means of electricity.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Badische Anilin und Soda Fabrik, Germany.)

**5714. Improvements in fittings of electroliers, wall brackets, and the like used in electric wiring.** Albert Henry Wheeler, 322, High Holborn, London. (Frank Armonde Wheeler, Natal.)

**5731. Improvements in electrical regulating devices applicable to clocks.** Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Actiengesellschaft "Magneta" Eletrische Uhren ohne Batterie und ohne Contacte, Switzerland.)

MARCH 9.

**5758. Improvements in or relating to electric cable conductors.** William Ernest Hitch, 14, Abbey-road, Oxford

**5768. Improved automatic cut-out for electric trolley wires and the like.** John Woodward, 14, Ludlow-street, off Green-road, Leeds.

**5773. Improvements in plough or collector gears for electric conduit tramways.** Paul Traugott Julius Estler, 52, Chancery-lane, London.

**5786. Improvements in and relating to luminous gas or vapour electric lamps.** The British Thomson-Houston Company, Limited, and Ernest Schattner, 83, Cannon-street, London.

**5799. Improved electrical apparatus for separating coke from cinders and other substances.** Henri Lelarge, Fife House, Kingston-on-Thames. (Complete specification.)

**5803. Improvements in and relating to electric motors.** Mavor and Coulson, Limited, and Henry Alexander Mavor, 46, Lincoln's-inn-fields, London.

**5804. Improvements in and relating to the electrical firing apparatus for internal-combustion explosion engines.** Kenric James McMullen, 323, High Holborn, London.

**5824. An improved electric igniter for explosion motors.** Hermann Luthi, 40, Chancery-lane, London. (Complete specification.)

**5826. Improvements in electric arc lamps.** William James Davy, 40, Chancery-lane, London.

MARCH 10.

**5846. An improved electrical annunciator and relay.** Alfred Charles Brown, 7, Queen's-square, Finsbury-avenue, London.

**5860. An improved electric lampholder.** Hugo Hirst and John Hillery Collings, 71, Queen Victoria-street, London.

**5861. Improved insulating linings for covers or containers for electrical apparatus.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

**5879. Improvements in or relating to electric fittings and the like.** Harry Riley Webb, 2, Church-gate, Nottingham.

**5892. Improvements in or relating to electric lamps of the character known as vapour lamps.** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**5914. An electric pocket lamp, cigar, cigarette, and gas lighter combined.** Sigi Kraus, 28, Burgstrasse, Berlin, Germany. (Complete specification.)

**5921. Improvements in electric melting furnaces.** La Société Anonyme l'Industrie Verrière et ses dérivés, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, March 21, 1903, being date of application in Belgium.) (Complete specification.)

**5926. Improvements in and relating to electric motors.** Mavor and Coulson, Limited, and Henry Alexander Mavor, 46, Lincoln's-inn-fields, London.

**5931. Improvements in connectors for electric conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

MARCH 11.

**5983. Improvements in apparatus for starting and controlling electromotors.** Ben Nelson Dadge, 34, Castle-street, Liverpool.

**5996. Improvements in or relating to electric contact breakers or interrupters for induction coils.** Harry William Charles Cox and Frederick Butt, 10, Cursitor-street, Chancery-lane, London.

**5998. Improvements in and relating to electro-capillary relays.** James Tarbotton Armstrong and Axel Orling, 61, Chancery-lane, London.

**6013. Improvements in asynchronous motors.** Georges Meller, 7, Southampton-buildings, Chancery-lane, London.

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**6006. Improvements in or relating to electric motor starting and controlling gear.** Bertram Clough Williams-Ellis, Sonning Cottage, Thames Ditton, Surrey.

**6030. Improvements in and connected with telephone systems.** George Ernest Parker and Matthew Atkinson Adam, 18, Southampton-buildings, Chancery-lane, London.

**6035. Improvements in clips for attaching pipes, electric cables, or the like, to walls or other fixtures.** Frederick Tyers, 111, Hatton-garden, London.

**6036. Improvements in and relating to tubular electric resistances.** The British Thomson-Houston Company, Limited, Edwin Joseph Murphy, and Harry Wiathrop Turner, 83, Cannon-street, London.

**6037. Improvements in apparatus for producing high vacua.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6038. Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6039. Improvements in controlling valves for air and other pressure systms.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6040. Improvements in electric arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**6041. Improvements in electric arc lamys.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**6042. Improvements in electric arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

MARCH 12.

**6068. Improvements in methods of controlling the voltage under conditions of varying speeds and varying resistances for railway carriage lighting and all power and lighting under conditions of varying speeds and demands.** Leonard James Aron, 104, Colmore-row, Birmingham.

**6076. Improvements in telephone receivers which may be also used as telephone transmitters.** Alexander Marr, 19, Cawdor-road, Fallowfield, Manchester.

**6104. Improvements in electric contact breakers or tremblers.** John Crisp Fuller and George Fuller, 33, Chancery-lane, London.

**6110. Improvements in and relating to electric arc lamps.** Charles Edwin Foster, Edwin Rudolf Grote, and Milton Victor Ely, Palace-chambers, Westminster, London.

**6116. Improvements in electrical apparatus for aiming and shooting practice.** Franz Walloch and the firm of C. Lorenz, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 21, 1903, being date of application in Germany.) (Complete specification.)

**6117. Improved construction of clip or holder for electric fuse wires and their insulator casings.** Marcus Pulvermacher, 173, Fleet-street, London.

**6126. Improvements in variable-speed dynamos.** Henry Leitner Lynton, Dartnell-park, Byfleet, Surrey.

**6132. Improvements in electric accumulators.** Henri Contal, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, March 24, 1903, being date of application in France.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 31, 1904.*

1903.

**2928. Electric tramway systems.** Zuppinger.

**5150. Contact breakers for induction or sparking coils and the like.** Sanders.

**5170. Electric motor-control systems.** Carolan. (General Electric Company.)

**5289. Rotary fans for cooling dynamos and other machines and for other purposes.** Carolan. (General Electric Company.)

**5292. Electric train-control systems.** Carolan. (General Electric Company.)

**5494. Electric motors and regulating devices for railway trains or vehicles actuated by electrical energy.** Raworth.

**5561. Dynamo-electric machines.** Porsche.

**6784. Voltage regulators for use in charging storage batteries.** Le Blanc.

**7141. Alternating electric current motors.** Carolan. (General Electric Company.)

**7142. Electric metering systems.** Carolan. (General Electric Company.)

**7910. Apparatus for automatically operating the track and conductor switch points of electric tramway systems.** Hartley and Grenwood.

**7676. Telephonic systems and the disposition of the apparatus employed therein.** Wilson.

**8292. Typewriting telegraph receiving instruments.** Steljes and Typewriting Telegraph Corporation, Limited.

**9324. Electromagnets and armatures for use with bells, indicators, and the like, and for other purposes.** Parsons.

**9382. Electric lifts.** Edwin Charles Stevens and Percy Herbert Stevens, executors of the late John Sanders Stevens, deceased, Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens.

**9869. Devices for detecting high voltage in electrical circuits and apparatus.** Carolan. (General Elecric Company.)

**12578. Electric dry battery adapted to be used in connection with hat or head bands.** Gessmann.

**17721. Coin-freed electricity meters.** Beaumont.

**22673. Regulating dynamos, motors, and like electric machines.** Müller.

**23290. Wave telegraphy.** Fessenden.

1904.

**1296. Electrical ignition apparatus for internal-combustion engines.** Postans.

**1349. Electromagnetic clutch, speed varying, and brake mechanism.** Fairweather. (Arnold Magnetic Clutch Company.)

**1714. Electrical signalling apparatus.** Pieper.

**1878. Arc lamp.** Carbone. (Date applied for under International Convention, Aug. 22, 1903.)

**3212. Flexible conduits for electric conductors.** Lake. (Wilson.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6¼ |
| —— 5 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅝ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3¾-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 93-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅝ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅝ |
| Crompton and Co. ..... | 3 | .. | 1⅝-2¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-98,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1¼-1⅝ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9¼-9⅝ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 95-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 12-13 |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5⅛ xd |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18¼-19¼ |
| —— 4 per cent. Debentures..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 | .. | 33-36 xd |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,801-101,800 .. | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 115-118 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12½-13½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9½-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10½-11½ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10¼-10⅝ |
| —— 7 per cent. Preference ..... | 5 | .. | 9⅜-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14½ |
| —— ,, ,, £10 Ord. .... | 6 | .. | 10⅝ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. .. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 101-103 |
| Chelsea Electricity Supply ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary..... | 10 | .. | 10½-11 xd |
| —— 6 per cent. Cumulative Pref..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5⅜ 6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 2¼-3¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5⅜-6⅝ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7⅛-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 10½-11⅞ |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 103-106 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Kensington and Knightsbridge and Notting Hill | 100 — | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 — | 9⅜-10¼ |
| London Electric, Ordinary | 5 — | 1¼-1⅜ |
| —— 6 per cent. Pref. | 5 .. | 4¼-5 xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 95-98 |
| Metropolitan Ordinary | 10 .. | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 .. | 95 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 .. | 98-101 |
| —— Preference | 4 .. | 100 103 |
| Notting Hill Electric Lighting | 10 .. | 13-14 |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 1,001-14,310 | 5 .. | 5¼-6 xd |
| —— 4 per cent. Debenture Stock | 100 .. | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 .. | 96-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 .. | 3-3½ xd |
| —— 4 per cent. Debenture Stock | 100 .. | 85-90 |
| South London, Ordinary | .. .. | 3-3½ xd |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 .. | 14-15 |
| —— 7 per cent. Pref. | 5 .. | 8-9 |
| —— 3½ per cent. Deb. | 100 .. | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 .. | 4⅜-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 .. | 4⅞-5¼ |
| Westminster, Ordinary | 5 — | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 .. | 6-6¼ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 — | 92-95 |
| —— 4 per cent. Pref. | 100 — | 98-101 |
| —— ,, deferred | 100 — | 86-89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 — | 110-113 |
| City and South London, Consolidated Ordinary | 100 — | 49-52 |
| —— 4 per cent. Debenture Stock | 100 — | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 — | 123-126 |
| —— ,, ,, ,, '96 | 100 — | 119-122 |
| —— ,, ,, ,, '01 | 100 — | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | — — | 13-13½ |
| —— Ordinary, 1-50,000 | — — | 7⅛-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — — | 103-104 |
| Waterloo and City, Ordinary | 100 — | 88-91 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 .. | 4⅝-4¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 .. | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 .. | 13½-14¼ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 .. | 2-3 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 .. | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 .. | 82-85 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 .. | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 .. | 103-105 p.c. |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 — | 9-10 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 — | 10-11 |
| —— 5 per cent. Perpetual Debenture Stock | 100 — | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 — | 2⅝-3⅛ |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 — | 5¼-5⅝ |
| —— "B" 5 per cent. Cm. Pf., 1-27,600 | 5 — | 4⅝-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 — | 104-107 |
| —— Prov. Cert., all paid | 100 — | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 — | 1⅜-2 |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 .. | 4⅜-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 — | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 — | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 — | 11-12 |
| —— Debentures | 100 — | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 — | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 — | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 — | 94-97 |
| Imperial Tramways Ordinary | all — | 22-22½ |
| —— 6 per cent. Cum. Pref. | all — | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 — | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 — | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 — | 11-11⅛ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 .. | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,514,016 | 1 .. | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 .. | ⅞-1⅛ |
| New General Traction, Ordinary | 5 — | ¼ |
| —— 6 per cent. Cum. Pref. | 5 — | 1⅛-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 — | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 — | 11½-12⅛ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 .. | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 — | 8¼-9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 — | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 — | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 — | 1 |
| —— £101,132 6 per cent. Preference | 1 — | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. — | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 — | 99-101 |
| —— Deferred Stock | 100 .. | 73-76 |
| —— 6 per cent. Cum. First Pref. | 10 — | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 — | 13½-14½ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 — | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 — | 94 96 |
| —— 4 per cent. Deb. Stock, Red. | 100 — | 99-101 |
| Oriental Telephone and Electric Company | 1 — | ¾-1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 12 | 1,075 | 839 | + 226 | + 9,795h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 12 | 158 | 173 | - 15 | + 156 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Birmingham Tramways | ,, 12 | 573 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 4 | 693 | 679 | + 14 | + 2,119 | 24 | 24 | March 25g | 40,964 | 7,234,105 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 10 | 277 | 323 | - 46 | - 342 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 12 | 213 | 235 | - 22 | - 105 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 13 | 1,705 | 1,669 | + 36 | + 8,328 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 9 | 905 | 809 | + 96 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 13 | 3,494 | 3,349 | + 45 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 13 | 762 | 816 | - 54 | + 2,464h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 11 | 4,343 | 4,254 | + 89 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 12 | 873 | 710 | + 163 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 13 | 281 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 12 | 1,806 | 1,676 | + 130 | +23,181 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 12 | 156 | 143 | + 13 | + 249 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 12 | 7,119 | 7,112 | + 7 | + 757h | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,571a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 13 | 3,101 | 3,090 | + 11 | - 528h | 6⅝ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 10 | 347 | 384 | - 37 | - 78 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 11 | 185 | 217 | - 32 | - 287 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 12 | 164 | 183 | - 21 | 126 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 13 | 103 | 94 | + 9 | + 15h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 11 | 3,484 | 3,627 | - 173 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06A |
| Dublin S. District, Electric | ,, 11 | 644 | 680 | - 36 | | | | | | | | | | | |
| Dundee City Tramways | ,, 9 | 749 | 751 | - 2 | | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 12 | 609 | 528 | + 81 | + 8,736 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 12 | 12,933 | 12,935 | + 3 | +51,131h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | ,, 9 | 2,095 | 2,165 | - 61 | + 6,205 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 5 | 1,078 | 1,014 | + 34 | — | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 12 | 1,969 | 1,744 | + 225 | + 7,773 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 9 | 117 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 9 | 184 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 12 | 4,792 | 4,897 | - 99 | +15,287 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 5 | 9,004 | 9,078 | - 74 | + 3,015 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 12 | 1,535 | 1,514 | + 21 | + 332h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 5 | 9,138 | 7,915 | +1,223 | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 12 | 122 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 12 | 97 | 68 | + 29 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 12 | 3,575 | 3,012 | + 483 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,176 | 6·17 |
| Portsmouth Corporation | ,, 12 | 1,431 | 1,402 | + 29 | + 3,502 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 14 | 104 | 109 | - 5 | — | 4½ | 4½ | March 31g | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 10 | 325 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 14 | 3,639 | 2,990 | + 649 | +51,441 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 13 | 4,447 | 4,097 | + 349 | +18,020 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·304 | 10·488 | 7,510 | 7·0 |
| Southampton Corporation | ,, 10 | 803 | 849 | - 46 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·346 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 13 | 1,122 | 996 | + 126 | + 2,920 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 12 | 571 | 535 | + 36 | + 3,955 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·63 | 3,593 | 7·03 |
| West Ham Corporation | ,, 10 | 286 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Indiarubber.**—In the *Bulletin* of the Colorado College Museum for December last there appears a description of a new indiarubber plant, the Pieradenia odorata utilis, belonging to the order compositæ, and plentiful near Buena Vista, Colorado, U.S. The roots contain from 5 to 12 per cent. of rubber. The crowns of the plant contain about the same proportion. The less permanent parts, such as leaves and seeds, have little or none of it.

**The McMillan Memorial Fund.**—We have received from the Institution of Electrical Engineers a second list of subscribers to the above fund, which covers all subscriptions received from the 5th to the 18th inst. inclusive. The amount of these subscriptions is £189. 10s. We trust that the interest in the fund will be maintained until a considerably larger sum has been realised, as there are a large number of associate members and associates who have yet to send in their quota.

**Books Received.**—We have received from the publishers, Messrs. Blackie and Son, Limited, Parts 1 and 2 of "Elementary Geometry," by Cecil Hawkins. These two books are each published at 2s, and deal with the geometry of the straight line, the circle, and plane rectilineal figures. Messrs. Merritt and Hatcher, Limited, the publishers, have sent us a shilling book on "Oil-Engines: their Selection, Erection, and Correction," by Mr. W. A. Tookey. This book deals with the maintenance of oil-engines, and contains some useful information for oil-engine attendants. Practically all the standard types of oil-engines are illustrated and described in this book.

**The Iroquois Theatre Fire.**—The enquiry into this terrible fire at Chicago, by which some 575 persons lost their lives, has led to three charges of involuntary manslaughter. The operator of the electric searchlight which actually fired the drapery which started the conflagration is not amongst these. It was proved at the enquiry that he had called attention to the dangerous proximity of this inflammable material to his arc light. In consequence of this the jury exonerated him. We are pleased to see that amongst those charged are a building commissioner and a building inspector, both public officials, who presumably did not enforce the powers vested in them.

**Electro-Harmonic Society.**—The last of the society's smoking concerts for the season will be held this evening (the 25th inst.) at the Holborn Restaurant, King's Hall, commencing at eight o'clock, and a capital variety entertainment has been arranged. Vocal music will be provided by Mr. W. Maxwell and Mr. W. Forington, and instrumental by Mr. Arthur Smith and the orchestra; while Messrs. Astley Weaver, Alexander Watson, and Frederick Chester will contribute humorous sketches, recitations, and a ventriloquial sketch, etc., respectively. The musical directors are Prof. A. E. Izard, R.A.M., and Mr. T. E. Gatehouse. The chair will be taken by Mr. Wm. Mordey.

**Electricity in the Far East.**—We learn from the *Western Electrician* that a private corporation, having a capital equivalent to £26,823, is planning, unless prevented by war-time conditions, to provide an electric light system for the city of Harbin, Manchuria, which is the principal base of the Russian army. This city is divided into three sections, known as the old town, the river town, and the administration town. It lies 600 miles north of Port Arthur on the Trans-Siberian Railway, and has been developed by the Russians so rapidly that it has become a centre of industrial force in the affairs of North-Eastern Asia. The corporation mentioned also propose to construct an electric street railway connecting the three sections of the city.

**Wireless Telegraphy.**—The arrangements made by the Belgian Government for the sending of commercial messages by wireless telegraphy from Nieuport to the Dover-Ostend steamers have involved the establishment of a new Marconi station at Nieuport-Bains. The new station is equipped with the latest apparatus, and the staff of operators will maintain a continuous service. Other information recently to hand in connection with the Marconi system is to the effect that an agreement has been signed between the company and the Great Western Union Telegraph Company in the United States. Under this we gather that the latter company will utilise the Marconi system, and that a special code for this purpose is being issued to the offices of the company in the United States and Canada.

**Electricity and Fires.**—In our correspondence column this week will be found a letter correcting a statement which was made in a note in our issue of Feb. 26 on the above subject. In the preparation of this note we were led to believe from our esteemed contemporary, the *Canadian Engineer*, that there had been a very large number of fires in Montreal due to defective electric wiring. We find now that the number of fires quoted was for the whole of the United States, and not from Montreal, as we then stated. Mr. K. B. Thornton, the superintendent of the mains department of the Montreal Light, Heating, and Power Company, rightly justifies the work done under his department by the fact that very few fires occur. In fact, during the three months in question, there was only one conflagration which could be traced to defective electric wiring. This shows that even with overhead mains safety can be ensured if due care is taken in supervision.

**Wireless Telegraphy for Lighthouses.**—Replying to a question from Mr. Henniker Heaton as to whether, with a view to the preservation of life at sea, he was arranging for all lighthouses and lightships of the United Kingdom to be connected by wireless telegraphy, the President of the Board of Trade stated that preparations were being made by the Trinity House for the fitting-up of wireless telegraphic apparatus on certain of their lightships on the East Coast, by way of experiment. The matter was being pushed forward, and an agreement for the use of patent rights had been drawn up, and was now being considered by the various departments interested. Permission had been granted to Lloyd's to establish a wireless telegraphic station at the Fastnet. In regard to other light stations, many of which are already connected with the shore by cable, the President could not say at the present juncture to what extent the system would be employed.

**The Metropolitan Electrification.**—On Tuesday last Mr. A. E. Ellis, the general manager of the Metropolitan Railway Company, took a party of experts over the Baker-street to Harrow and Uxbridge line on an electric train. The trial trip was a most successful one, and gave an excellent opportunity of inspecting the new type of first and second corridor cars built for use on this line. These cars are 52½ft. long, 8ft. 9in. wide. In general design they are not unlike other cars now at work on electric railways, in that the exits are at the ends of the cars only. They are heated and lighted by electricity. The equipment on the Neasden power station is making good progress. These works when completed will contain machinery of 14,000 h.p, capable of working up to 17,000 h.p. during heavy loads. The electricity will be distributed at 11,000 volts, and then transformed down to 600 volts at the nine sub-stations along the line. It is hoped to inaugurate the electrical service on the above line within a few months.

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**British Electrical Superannuation Fund.**—The annual general meeting of the members of this fund was held on Wednesday, the 16th inst., when Mr. C. G. Tegetmeier took the chair, through the indisposition of Sir Ernest Spencer, M.P. We have received a report of the chairman's speech, and also a copy of the annual report of the managing trustees. From this we gather that the membership has now reached the number of 183, of whom by far the larger proportion are employed either directly by the British Electric Traction Company or by companies associated with them. There are now some 50 companies who have joined the fund. The Chairman, in the course of his speech, regretted that other firms in electrical business outside the immediate circle of the British Electric Traction Company's organisation had not availed themselves to a larger extent of the fund. Another point which we notice is that 45 members left the fund during the year. If this rate of withdrawal were to go on, the fund, we are afraid, would cease to serve the purpose for which it was organised.

**The Locomotion Problem.**—Mr. Charles Bright chose this subject for some lectures given before the Uxbridge Literary Institute. The general trend of Mr. Bright's opinions is orthodox, in that he advocates electric tramways for outlying areas, while doubting their efficacy for the relief of congestion in overcrowded streets. Speaking of the effect which electric tramways would have in improving the position of agriculture, the author stated that there were two causes which contributed principally to the depression in that branch—*i.e*, the deficiency of labour and the need of cheap and speedy means of transit. He considered that by linking up certain towns and villages both these difficulties would be largely overcome. We are not quite clear that the first difficulty is to be so easily solved, because the surplus labour in the towns is not, as a rule, of the class required on the land. In fact, the reverse is quite as likely to be the case, as with increased means of communication it will be even more difficult to keep the agricultural labourer on the land. Mr. Bright proceeded at the end of his lecture to advocate company control for interurban traction systems.

**The Allis-Chalmers Reorganisation** —A few weeks ago we notified the fact that the Allis-Chalmers Company were entering the field of electrical manufacturing in the United States, and that they would be active competitors with the other large firms who have hitherto held almost a control of the American market for heavy electrical engineering contracts. We now learn that the firm has concluded an alliance with the Bullock Electrical Manufacturing Company, which will enable them immediately to fulfil orders for electrical plant. This latter firm have as their engineer Mr. B. A. Behrend, who in years past contributed a number of articles to our columns. Under his design apparatus covering the entire field of all direct and alternating current working have been standardised. The firm have manufactured some of the largest types of poly phase alternators and synchronous motors made in the United States. We also understand that they are taking up the manufacture of tramway equipments. The directorate of the Allis-Chalmers Company is also being reorganised, Mr. Charles Allis retiring from the position of president in favour of Mr. B. H. Warren, who was formerly connected with the Westinghouse Company.

**Parliamentary Bills.**—The report made by the Board of Trade upon all the Bills and provisional orders for the session 1904 does not indicate satisfactory progress. There is a marked falling off not only in the number of Bills for new works, but also a much larger decrease in the total amount of money proposed to be raised. Thus, the total number of Bills this session relating to railways, canals, tramways, and the supply of electricity, gas, and water is 159, as compared with 188 last session. The total amount of money proposed to be raised is £37,825,761, as compared with £75,287,015, a decrease of practically 50 per cent. The Bills which might have been expected for the improvement of the traffic conditions in London are hung up owing to the Royal Commission on London Traffic, which has not yet issued its report. There are 15 Bills relating to electricity and the supply of electrical energy, for which the proposed capital is over 12 millions, although in seven cases the capital required is not stated. In the majority of these Bills the powers sought are beyond the scope of the Electric Lighting Acts under which provisional orders are granted. There are 39 Bills relating to tramways, involving the construction of some 228 miles of tramways and the spending of £5,325,971. The falling off in this class of Bill is not so great as in other sections of the report.

**Australian Patent Law.**—The following new regulations in connection with patent law in Australia will be of interest to our readers. The information has been forwarded to us by Messrs. W. P. Thompson and Co. We gather from it that the Governor-General in Council of Australia has decreed, in accordance with the new Federal Law, that patent applications for Australia can now be formally made at the custom house of the capital city of each state. Applications so filed will be marked with the date, hour, and minute of receipt, and the applications will be subsequently recorded at the Patent Office as having been filed at that date. Applications thus filed will not be merely taken in order of their dates, but they will be held to be dated as far as regards novelty from the date of actually filing at the custom house unless dated under the convention. Under the convention nearly all the principal countries and colonies have agreed to grant the right to a patentee who has filed an application for a patent in one of the countries or colonies to date any or all the other applications he may make for the same invention in other realms during the year as of the date of his original first application. The application in Australia can either be a provisional one or a complete. The fees and stamp duties are just double those of an application for Great Britain and Ireland.

**Water-Vapour.** — At the monthly meeting of the Royal Meteorological Society, held on the 16th inst., Mr. Richard H. Curtis delivered a lecture on this subject, illustrated by experiments and lantern slides. After explaining that water-vapour is water in the state of a gas, he proceeded to speak of the processes of evaporation and condensation, and showed that the capacity of the air for moisture varies according to the temperature. The amount of vapour in the air has a great deal to do with our personal comfort. A dry cold air is not so unpleasant and does not feel so cold as a damp air, although the temperature of the damp air, as shown by the thermometer, may be higher than that of the drier one. But our sensations are often at variance with the thermometer, and this generally so because of the way in which they are affected by the vapour of the air. If the air be dry, a degree of heat can be enjoyed which would be simply unendurable if it occurred with a humid atmosphere. The amount of vapour in the air is ascertained by means of an instrument known as a hygrometer, various patterns of which were shown by the lecturer. He then referred to some phenomena of the atmosphere in which water-vapour plays a leading part, and described the formation of dew hoar-frost, fog, cloud, halos, rain, snow, and hail. The lecturer concluded by saying that he had tried to show how a particle of water may be taken from the ocean and

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stored away invisible in the atmosphere above it; how that particle may travel for many miles to distant parts of the globe, and then by the action of another of Nature's processes be changed back again into water and fall once more upon the ground beneath. There it may unite itself to other similar drops and together form a tiny stream, which may gradually grow to the dimensions of a river, and once again our drop of water may find itself a constituent part of the ocean, to repeat its pilgrimage and carry on the part it is destined to play in the economy of Nature.

**Rating of Machinery.**—An influential and well-attended meeting of members of Parliament favourable to the Rating of Machinery Bill was held on March 22 in one of the committee rooms of the House of Commons. Sir William Holland presided. The meeting expressed their satisfaction at the result of the debate on the second reading of the Bill on March 18, when a substantial majority was obtained in spite of a small House and a somewhat unexpected debate. The desirability of removing the objection taken to the provisions of the measure by members of Parliament representing particular localities in England was considered, and in view of the misconceptions which apparently exist in these districts as to the effect of the operation of the Bill, it was decided to immediately appoint a sub-committee for the purpose of taking steps to satisfy these particular opponents that their apprehensions are, in fact, without foundation. The final form of the sub-committee was not absolutely decided upon, but the following members of Parliament were elected to act, with power to add to their number: Sir W. H. Holland, Sir W. H. Houldsworth, Sir W. E. M. Tomlinson, Sir Edward Strachey, Sir John Rolleston, Mr. Alfred Emmott, Mr. D. J. Shackleton, Mr. George White, and Mr. Edward Chapman. The feeling was also expressed that the Machinery Users' Association should, through its officials, act in direct co-operation with the above sub-committee.

**New York Electric Railway.**—The New York Central Railroad Company have decided to electrify some 40 or 50 miles of their lines extending from the Grand Central depôt in New York City, and not only will all the suburban traffic be hauled by electricity, but at the extremity of the electrified portions of the line the steam locomotives will be detached from the heaviest "through" trains, which will be brought down to the heart of the city by electric traction. The contract has been awarded to the General Electric Company, of Schenectady, U.S.A., and its magnitude is shown by the fact that it includes eight Curtis turbo-generator sets, with the requisite auxiliary plant, and 30 electric locomotives of 2,200 h.p. each. The turbines will be four-stage machines, working at a steam pressure of 200lb. per square inch. The locomotives are to be the most powerful in the world, steam or electric, and will mark a very distinct advance in electric locomotive design. The specifications require that each should be guaranteed capable of hauling a train weighing 500 tons a speed of 60 miles an hour. The largest steam locomotives have been found capable of developing at a maximum 1,500 h.p.—700 h.p. less than of the new electric locomotives. Each of these latter will be equipped with four 550-h.p. gearless motors, with the armature built up on the axle, and the motor frame built into the truck, acting also as a truck frame. The multiple-unit system is to be employed for the control of these immense locomotives, so that two of them working together can draw with ease the biggest trains that the New York Central system has ever known. The continuous-current system will be used. This innovation on the part of one of the largest trunk systems in the world marks an epoch in the annals of railway traction, and may be expected to go far in determining the value of electrical motive power for very heavy suburban traffic.

**Three-Phase Traction.**—In our last issue there was an announcement that Messrs. Bruce Peebles and Co. had secured a contract for the complete equipment of an electrical railway in Canada which will run on the three phase system. The firm is to be congratulated on securing this contract in the face of American competition. We are able now to give further details of the line. The railway runs through an agricultural district of Canada, the first portion of which connects London, Ontario, through the city of St. Thomas to Port Stanley on Lake Erie. This portion of the line is some 30 miles in length. As soon as this has been equipped for electrical running, the remaining portion of the line between London and Hamilton will be electrified on the same system, which will bring the total length up to 160 miles. The Ganz system, for which Messrs. Bruce Peebles and Co. hold the sole English rights, has been adopted, and for this particular line they have guaranteed figures which show a saving of 30 per cent. both in first cost and running cost over continuous-current or single-phase systems. The power will be transmitted at 10,000 volts, 25 periods, and will be transformed down to 1,000 volts for the motorcars, of which there are 10 in number, each motorcar being designed to go at a speed of 30 miles an hour on the level and 15 miles an hour up to grades of 1 in 25. Each car holds 50 passengers, and is capable of hauling either freight or passenger trailer in addition. The line is built partly across private right of way and partly across public roads, as is the case with urban railways in Canada and the United States, and considerable interest will await the results in practice. The line is under contract to be completed in six months from date.

**An Oil-Cooled Transformer Judgment.** — The proceedings taken by the Westinghouse Electric and Manufacturing Company in the United States Circuit Court for the Eastern District of Missouri to restrain the Wagner Electric Manufacturing Company from infringing Clause 4 of United States Patent No. 366,362 for alternating-current transformer construction have proved abortive. This clause is as follows: "The combination, substantially as described (in specification), of an electric converter constructed with open spaces in its core, an enclosing case, and a non-conducting fluid or gas in said case adapted to circulate through said spaces and about the converter." The object of the defendant company's oil-cooled transformers—the subject matter of the litigation—is, according to the specification, "to provide a simple and efficient converter which will not become overheated when employed for a long time in transforming currents of high E.M.F., and which will be thoroughly ventilated." The plaintiff company had been successful in a suit against the Union Carbide Company, of Niagara Falls, in consequence of which the Wagner Company had modified its transformer construction; but its validity was still disputed by the plaintiff company. Judge Adams, after pointing out great dissimilarity between the plaintiffs' and defendants' devices, decided that he could not construe the verdict in the Carbide case as giving the plaintiff company the monopoly of all means by which the external and internal surfaces of the heat-producing parts of a converter can be cooled. This view would preclude the use of any and every other device looking toward the accomplishment of the main object—namely, the circulation of oil throughout the heat-producing parts of a converter. He, therefore, gave his decision as follows: "First, that the transformer now being used by the defendant is not within the true

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meaning of the patent itself an infringement of Clause 4; second, the construction which I have placed upon this claim is in harmony with the cotemporaneous and continuous construction placed upon the same claim by the patentee himself, and by the plaintiff company; third, the plaintiff company by its own conduct is estopped from claiming the contrary." We are very pleased to hear of this result.

**London Chamber of Commerce.**—We have received the council's twenty-second annual report, presented to the members yesterday, which contains a concise and complete review of the very extensive and varied operations of the Chamber and its numerous committees during the past year. The subjects dealt with by the Chamber included commercial education, the fiscal question, Anglo-French relations, the proposed port authority for London, various electrical matters, and the fifth congress of chambers of commerce of the Empire. The removal last autumn to more commodious premises in Oxford-court, Cannon-street, has materially facilitated the business of the institution. The revenue for the year reached the record figure of over £15,000; but, in view of the wide scope of the Chamber's operations, the possibility of increasing, voluntarily or otherwise, the low rate of subscriptions has been contemplated by the council. The Electrical Trades Section, by communication with the Departmental Committee on Electricity in Mines, elucidated the position of the English electrical industry, concerning which certain evidence given before the Departmental Committee was calculated to create misapprehension. Support was given to the recommendations of the Mansion House Committee regarding the Port of London Bill, and in connection with the income-tax assessment of London agents of foreign firms the section recorded its opinion that agents in this country should be chargeable with a tax upon the profits made by their foreign principals in the United Kingdom. The section also considered the Supply of Electricity Bill and the Workmen's Compensation and Employers' Liability Acts. The Postal, Telegraph, and Telephones Committee were instrumental in obtaining the reduction from 5½d. to 4½d. per word for telegraphing direct to Russia, which is to come into force not later than July 1, and also decided upon the means to be taken for demonstrating to the Postmaster-General the necessity for extending the underground telegraph system consequent upon the frequent breakdowns in the overhead-wire system. The report impresses one with the invaluable and constantly increasing work performed by this energetic institution.

**Post Office Telephones.**—On Tuesday last Lord Stanley gave, in the House of Commons, a good deal of information respecting the Government telephone work, for which £3,000,000 was voted. He said that in previous years sums amounting altogether to £4,300,000 had been voted for the telephone service of the Post Office. The sum now required was for trunk lines and exchanges in places where there was now a great demand for telephones. The telephone was extending to districts not reached by the telegraph. Of the £4,300,000, there had been spent on trunk lines, £2,180,000; exchanges in London, £1,495,000; in the provinces, £262,000; and on telephone requirements, £233,000; leaving a balance of £136,000, which would just carry the Post Office over the present financial year. Out of the £3,000,000 now asked for, roughly £1,300,000 would be set apart for trunk lines, £1,500,000 for exchanges in London, and £200,000 for expenditure in the provinces. This would carry them on for five years, but if the demand for telephones increased, probably the House would be asked to grant a further sum. The number of conversations that had taken place during the year by telephone was 12,895,883. The capacity of the London plant provided for 40,000 subscribers. They had now 15,292, or a third, and the number was increasing largely. An exchange was to be opened at Hampstead, and another was in progress at Ealing, to provide for 2,000 subscribers. In London there were 1,094 miles of underground pipes and 110,128 miles of wire in connection with the system. As to the provincial exchanges, the number of subscribers had increased from 1,259 at the end of 1899 to 5,000 at the present time. In the central exchange in London the receipts from March 1, 1902, to March 31 last year had amounted to £61,000. As to the actual profits, a great deal of the capital was lying idle and waiting to be developed. There had been such a large increase since last year that he was sanguine enough to believe that in another year they would be a paying concern. The profits had jumped from £6,000 to £48,000 in one year. They were not competing with the National Telephone Company in areas supplied by that company; the intention of the Post Office was to supply places which, under present circumstances, would never be able to get the telephone. The purchase of the undertaking of the National Telephone Company by arbitration would be a very expensive matter, and he, personally, was much more inclined to accept an alternative policy, and come to an amicable agreement with the company. This matter was not in any way bound up with the present grant. Any agreement with the company as to purchase would have to come before the House of Commons for ratification, and it would then be fully discussed.

**"The Wisconsin Engineer."**—We have received the quarterly volume of this journal, which is the organ of the University of Wisconsin, dated February, 1904. It contains an interesting article on the New York rapid transit system, with illustrated details of construction. The following paper by Mr. C. F. Burgess on some uses of electricity in the working of metals is an excellent general survey of what has been done in a large number of directions. The author commences with a reference to electro-plating, and describes the later developments by which metal are cleaned by means of electrolysis. Electric welding and electric heating are also described, and, in conclusion, reference is made to the electrolytic forge, which was introduced some 10 years ago. The use of this consisted in placing an iron rod in a solution of common washing soda, and heating it to the welding temperature by an electric current. The cause of the heating is the current which liberates a layer of hydrogen around the iron, which forms a high-resistance envelope, and hence becomes a source of great local heating. The advantages claimed for it were rapidity, cleanliness, and the impossibility of forming a scale or introducing impurities on account of the reducing action on the hydrogen, but in spite of these claims the liquid forge has not become of practical importance on account of one serious objection, which is the expense for power. Thus, to heat an iron rod ½in. in diameter requires 50 amperes at 250 volts, or 17 h.p. Mr. Burgess then described some experiments which were made in the Wisconsin laboratory to obtain the same heating effect with an expenditure of from 5 to 10 per cent. of this power by replacing the liquid with powdered graphite having a good conductivity. Measurements were made by using a round iron vessel containing the finely-divided graphite, the vessel constituting one of the electrodes to which connection was made to one of the terminals of the secondary of a transformer. The other terminal was connected to the rod to be heated, and the end of this was immersed in the graphite. The current thus flowing from the sides of the vessel to the rod placed

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concentrically within it reached a high current density in the immediate neighbourhood of the rod, and thus produced heating. In addition to this heating, innumerable small arcs were produced at various points of contact between the iron and graphite, thereby increasing the heat. Either alternating or direct current serves equally well for this purpose, the pressure required being about 25 volts, and the current necessary somewhat less than that of liquid forge. As far as consumption of power is concerned, this method of heating would be entirely practicable. A difficulty in its operation, however, lies from the fact that where the heat is the most intense a cloud of the fine graphite arises, making the process a dirty one, as well as one wasteful of graphite. It is possible that by incorporating the graphite with suitable inert material this objection could be overcome, but the experiments were not carried far enough to determine this point.

**Action of Magnetic Fields on a Feeble Source of Light.**—The discovery of the N-rays has induced Mr. C. Gutton to investigate whether magnetic fields would, like these rays, act on phosphorescent substances. As pointed out in a note recently read before the French Academy of Sciences, he carried along a magnetised rod a piece of pasteboard covered with spots of phosphorescent sulphide, when the brilliancy of the phosphorescence augmented in the neighbourhood of the poles and diminished on the sulphide approaching the middle of the magnet. In order to eliminate the effect of N-rays as emitted by tempered steel, the author covered the magnet with a sheet of lead, above which the sulphide was carried along when in the neighbourhood of the poles. The phosphorescence again proved more marked than in the middle of the magnet. This shows the existence of an action of the magnetic field on the phosphorescent sulphide. This action takes place in a vacuum, as the experiment may equally be made with phosphorescent substances enclosed in a Crookes tube. The author next examined the action exerted by the field of a coil traversed by current. When the sulphide is carried along in the interior of the coil in a direction parallel to its axis, the luminosity is also a minimum in the middle, while on approaching the ends an increase is noted. If the coil be so long as to have a uniform field throughout, the action of this field is nil. The field is, however, stronger in the interior than outside of the coil. Generally speaking, the action of a field is greatest when the field is less uniform. The action above described is remarkable for its extreme sensitiveness, as may be inferred from the following details given by the author. On approaching towards the sulphide, being protected against the influence of N-rays by a lead screen, a bismuth rod, or a testing tube filled with ferric chloride solution, the rather feeble variations of the field as produced by the substances proved sufficient to augment the phosphorescence. The phosphorescent sulphide proves sensitive to magnetic fields due to even very feeble currents. When placing the sulphide at a distance of 1cm. from a rectilinear wire traversed by a current, and inserting between the wire and the sulphide some black paper and lead, arresting any N-rays and thermic effects, an action was observed even on throwing the current of a Daniell cell into a circuit of a resistance as high as 100,000 ohms. According to Prof. Blondlot, N-rays may be observed also by placing the source of rays in the neighbourhood of the eye, instead of causing them to fall on a slightly luminious body, when any objects slightly illuminated are much more distinct to the eye. Now the author shows the same to be true in the case of magnetic fields acting on the eye. On inspecting scraps of white paper placed in a nearly dark room, the author was able to distinguish them much more clearly as a magnet enclosed in a lead cover was placed in front of his eye. If a magnetic needle be placed before the eye, any slightly illuminated white objects are seen more clearly if the ends are in front of the eye than in the case of the eye being placed near the centre of the needle.

**Electro-Chemistry.**—Mr. Bertram Blount delivered the last of his series of three Cantor lectures on the above subject at the Society of Arts last Monday. It was devoted to electrical furnaces. Considered from a general point of view, the electrical furnace had the advantage that it could produce exceedingly high temperatures at the point where this temperature was required. These furnaces, however, could not compete in certain operations with a fuel-fed furnace, as was obvious from the fact that when the electricity was produced from a steam-engine, only about 15 per cent. of the heat in the fuel was available in the electrical furnace. Mr. Blount classed electrical furnaces into two divisions: those in which there was an arc, and those which heated by means of the high-resistance of the charge through which the current passed. The arc furnace was not used much in practice, nearly all the commercial work being done by what might be termed the "resistance furnace." The products of electrical furnaces were characterised by the simplicity of their composition, all complex bodies tending to be split up into more simple forms at these high temperatures. Dealing with furnaces for the manufacture of calcium carbide, these, again, were classified as to the product. In one class of furnace the calcium carbide was tapped off, whereas in the other type it was produced in a large block, which was built up on the lower electrode. Although the purity of the tapped was higher than that of the block carbide, the latter was cheaper to produce. Now that this manufacture was being carried on commercially, many improvements were being made, with the result that 1 h.p. working continuously throughout the year could now produce 1½ tons of carbide, whereas two or three years ago a ton was considered a good result. The manufacture of carborundum—*i.e.*, silicon carbide—had also been greatly developed during the past few years, and was now quite on a commercial footing. Mr. Acheson, who had started this work at Niagara, had also made a great success of the process for the electrical manufacture of graphite. The production of iron and steel in electrical furnaces was the last point dealt with in the lecture. Mr. Blount showed that, for economical reasons, the manufacture of pig iron electrically, while easily done, could not be resorted to for commercial purposes, save in exceptional cases. For instance, in a country where fuel was dear, water power cheap, and a heavy import duty on pig iron prevailed, there was a chance for the electrical process. He believed that it was being tried on a commercial scale in Chili and Peru. On the other hand, the manufacture of steel alloys or of steel from cast iron was commercially possible, and a few arrangements for carrying out such special work were described. The manufacture of zinc was at present a laborious and costly process, which he thought the electrical furnace would entirely reorganise in the near future, in the same way as it had displaced older methods for the manufacture of phosphorus and carbon bi-sulphide. The lecture was concluded by some experiments with electrical furnaces, which were quite successful. Calcium carbide, carborundum, and chromium were all produced in this way in the lecture theatre at the Society of Arts with the limited power available—*i.e.*, 30 h.p. At the conclusion of the lecture Sir H. Trueman Wood proposed a vote of thanks to Mr. Bertram Blount, which was heartily accorded.

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## THE LIVERPOOL, SOUTHPORT, AND CROSSENS ELECTRIFICATION.

*(Concluded from page 458.)*

PERMANENT WAY.

The equipment of the permanent way is novel in certain respects, and in others may be taken as inaugurating standard practice for main-line conversion. Thus, while a third rail is provided and laid in a position fixed after consultation with other main-line railway companies, the return circuit is distinctly new in design and execution. The details of the same can be followed from Figs. 12 and 13, which shows the fourth rail laid down the centre of the track. Whilst the joints of both the third and the fourth rail are bonded in the ordinary way in the manner described below, the fourth rail is also cross-bonded to the ends of each running rail. By this arrangement the troublesome bonding at the joints of the running rails is avoided, as also the complications involved by using an insulated fourth rail for the return. The further advantage is obtained that the running rails participate to a marked degree in conducting the return current, thus increasing the conductivity of the return circuit, with consequent reduction of drop. No collector shoe is provided on the train for the fourth rail, the current being delivered through the wheels to the running rails, and thence, through the cross-bonds, to the fourth rail. The installation of this rail also makes it a comparatively simple matter to renew the running rails without interfering appreciably with the continuity of the return circuit.

The third and fourth rails are both of equal section, and consist of mild steel of special high conductivity, the resistance being proved by test to be not greater than 7¼ times that of pure copper. As a matter of fact, the average resistance is somewhat lower. The rails have been supplied by the North-Eastern Steel Company, of Middlesbrough, are of Vignoles section, weigh 70lb. per yard, and are in lengths of 60ft.

The third rail is supported at intervals of about 10ft. on insulators of reconstructed granite, held in position by two clips, the centre of the rail being exactly 3ft. 11½in. from the centre line of the track, and the top of the rail 3in. above the surface of the track rails (Fig. 13). These dimensions are those agreed upon by all the main-line railway companies at a meeting held at the Clearing House on March 3, 1903, in order to obtain uniformity in case of electrical extensions on the third-rail system. Generally the third rail is placed in the six-foot way between the tracks, but occasionally it is brought outside the track to suit special conditions. At all level crossings, as in Fig. 12, gaps in this rail have been provided of such a length that there can be no risk whatever to the public; where these gaps occur the third rails are bonded with cable underground. Timber guarding has been provided at all the busy places on the line and in stations to prevent the possibility of any person coming into contact with the third rail, though even if they did so, the consequences, while unpleasant, would not be serious. The fourth rail is supported on wooden blocks, and is placed in the middle of the four-foot way between the two running rails.

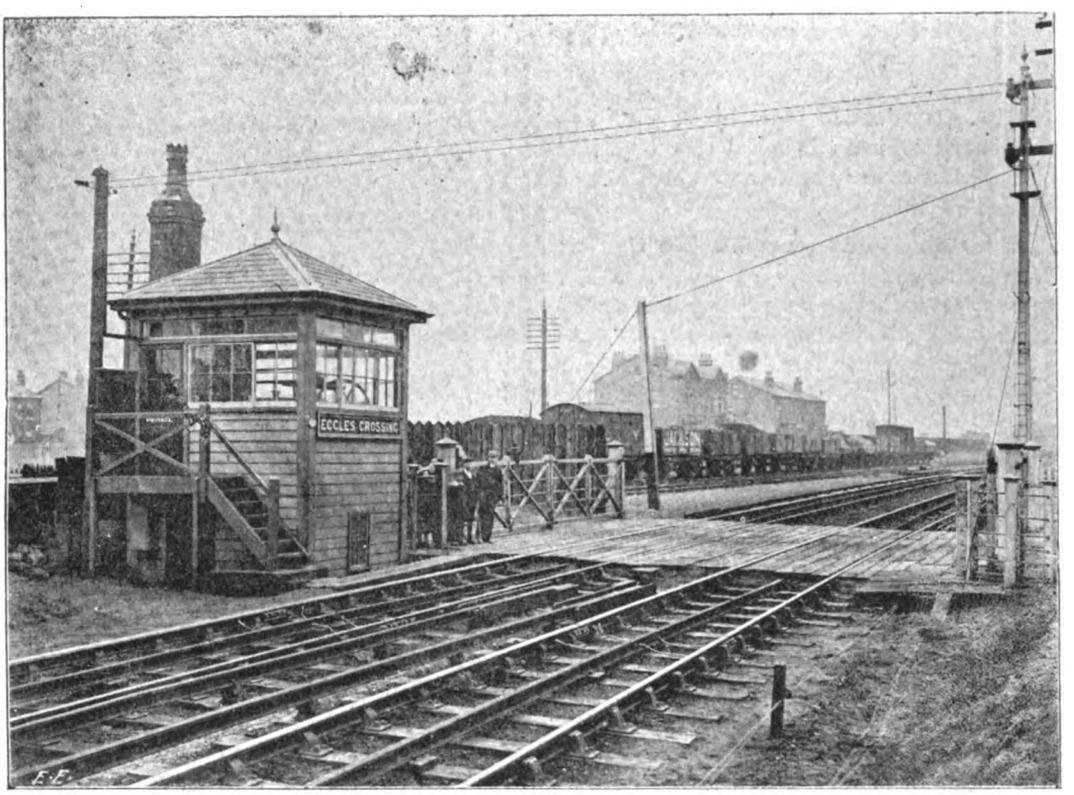


FIG. 12.—View of the Third and Fourth Rail Construction at Eccles Crossing. The bonding of the track rails can be seen.

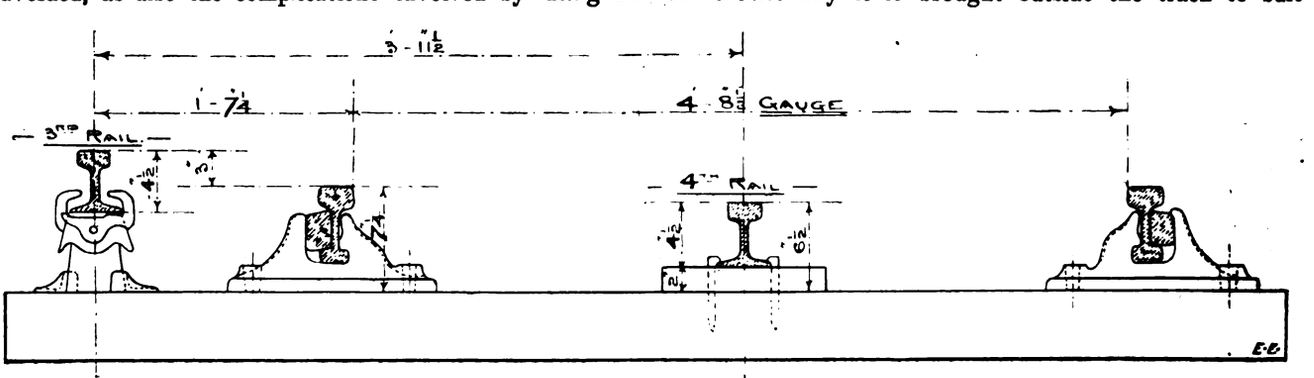


FIG. 13.—Section of Track showing Third and Fourth Rails.

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At most stations the third rail is interrupted and the ends are connected by cables to section switches. This apparatus consists of four knife switches, one for each end of the up and down line, which, in the ordinary way of working, are connected in parallel. By cutting out one of these switches in two adjacent boxes any part of the up or down line may be made dead. To provide for expansion and contraction due to changes of temperature in the rails, they are divided into sections of 300ft., and the joints between the rails making up this section are known as "fixed joints." The joints connecting the sections themselves are known as "expansion joints." At the fixed joints no provision is

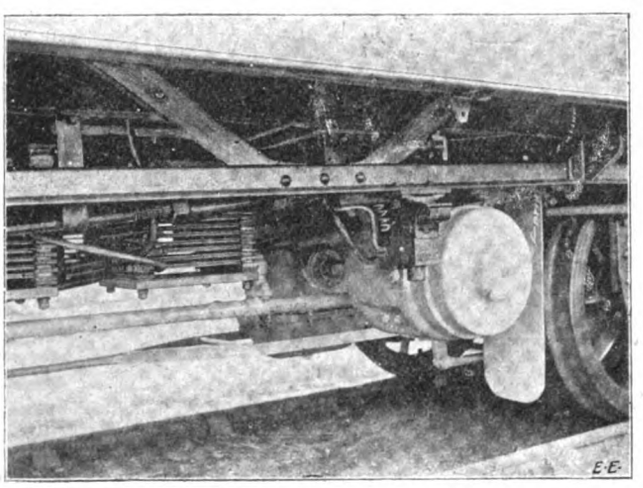

FIG. 14.—The Collector Shoe and Attachment to Underframe of Bogie.

made for expansion or contraction, this being concentrated at the expansion joints. The fishplates at the fixed joints are made as rigid as possible, and the bonds are four in number, two bonds being fixed in the web of the rail and two bonds in the flange of the rail. It was deemed advisable to use bonds of semi-flexible type, which have a conductor built up of parallel strands of copper ribbon or "flat wire" with solid copper terminals. They are thus sufficiently flexible to provide for any movement which may take place at the joints, and are more easily adjusted in case of any variation in distance between the bond holes at the time of construction. The bonds at

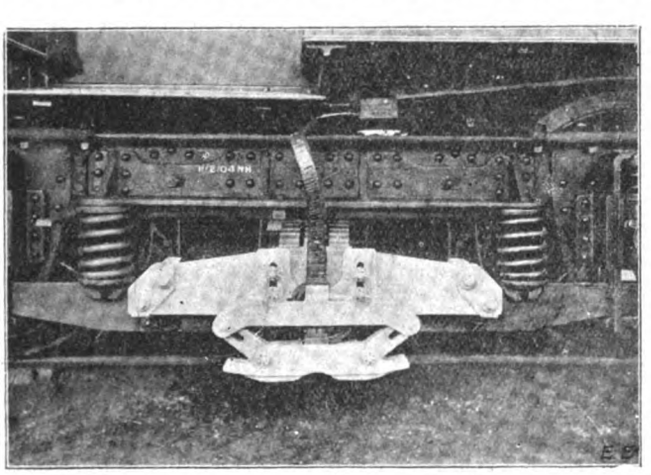

FIG. 15.—View of Motor-Driven Vacuum Pump.

the expansion joints are four in number, of the same cross-section as those at the fixed joints, but all four are fixed in the flange of the rail. These bonds are also made of "flat wire." The fishplates at the expansion joints are of special design, and properly slotted to provide for any change of length which may take place in the 300ft. section. This system of bonding is carried out on both the third and fourth rails. The terminals of all the bonds are of solid copper, and are expanded in the bond holes by means of screw or hydraulic compressors. Each track rail is bonded to the fourth or negative rail by means of two flexible cable bonds. The bonds were supplied by the Forest City Electric Company.

## THE ROLLING-STOCK.

The new rolling-stock has been constructed in the shops of the Lancashire and Yorkshire Railway Company. The trains consist normally of two first and two third class cars, as shown in Fig. 1, the latter being at either end and equipped with two motor bogies, each bogie carrying two 150-h.p motors, there being, therefore, eight motors per train. The current is collected by cast-steel slippers (Fig. 14) attached to a beam on each side of the motor bogie, which rub on the third rail. Both types of cars are 60ft. long and 10ft. wide, being the widest carriages in this country, and have 8ft. wheel-base bogies fixed 40ft. 6in. centre to centre apart. They are arranged with straight sides, matchboarded below the side lights. There is a monitor or clerestory roof 6ft. 2in. wide, the top being 12ft. 7⅞in. from the rail level. The vehicles are painted in the company's standard colours of brown and crimson lake. The motorcars have a luggage and motor compartment at one end. Access is obtained through entrance vestibules, which are recessed back at either end, the whole arrangement being so designed that the doors shall not project beyond the 10ft. width when extended. Immediately inside the compartments the seats are placed longitudinally against the side of the car, so that ample space is allowed for the inlet and outlet of passengers. The cars are otherwise fitted with cross seats and reversible backs with a passage between, the first-class accommodating two on either side and a total of 66 passengers per car, the third-class seating three on one side and two on the other,

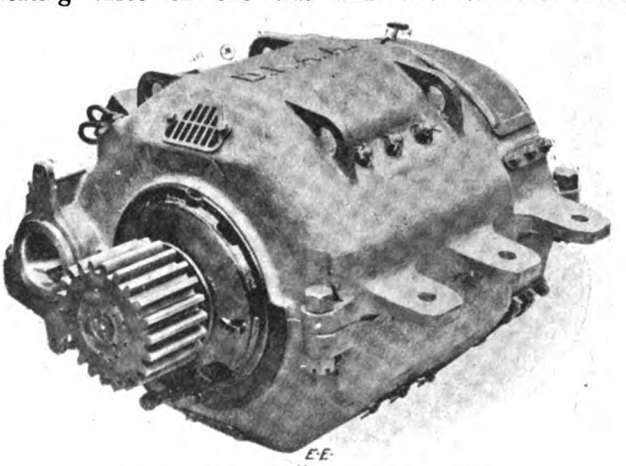

FIG. 16.—The Dick-Kerr 150-h.p. Railway Motor.

and a total of 69 passengers per car, the total accommodation in a normal train being in this way 270 passengers. Between all cars vestibule gangways are provided, and it is, therefore, possible to pass from one end of the train to the other, only those between the first class being, however, for the use of passengers. The finish and equipments of these cars are such as will be highly appreciated by the public. At the driving end of the third-class cars a luggage compartment is arranged for light luggage. Oak shutters on either side which roll down in blind fashion and close or open the whole length of the compartment, have been arranged with the object of facilitating the work of the guard. The underframes throughout are of steel, the side and centre sills being of channel section, each sill being trussed with rods passing over the bolsters to the steel plate headstocks. The bolsters are of steel channel, riveted to the underside of the sills, and supported by straps. Central buffing and draw gear is arranged at each end of the trailer cars and the trailing end of the motorcars, the couplers being fitted with side guide springs to damp oscillation and lateral motion when passing over crossings and round curves. At the motor compartment end standard buffing gear is utilised to simplify the running or shunting of these trains if brought in contact with ordinary rolling-stock.

All cars are electrically lighted and heated, the necessary switches being placed in the vestibule entrance of each coach, and so arranged as only to be accessible by means of a special key carried by the guard. There is a through bell communication which enables the guard, by means of a special key, to give the motorman the signal to start from any

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vestibule entrance on the train. The total weight without passengers of each trailer car is 26 tons and of each motor-car 44 tons, making the total weight of each four-car train 140 tons. The length over all is 248ft. 6in.

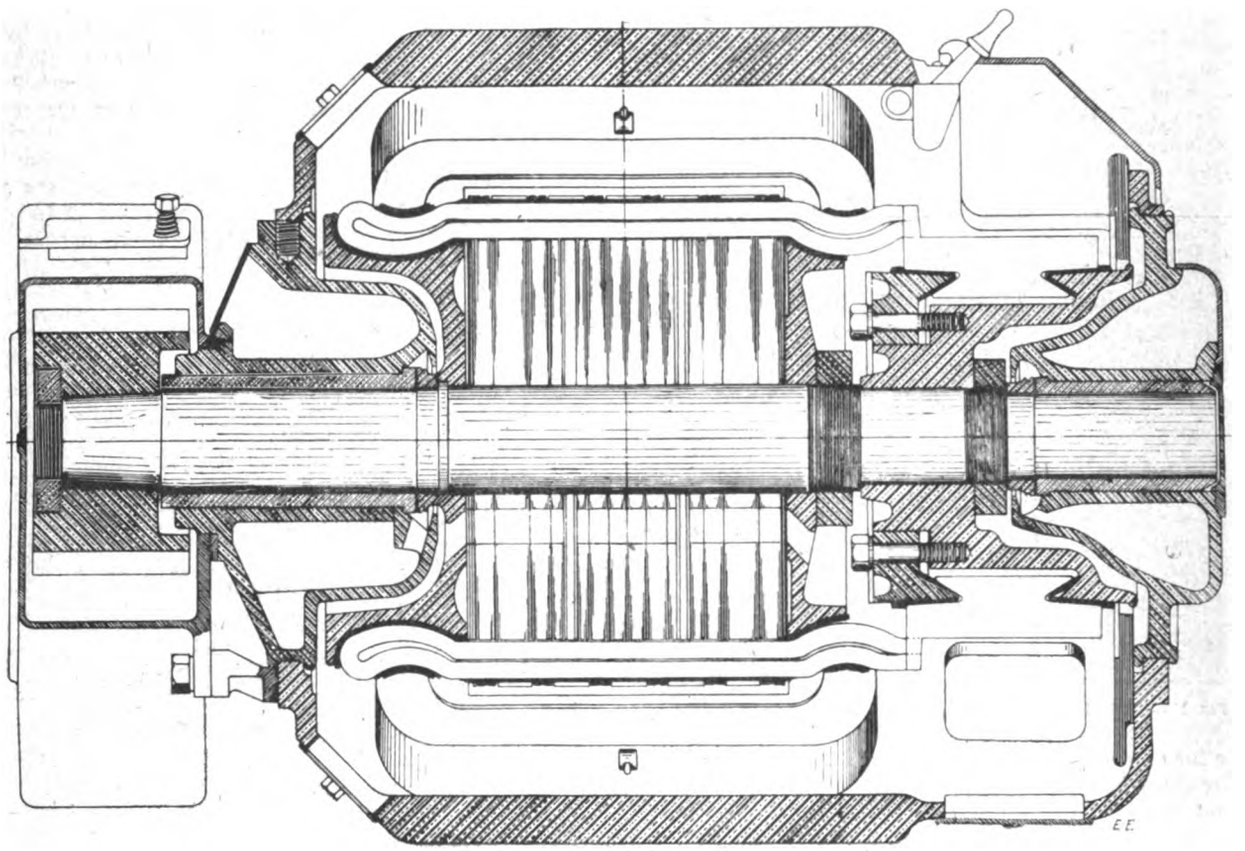

FIG. 17.—Section of the 150-h.p. Motor.

The motor bogie is entirely built of steel, and, as stated before, has an 8ft. wheel base. The wheels are 3ft. 6in. in diameter, an exceptional size in connection with electric traction. The weight of the coach is transmitted from the top bolster by means of elliptical springs to the swing beam, the weight being transmitted thence in the usual method by swing links to the bogie. Steel angles form the side frames; cast-steel stiffeners riveted to the outside of these form nests for the tops of the heavy helical springs which intervene between the bogie frame and the straight equaliser bar. This equaliser bar is carried in stirrups below the axle boxes, the stirrups themselves bearing on the box tops by means of very stiff three-coil helical springs. A special feature in connection with the axle boxes is that the fillets on the journals are kept quite clear of the brasses, thus avoiding a fruitful source of hot bearings. The gears are not split, but forced solid on to an enlargement on the axle and keyed.

The current, as already stated, is collected by cast-steel slippers on each side of the motor bogies (Fig. 14). These

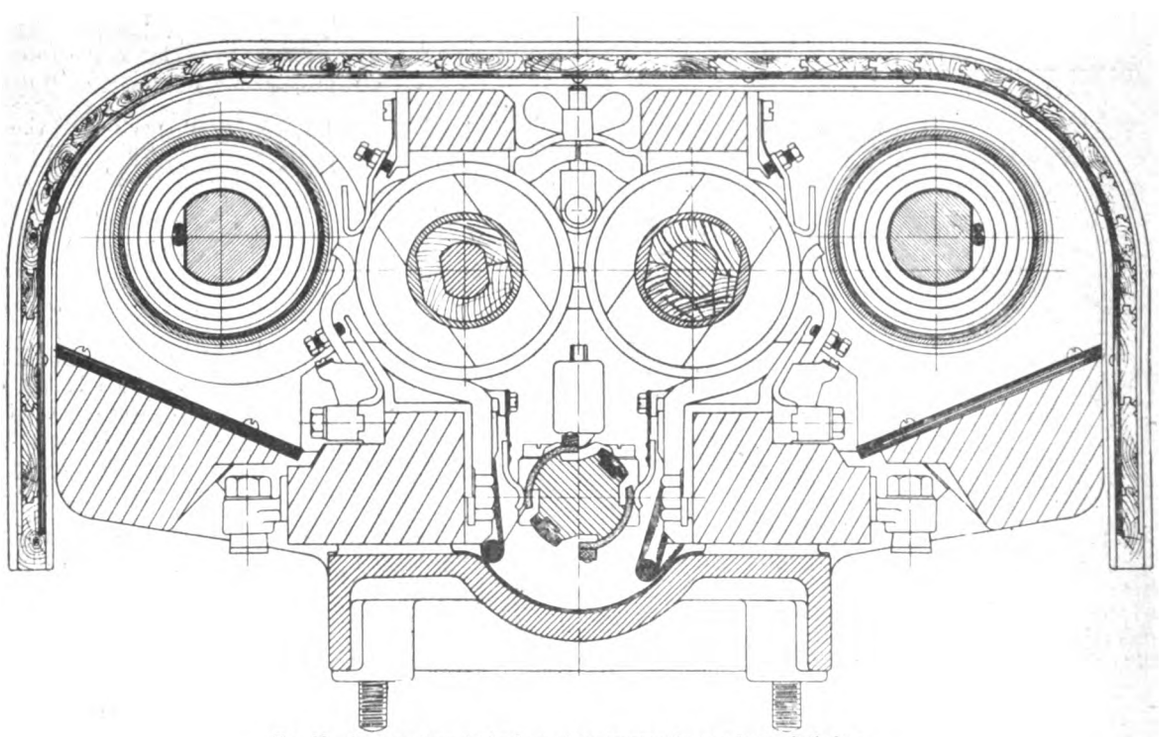

FIG. 18.—Section through the Controller showing the two Power Cylinders.

slippers weigh about 90lb. each, and have so far given the greatest satisfaction On straight runs of third rail there are thus four shoes collecting at one time. From these slippers, which are suspended by forged slotted links from a wooden beam carried on extensions on the bogie, a highly flexible lead of special construction is carried to a fixed terminal

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from which the main cables pass to the controller. The vacuum brake is used on the trains, thus making them adaptable for service with the company's other rolling-stock and locomotives at any time. The general arrangement of fittings and brake cylinders is similar to that

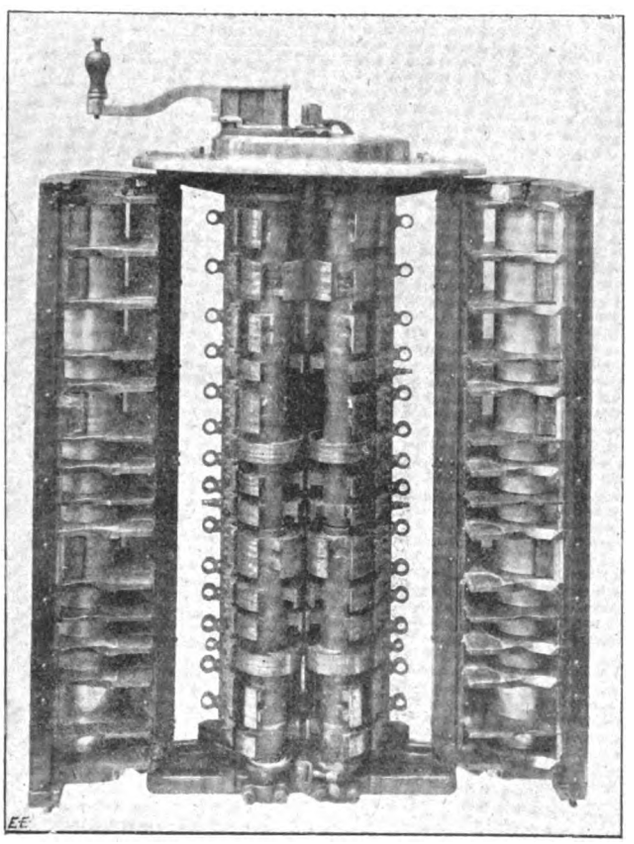

FIG. 19.—The Controller Open with Blow-Out Magnets detached.

already in use; the steam-ejector is replaced by a twin-cylinder geared vacuum pump (Fig. 15) driven by a 3-h.p. 600-volt motor; the usual ball valves on the brake cylinder are dispensed with, and an electrically-actuated valve is substituted; the movement of the motorman's valve when the brake handle is placed in the brake off position lifts these valves along the train, procuring, if desired, an almost instantaneous release of the brake. Automatic electro-pneumatic regulators in the pump motor circuits maintain a constant vacuum in the vacuum reservoir. A large motorcar horn containing a reversed reed of special construction is used in place of a whistle, a connection to the vacuum reservoirs enabling the air for blowing it to be supplied from the atmosphere.

The motorman's compartment, in addition to the controller and switches for the main motors, contains a motorman's brake valve, a vacuum gauge, a single-pole switch for starting the brake motors, and fuses for the pump motor and brake control circuits. The motor compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with uralite, the floor also being fireproof. In addition to the cable troughs in which the cables are placed for conveying current to the motors and equipment being lined with uralite, the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect.

As has been already stated, there are eight motors on a complete train, which drive on to the axles through single-reduction gear. They are of the Dick-Kerr 4-A railway type (Figs. 16 and 17), rated to develop 150 b.h.p. at an armature speed of 470 revolutions. The weight of the complete motor is 6,050lb., the armature 1,920lb., and the gear wheels and housing 508lb. The conditions of performance which the motor has to fulfil, both as regards speed and high acceleration, have necessitated liberality in design, and in consequence they will give considerable overloads for short periods with a moderate rise in temperature. The main features of the motor are similar to those of the standard traction type. The magnetic field is built up of steel shells, in which are four laminated steel poles, secured to the shells by bolts. The spools are built up of copper wire and asbestos ribbon, heavily taped over all, impregnated and baked. The core discs of the armature are of annealed steel, punched with keyways and air-ducts, and are strung direct on the shaft. The windings are former-wound, insulated with a special combination of mica. The commutators are built up of drop forged copper bars insulated with pure mica, the whole being carried on a special hard micanite ring. The brushes are carried from a special bracket designed to give considerable adjustment, and the complete design of the motor is such that ready access is obtained to the brushes and the commutator. The brushes are of high-grade carbon, copper plated.

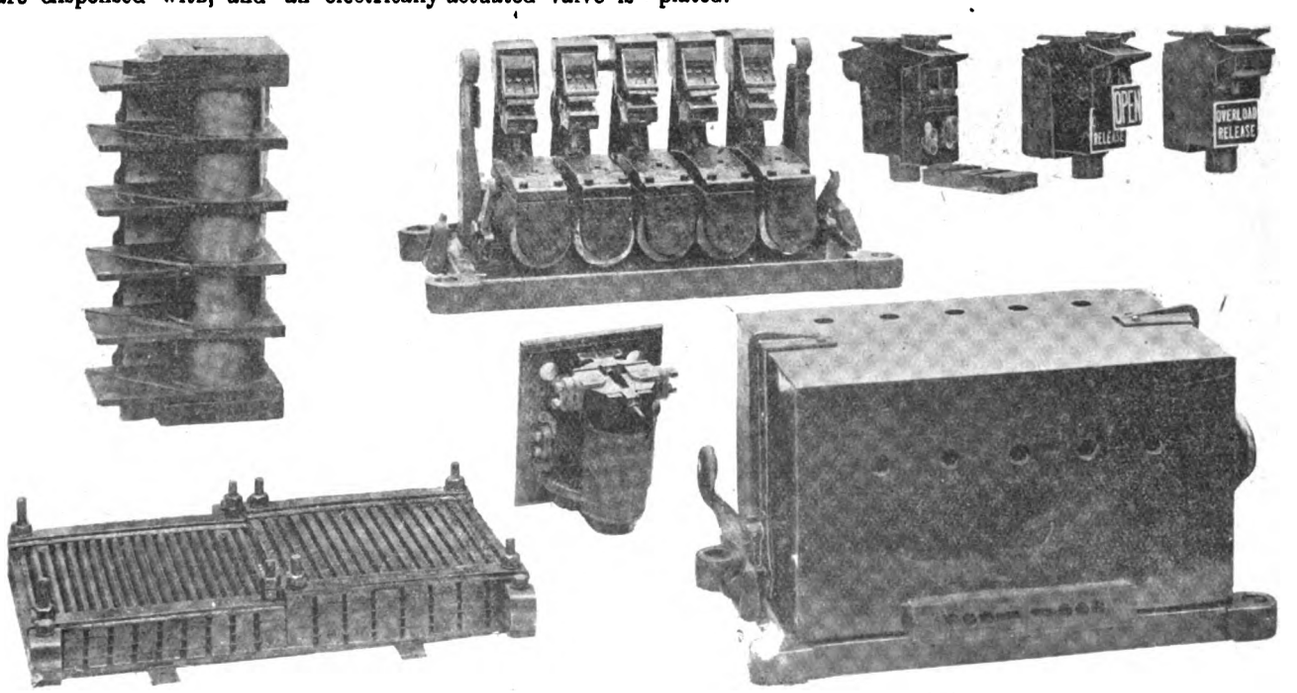


FIG. 20.—Details of the Reversers, Overload Releases, Solenoid Shunt Switches, and Rheostats.

Perhaps the most interesting features of the equipment is the method of control, which may be termed the direct multiple-control system, in contra-distinction to the multiple-unit, the main difference in the systems being that in the case of the former it is possible to control the whole equipment of the train by means of two main cables connecting the front and rear cars. Previously the great difficulty

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in the way of such a simple arrangement lay in the construction of the controller, it being practically impossible to carry the whole of the current through one controller. In the Dick-Kerr system this is rendered possible by the use on the controller of the metallic shield blow-out, which is part of the standard design of their tramway and railway controllers. The equipment now under consideration provides in each driving compartment two power cylinders, each controlling one-half of the train—that is, one motorcar is actuated from one cylinder and the rear motorcar controlled from the other. These two cylinders are actuated by a single handle. Without, therefore, interfering in any degree with the completeness of the train, it would be possible to divide one of the present trains into two distinct units. In other words, the system embraces the whole of the advantages of the multiple-unit control without the necessity of employing numerous connections involved by a contactor system. The train is always operated by the motorman in his cab at the front. In the cab is a Dick-Kerr D.M. 4 controller (Figs. 18 and 19), capable, in conjunction with eight reversers, which are bolted up adjacent to their various motors under the floor, of operating the eight motors on the two motorcars. The two power cylinders of the controller are geared together and operated from a crank handle, each cylinder barrel being flanked by a powerful metallic shield blow-out solenoid. These may be swung open on hinge pins, such action automatically cutting the winding out of circuit, or, if necessary, lifted off and removed for inspecting the cylinders and contact fingers, as in Fig. 19. There is also provided two sets of a single-pole quick-break knife switches and a metallic shield blow-out circuit breakers, one for each motorcar, each of these designed for an overload with a calibration of 500 to 1,600 amperes. The reversal of direction of the motors is effected by means of a special apparatus (Fig. 20) operated by the controller reversing barrel. This reversing apparatus carry contacts which are normally left open by gravity, but can be closed by an electromagnet, which becomes operative through the agency of the controller reversing barrel. There are eight reversers per train, one per motor, which motors when starting are arranged in four parallels of two in series across the system. In series with each reverser pair are the contacts of two magnetic overload releases, the coils of which are each in the main circuit of one of the motors, its reverser contacts and solenoids as shown in the diagram of connections (Fig. 21). Consequently, whether a pair of motors be in series or in parallel, the overload current in either one will cause both releases to open and cut out the pair. These releases are enclosed in small neat cast-iron boxes mounted on the sides of the car near the truck, facing outwards. When open a flap falls down exhibiting "Open" in raised white letters on a scarlet ground, which catches the eye immediately. The releases may also be tripped by hand to cut out any pair of motors that may become disabled. Powerful and certain action of the reversers (Fig. 20) is secured by a compact magnetic circuit and a free and balanced suspension of a heavy clapper, while uniform and reliable contact is ensured by the use of several independent spring

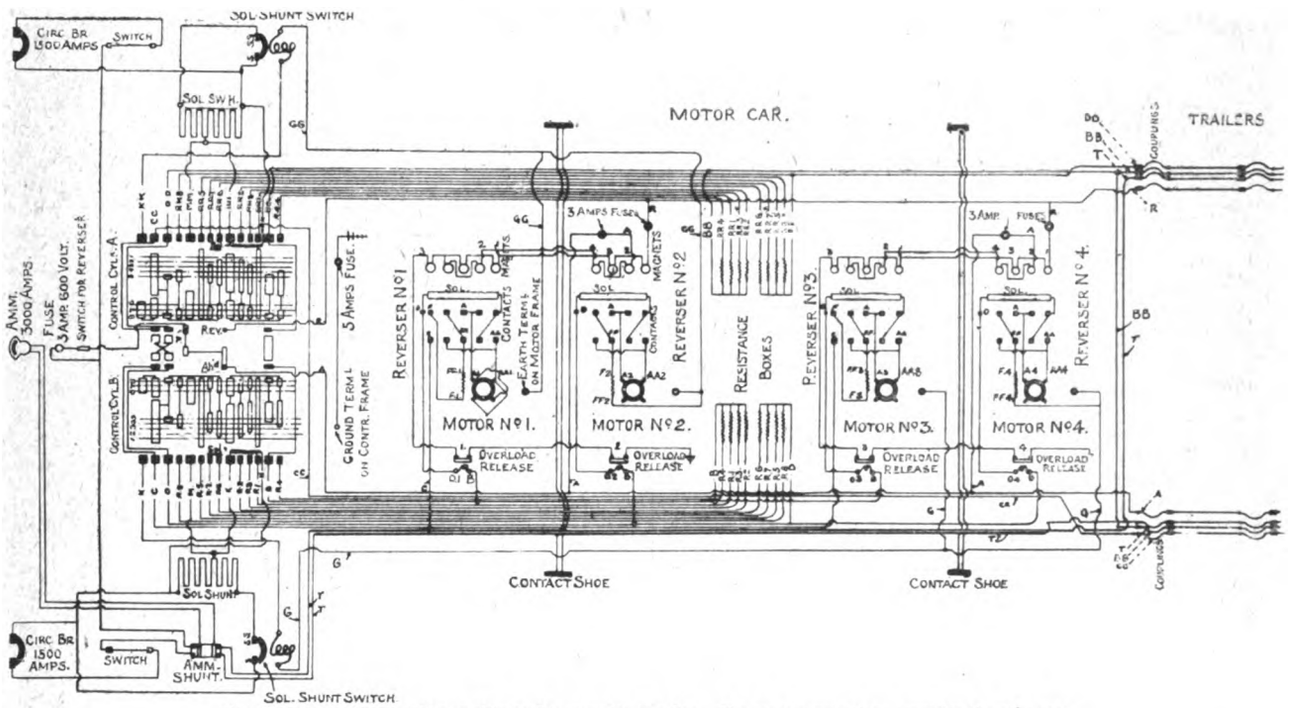


FIG. 21.—Controller and Motor Wiring Diagram for one Car. The same connections serve for the other car.

contacts, so hung as to render sticking impossible. In circuit with each pair of reversers is a cartridge fuse and hand knock-out switch in the cab. The latter is for opening the relay circuits of the reversers, in order to cut off the motors should the controller cylinders stick in any way, or an accident be imminent. In accordance with the usual practice, the power cylinder is locked when the reversing is in an "off" position, and only then can the handle be removed, while the reversing is locked when on "reversed" or "ahead," and the power on one of the notches. The

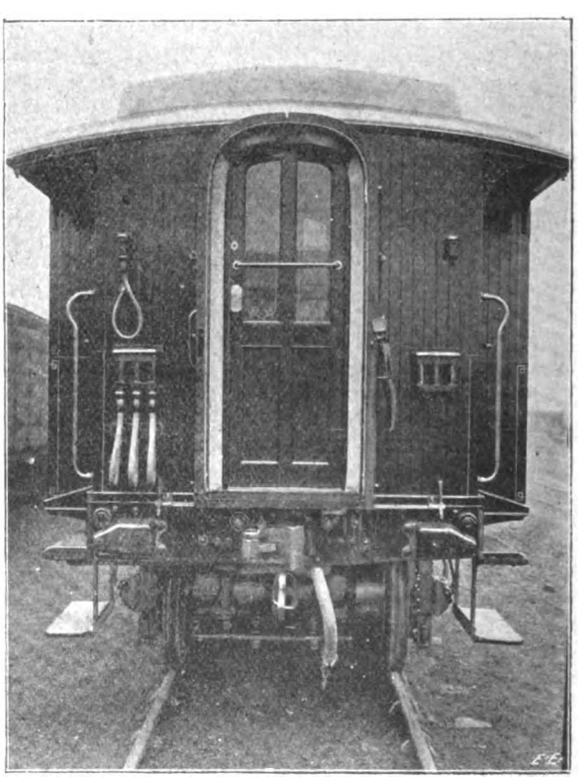

FIG. 22.—End View of Car showing the Electric Connectors arranged three on either side of gangway. They form three circuits each with two cables in parallel.

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power couplings between two cars simply consist of stationary male plug contacts in insulating tubes screwed to the ends of the coaches, with dummies facing them on the coaches opposite, into which female plugs, buried in insulating handles at the end of long flexible leads, click home, according to whether connection or disconnection is required. The heat, light, and reverser couplings are mechanically in one and similar in arrangement to the power. They are all mounted about half-way up the car wall comfortably in reach from the platform, thus obviating all risk of getting on the track and shocks from the third rail.

The diagram of connections given in Fig. 21 shows the method of control, and is worthy of careful study. It is given for a single car only, but the connections on the other motorcar are exactly similar. The only point to be remembered in following through the connections is that the main cable, D D, on the front car connects on to the cable, C C, on the rear car. Conversely, C C on the front car is connected on to D D on the rear car.

The trial trip which was made at the time of our visit was a most satisfactory one, speeds up to nearly 60 miles per hour being obtained. Observations made of the current taken when accelerating showed that this frequently rose to from 1,500 to 1,800 amperes. The controllers handled this large current without the slightest trouble.

In conclusion, we have to thank Mr. Aspinall for the permission to view the line, and Messrs. Dick, Kerr, and Co. for the complete information which they have given us respecting the equipment. The work of erection has throughout been superintended for this firm by Mr. P. W. D'Alton Mr. O'Brien has acted as electrical engineer for the Lancashire and Yorkshire Railway.

## WIRELESS TELEGRAPHY.

BY R. G BLAINE, M.E, A.M.I.C.E., ETC.

*(Continued from page 407.)*

### III.—HERTZ-WAVE SYSTEMS.

*Hertz Phenomena—The Electric Voice.*—Perhaps no single worker has done so much to make success in modern ether-wave signalling possible as the great Heinrich Hertz, who died on Jan. 1, 1894, in his thirty-seventh year. Up till his time the "action-at-a-distance" theory had prevented advance in Germany. Following the beautiful theory of Maxwell on the transmission of vibrations in the ether, and the state of stress in that medium under certain electromagnetic conditions, Hertz took the matter up at the instigation of his master and friend Von Helmholtz. He used at first short flat coils, called Reiss' spirals, and found that the discharge of a Leyden jar passed through one spiral was able to excite induced currents in the other, provided a minute space or spark-gap was left in the latter. In his researches he found, among other things, that the velocity of electromagnetic waves *in air* was the same as that of light, but was much smaller *in wires*, the ratio being about 4 : 7. He also showed that ether waves could be reflected, refracted, polarised, and diffused like light. In fact, the work of Hertz was the first great advance towards long-distance wireless telegraphy, and the account of his work surprised and delighted the scientific world in 1887-88.

In the famous Hertz researches the condenser plays an important part. A condenser consists of two conducting surfaces with a non-conductor or dielectric between. A Leyden jar is the commonest form of condenser, but much larger condensers of special form are used in wireless telegraphic work. Some of these will be illustrated in a later article. Most readers are familiar with the Leyden jar, which is merely a glass jar with a coating of tinfoil up to a certain height, both within and on the outside. A brass knob over the cork or stopper communicates through a stout wire with the inner coating. To charge the jar, this knob is held to the prime conductor of an electric machine giving a high pressure or voltage, the outer coating being connected to earth; or the knob may be connected to the positive pole of an electric generator, the outer coating being connected to the negative pole, thus the inner coating obtains a so-called negative charge, the dielectric being strained. The higher the pressure, the more the dielectric or insulator is strained.

The condenser has been likened to a spiral spring, the extension of which is proportional to the force acting on it, and also to the "stretchiness" or weakness of the spring. The electric displacement is proportional to the E.M.F. and also to the capacity of the condenser, which, in turn, depends on the areas of the conducting plates on the distance between their surfaces and the nature of the dielectric. When a weight is suspended from the spring and is set moving up and down, the spring and weight oscillate with a simple harmonic motion, which gradually diminishes in amplitude till the weight finally comes to rest. The discharge of a condenser has similar effects, causing oscillatory motion in the ether, which gradually dies out. The inertia of the spring has its analogue in the self-induction of the electric current in a circuit, which produces a magnetic field round the conductor, this self-induction tending to cause the current when flowing to continue to flow, and to oppose it at starting. A long wire has more self-induction or electric inertia than a short one of the same material, whilst with two similar wires of iron and copper the iron has more self-induction than the copper.

In the case of the condenser the discharge obviously occupies only a short time, and it is necessary to recharge it. In wireless telegraphy, not a single impulse, but a train of ether waves is wanted, and the induction coil, due originally to Ruhmkorff, is used, or an alternator with large condensers for great distances. The Ruhmkorff coil consists of soft-iron wires of considerable diameter fixed into a disc of the same material at each end. Round this core the primary coil of copper wire—say, 2mm. in diameter—is wound. The secondary coil consists of specially insulated fine copper wire of great length, and usually in sections, in large coils as much as 94 miles of wire being sometimes used, but for an ordinary 10in. spark coil 17 miles of wire will do; this is wound outside the primary coil. The two ends of the primary go to two terminals on the base of the instrument, and the ends of the secondary to two separate terminals, through which pass two brass rods with spark knobs at the ends. The primary coil has a battery and a condenser in its circuit. The condenser is usually in the base of the apparatus, and is made of alternate layers of tinfoil and paraffined paper; into this the current flows when the circuit is broken. The object of the condenser is to make the break of circuit more sudden by preventing the spark of the "extra current" in the primary, due to self-induction, from leaping across the gap of the interrupter, and also to store up the electricity of this "extra self-induced current," so that when the circuit is again made the current shall attain its full strength more gradually, and thus serve to reduce the inductive action at "make" in the secondary circuit.

This making and breaking of circuit is performed automatically by an interrupter, which in coils made in this country often consists of a vibrating strip of metal similar to the trembler of an electric bell. This, however, is not a good form of interrupter. For one thing, the frequency cannot be very readily varied, or, if so, only within narrow limits; there is also some difficulty with the platinum contacts, which are, moreover, expensive. For very large coils a Foucault mercury contact-breaker or interrupter is used, in which a metallic arm attached to a pointed platinum wire alternately raises the point of the wire out of, or depresses it into, a cup of mercury, the arm being attracted towards the coil whenever the latter is magnetised, the arm being drawn back again by a spring when the circuit is broken and the coil ceases to be a magnet. An interrupter somewhat on the same principle—not actuated, however, by the coil itself, but by two outside coils acting reciprocally—has recently been introduced by Drs. Lodge and Muirhead, and is described elsewhere. Mercury turbine interrupters are also used, as described later, and electrolytic interrupters, as shown in later figures. The coil—in laboratory instruments—has also usually a commutator for breaking the circuit or reversing the direction of the primary current. The discharge of the coil is more violent and produces a greater effect on the ether if it takes place in air under pressure, and some gases are even

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better than air. Thus the suddenness of break is 3½ times as great when the pressure is 80lb. per square inch as when it is 50lb. per square inch.

To get a sufficient store of energy for modern work, as well as for purposes of tuning, it is necessary that condensers be inserted in the secondary circuit, but for Transatlantic work these condensers, often of great capacity, are charged, not by a coil, but by an alternator. A modern induction coil, as used by Mr. Marconi for ship work, and giving a 10in. spark, is shown in Fig. 12. Employing the rule "3,000 volts per millimetre of spark," we see that the highest instantaneous pressure in the secondary coil must be in that case something like $3{,}000 \times 25{\cdot}4 \times 10 = 762{,}000$ volts. The vibrations of the ether set up by such a coil are very rapid, 30 or 40 taking place during the passage of a spark and as many as hundreds of millions sometimes in a second. It may be asked, "What determines the frequency

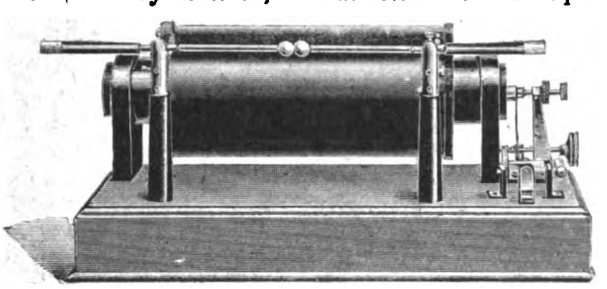

FIG. 12.—A Marconi 10in. Induction Coil. There are 17 miles of wire in this "coil."

or time-period of the oscillations?" The capacity and self-induction of the circuit are the determining factors. This may be simply illustrated by the Hertz oscillator (Fig. 13), consisting of two metal plates attached to two wires which have spark knobs at their ends. The knobs being not too far apart for discharge to take place, then the oscillator has a certain capacity due to the metal plates and air dielectric between, whilst the wires have a certain self-induction. The periodic time, T, is give by the equation $T = 2\pi\sqrt{LC}$, where L is the self-induction, C, the capacity. Of course, the frequency, $n$, is the reciprocal of T, and knowing the velocity of light, $v$, the wave-length, $\lambda$, of the oscillations in the ether may be calculated from $\lambda = T \times v$.

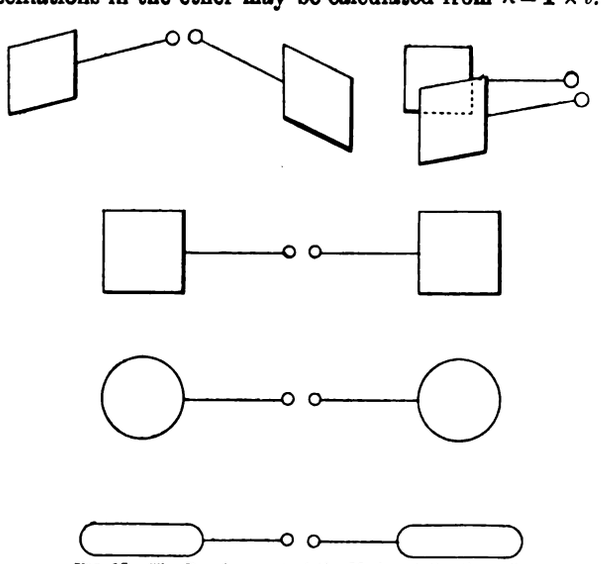

FIG. 13.—The Development of the Modern "Oscillator."

Returning to the analogy of a spring, it is well known that a weak—*i e*, non-stiff or slack—spring vibrates more slowly than a stiff one, so also the greater the capacity of the condensers in, or the self-induction of, the discharge circuit, the slower the oscillations. Circuits have been arranged by Dr. Lodge in which the oscillations were so slow as to give rise to a pleasant musical note, though the highest audible note (not at all pleasant) is one of only about 38,000 vibrations per second. Further, in the case of the spring the inertia of the weight at the centre of its swing, together with the elastic force of the spring at the ends of the swing, combine to produce the true oscillatory motion. Similarly, in Hertz waves, an electromagnetic and an electrostatic effect are both necessary. The electro-magnetic whirl at the middle of the swing, with the electrostatic strain at the ends of that oscillation, are requisite to set up true waves in the ether. The electrostatic strain is confined to the glass or other dielectric, just as the tension is confined to the spring. Air is a better dielectric than glass, and this is what Hertz employed. An ordinary condenser may consist of two sheets of tinfoil with glass between, but if we imagine the tinfoil sheets to be opened out till they finally take the shape shown in Fig. 13, we reach the "Hertz oscillator," which in some cases had sheets of zinc 40cm. (15¾in.) square with a

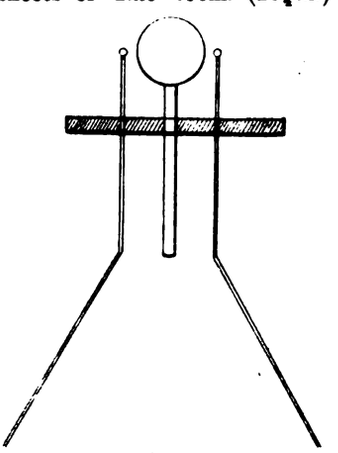

FIG. 14.

distance of 60cm. (23·6in.) between them, the spark-gap being 1cm. long. Two spheres may be employed or two cylinders with hemispherical ends.

As a rule, it may be stated that the smaller and dumpier the arrangement the quicker the vibration or the shorter the period. Spheres give quicker vibrations than plates. However, we cannot by these arrangements get up to a speed of anything like a billion per second, and yet to affect the retina the vibrations require to be at the rate of at least 400 billions per second (see Lodge's "Modern Views," p 341). Thus if the vibrations of the ether, started as above, convey readable messages to distant lands, they must be very much lower in frequency than the vibrations of light. A small oscillator used by Prof. Lodge, consisting of two spheres, gave a frequency of 300 millions per second, whilst a large oscillator of the shape shown in the third sketch of Fig. 13, when excited by a very large coil, had a frequency of 10 millions per second, and produced such marked effects that most of the gas and water pipes of the building and even neighbouring wire fences gave off sparks to conductors brought close to them. These

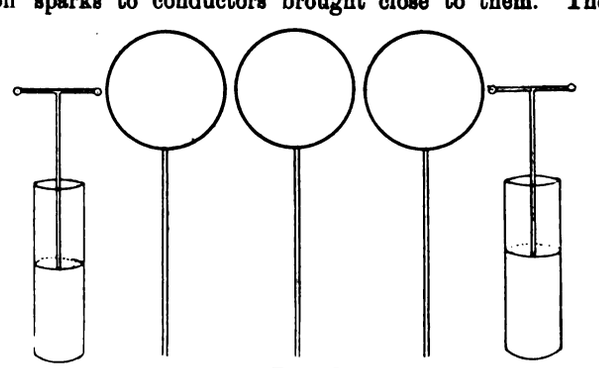

FIG. 15.

oscillators might be charged by an electric machine such as a Wimshurst or Voss machine, but a coil is better. Also, it has been found that light rays (especially ultra-violet rays) falling on the cathode discharging knob caused the spark to pass too easily and with less sudden break-down, therefore probably with less effect on the ether. Dr. Lodge has tried many forms of oscillators, some being very powerful. What is sometimes called the "Lodge standard" type is shown in outline in Fig. 14, whilst the triple-sphere oscillator is depicted in Fig. 15. The oscillations of the larger type of Lodge apparatus are much more damped, dying out more quickly than those from a Hertz apparatus, giving in some cases only 1½ periods.

*(To be continued.)*

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## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

673. The Corporation of A. decided to adopt electric lighting and traction for their town. They have appointed the consulting engineer, who is now ready to proceed with the work; the capacity of the plant to be 5,000 kw. They now require a resident engineer, who is to work under the direction of the consulting engineer to the Corporation, and when all is completed to take over the whole concern and organise a complete staff. (1) What should his qualifications be? (2) How is he to proceed in organising his staff? (3) State the class of men and their qualifications required for the various departments.—E. C.

674. If I have a cable made of four circular conductors, insulated with $\frac{5}{32}$in. of paper around each conductor and $\frac{5}{32}$in. around the bunch, may I supply two towns with single-phase current at 4,000 volts, each pair of conductors being connected to a phase of a two-phase 60-cycle generator? (*a*) Will a varying load at one town affect the voltage at the other town by mutual induction in the cable, the cable being four miles long? (*b*) Would it be permissible to supply these circuits by two separate 60-cycle single-phase generators, the shafts of which are not coupled together?—B. B. B.

### ANSWERS.

*Question No.* 665.—In a three-phase three-wire transmission scheme the power supplied to the sub-station is measured by two recording wattmeters of the motor type. One wattmeter is connected in each of the outer mains with its shunt connected between the inner and outer. It is found that in starting the motor-generator set at the sub-station one of the meters rotates rapidly forward in the normal direction, whilst the other rotates slowly backwards. As the set runs up to speed this latter meter stops, reverses its direction of rotation, rotating in its normal direction.

*Answer to No.* 665 (*awarded 7s. 6d.*).—The reason why one wattmeter gives a temporary negative reading on starting up the motor is that while starting up the power factor is less than ·5—that is, the phase of the current in the stator windings of the motor is more than 60deg. behind that of the volts.

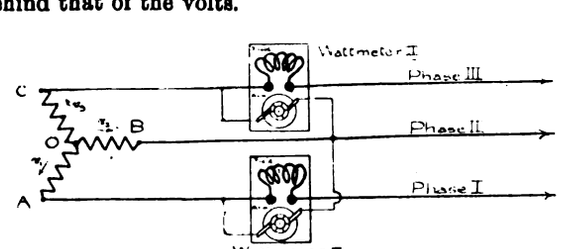


FIG. 1.—Diagram of Connections—Star winding.

Let Fig. 1 represent diagrammatically the three-phase lines with the current coils of the two wattmeters in phases I. and III., and their shunt coils joined across phases I. and II. and phases III. and II. respectively. Consider first a motor with star-connected stator, indicated in Fig. 1 by O A, O B, and O C, O being the neutral point. Let the volts across O A, O B, O C be denoted by $v_1$, $v_2$, $v_3$, and the volts across A B, B C, C A by $V_{AB}$, $V_{BC}$, $V_{CA}$. For convenience, let the E.M.F.'s acting away from O and the currents flowing away from O be reckoned positive. Let $\phi$ be the angle of phase difference between the currents and volts in O A, O B, and O C. We have to show that when cos $\phi$ is less than ·5 the wattmeters will read in opposite ways. To do this, draw the clock diagram (Fig. 2) for above system. Assuming that the volts and amperes follow the sine law, let $\overrightarrow{O\,A'}$, $\overrightarrow{O\,B'}$, $\overrightarrow{O\,C'}$ be three rotating vectors, 120deg. between each pair, whose projections on the vertical at any instant represent to some scale the volts, $v_1$, $v_2$, $v_3$. Similarly, let $\overrightarrow{O\,a}$, $\overrightarrow{O\,b}$, $\overrightarrow{O\,c}$ be three rotating vectors whose projections on the vertical represent at any instant to some scale the currents in the three phases, each one being behind the corresponding voltage vector by the angle of lag $\phi$. To find the rotating vectors for the volts across B C and B A (in Fig. 1), join B′ C′ and B′ A′ (Fig. 2), and

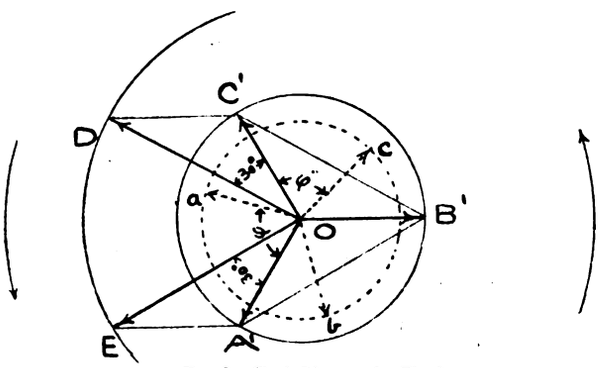


FIG. 2.—Clock Diagram for Fig. 1.

draw O D, O E equal and parallel to B′ C′ and B′ A′ respectively. Then the projections of O D and O E on the vertical will give to the same scale as before the volts across B C and B A in Fig. 1. Now angle O C′ B′ = 30deg. Therefore angle D O C = 30deg., since O D is parallel to B′ C′. Similarly angle E O A′ = 30deg. Therefore angle D O $c$ = $\phi$ + 30deg., and angle E O $a$ = $\phi$ − 30deg. But angle D O $c$ is the angle of phase difference between volts and amperes on wattmeter No. II, and angle E O $a$ is the angle of phase difference for volts and amperes on wattmeter No. I. Therefore, by a well-known proposition (which states that the mean value of the product of two sine functions with a given difference of phase between them, is equal to half the product of their maxima values multiplied by the cosine of the angle of phase difference), the watts recorded by meter I. will be

$$\tfrac{1}{2}\,O\,a\,.\,O\,E\,.\cos(\phi - 30)\times k \quad . \quad . \quad . \quad (1)$$

and by meter II.

$$\tfrac{1}{2}\,O\,c\,.\,O\,D\cos(\phi + 30)\times k \quad . \quad . \quad . \quad (2)$$

(where $k$ is a constant depending on the scales used in diagram). As the cosine of an angle is positive from − 90deg. to + 90deg. and negative from + 90deg. to + 270deg., we see that expression (1) is positive for all values of $\phi$ from 0deg. to 90deg., but that (2) is only positive while $\phi$ is less than 60deg., at which value (2) becomes = O, and as $\phi$ increases past 60deg. (2) becomes negative. If we suppose $\phi$ of opposite sign—*i.e.* suppose the current is leading—the wattmeter conditions are reversed, and (2) is always positive as $\phi$ goes from 0deg. to − 90deg., while (1) becomes = O at 60deg. = $-\phi$, and negative for larger values of $-\phi$.

Summing up, for values of the power factor from 1 to ·5 both wattmeters read in the same direction. For the value ·5 of the power factor, one wattmeter reads zero and the other measures the whole power. For values of the power factor less than ·5 the former wattmeter reverses, and its reading has to be subtracted from that of the other to obtain the total power.—R. S. B.

*Answer to No.* 665 (*awarded 7s. 6d.*).—Though not actually so stated in the question, the motor under consideration will almost certainly be of the asynchronous type, as a synchronous motor is driven up to synchronous speed with the supply from some external source before being switched in, and thus could not possibly affect the reading of the wattmeters. An induction motor, however, can be switched straight on to the line, but at starting takes a heavy lagging current. As the motor speeds up, the *L* of lag will decrease till a certain value is reached dependent on the load and the design of the machine. If the angle of lag exceeds 60deg., one wattmeter reading will give a negative and the other a positive reading, but if the angle be less than 60deg. both readings will be positive.

Fig. 1 shows the wattmeter connections, the series coils of wattmeters 1 and 2 being connected in phases O A and O B respectively, and the shunt coils between $A_1$ $C_1$ and

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$B_1C_1$ respectively. In Figs. 2 and 3 let O A, O B, and O C represent the coil volts, $e$, of the generator differing in phase by 120deg. Let O D, O F, and O E represent the

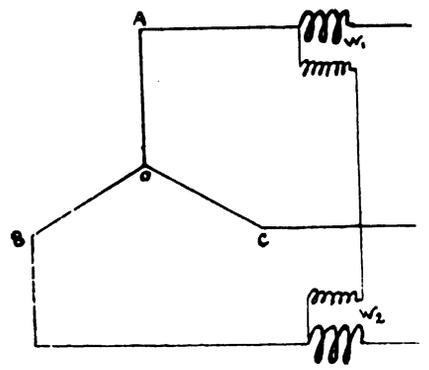


FIG. 1.

coil currents, $i$, differing in phase by some $\angle\phi$ from the coil volts. $AB_1$, $BC_1$, and C A will represent the line volts. If the $\angle\phi$ be less than 30deg., as in Fig. 2, produce

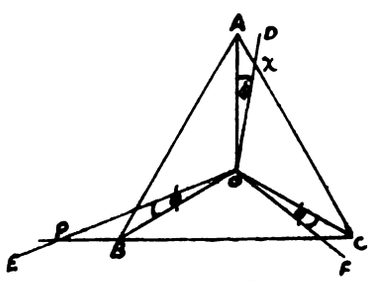


FIG. 2.

O E to cut B C produced in some point P. If $\angle\phi$ be greater than 30deg., as in Fig. 3, produce O E backwards to cut B C produced in some point G. Let $W_1$ and $W_2$

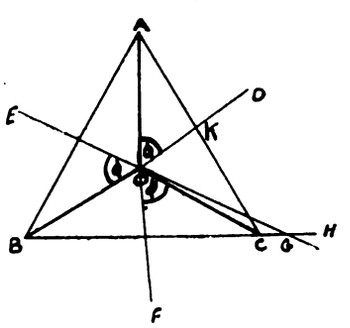


FIG. 3.

represent the readings of wattmeters 1 and 2 respectively. In the first case (Fig. 2),

$$W_1 = A C \times O D \cos \angle A \times D.$$

But $\angle A X D = \angle X O A + \angle X A O = \angle\phi + \angle 30.$

$$\therefore W_1 = \sqrt{3}\, e i \cos(\phi + 30),$$

and is positive, and

$$W_2 = B C \times O E \cos \angle O P B.$$

But $\angle O B C = \angle O P B + \angle B O P,$

$$\therefore \angle O B P = \angle O B C - \angle B O P = \angle 30 - \angle\phi;$$

$$\therefore W_2 = \sqrt{3}\, e i \cos(30 - \phi),$$

and is evidently positive, if in the second case (Fig. 3)

$$W_1 = A C \times O D \cos \angle A K D.$$

But $\angle A K D = \angle K O A + \angle K A O = \angle\phi + \angle 30;$

$$\therefore W_1 = \sqrt{3}\, e i \cos(\phi + 30),$$

which is positive if the $\angle\phi < 60$deg., and negative if $> 60$deg., as the cosine of an $\angle > 90$ is negative; and

$$W_2 = B C \times O E \cos \angle O G B.$$

But $\angle E O B = \angle O G B + \angle O B G;$

$$\therefore \angle O G B = \angle E O B - \angle O B G = \angle\phi - \angle 30;$$

$$\therefore W_2 = \sqrt{3}\, e i \cos(\phi - 30),$$

which must be positive. We thus see that when the $\angle$ of lag exceeds 60deg. $W_1$ is negative, whilst $W_2$ is always positive. The relations of the wattmeter readings to the $\angle$ of lag + 90deg. and − 90deg. are shown by the curves in Fig. 4, taken from Jackson's book on "Alter-

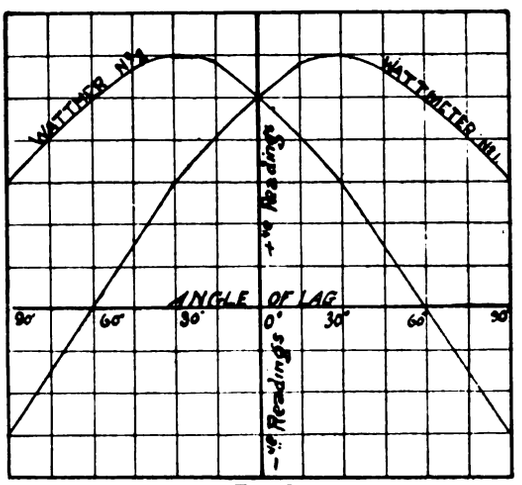


FIG. 4.

nating Currents." The readings of two wattmeters in a balanced (three-phase) circuit at any value of the lag are in the proportion of the corresponding ordinates of the two curves. The same conditions prevail in an unbalanced circuit, provided equivalent angles of lag are considered.—H. RANSON.

*Answer to No.* 665 (*awarded* 7*s.* 6*d.*).—When two wattmeters are connected as described, the sum of their readings gives the total number of watts used in the three phases.

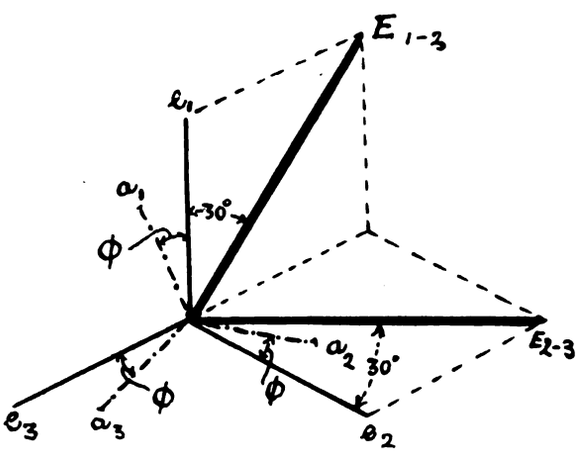


FIG. 1.

This can be seen to be the case from Fig. 1; $e_1$, $e_2$, and $e_3$ diagrammatically represent the voltages of the three phases in their proper angular relation. The same lines would also represent the currents if the circuit were non-inductive, with all the currents in phase with their voltages, but if there is an angle of lag $\phi$ between the current and voltage per phase, the lines $a_1$, $a_2$, and $a_3$ will represent the currents. Now if $e_1$ and $e_2$ represent the outer voltages and $e_3$ the inner voltage, the series coil of wattmeter I. will carry current $a_1$, and its shunt coil will be connected across voltages $e_1$ and $e_3$ in series, whilst the series coil of wattmeter II. will carry current $a_2$, and its shunt coil will be connected across voltages $e_2$ and $e_3$ in series. The vectorial sum of voltage $e_1$ and $e_3$ is given by the line $E_{1-3}$, whilst that of $e_2$ and $e_3$ is given by $E_{2-3}$.

It will be seen that for values of the angle $\phi$ below 30deg. (*i e*, power factors above ·866) the current $a_2$ in the series coil of wattmeter II. is ahead in phase of the current in its shunt coil (the latter being in phase with $E_{2-3}$), whilst the current, $\sim_1$, in the series coil of wattmeter I. lags behind the current in its shunt coil (in phase with $E_{1-3}$). As the inductance of the circuit increases the angle $\phi$ increases, and the phases of the shunt and series coil currents get nearer together in wattmeter II., but further apart in wattmeter I. This continues until $\phi$ reaches 30deg. (power factor = cos $\phi$ = ·866), when the currents in wattmeter II. are in phase, whilst those in wattmeter I. are 60deg. apart. With still lower power

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factors the phase difference in wattmeter II. begins to increase (the series current now lagging behind the shunt current), whilst in wattmeter I. the phase difference continues to increase.

When $\phi$ has increased to 60deg. (power factor = ·5), the phase displacement in wattmeter I. has become 90deg., and that wattmeter will stop; whilst in wattmeter II. the phase displacement is only 30deg., and that wattmeter will continue to rotate in its normal direction. Any further increase in $\phi$ will cause wattmeter I. to begin to rotate in the reverse direction, for the effect is the same as that of reversing one phase in a two-phase motor—the two currents, instead of being as in Fig. 2, become more or less as shown in Fig. 3, and thus reverse the direction in which the rotating field revolves.

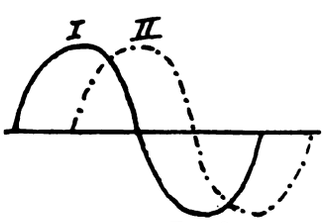


FIG. 2.

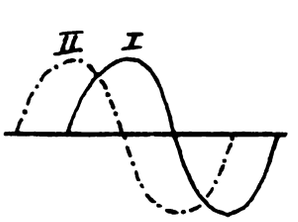


FIG 3.

Now, the power factor of an ordinary induction motor will almost invariably be below ·5 at starting, especially if its rotor is of the squirrel-cage type. The conditions are, therefore, just those required to make wattmeter I. at first rotate slowly in the reversed direction, whilst wattmeter II. runs round at a much higher speed in the normal direction. As the motor speeds up, the power factor gradually improves, and when it reaches the value of ·5, wattmeter I. will stop and then begin to rotate in its normal direction when the power factor exceeds ·5. Wattmeter II. will continue to run in the normal direction throughout, but at varying speeds according to the power absorbed by the motor-generator.—Q.

*Question No.* 666.—It is considered difficult to design continuous-current generators driven by high-speed turbines to operate sparklessly. Account for this. Explain, with sketches, arrangements adopted to overcome this difficulty.

*Best Answer to No.* 666 (*awarded* 10*s.*).—The high speed of a steam-turbine introduces conditions which present singly in other types of machines cause sparking. In the first place, limitations of peripheral speed necessitate a small diameter of armature, even although in most turbine machines speeds well over 10,000ft. per minute are used. If the machine must be of small diameter, it should therefore be long, but the span between the bearings is limited by considerations of the bending of the shaft, which is a consideration of much more importance with high-speed machines, because the centrifugal action on the bent shaft above a certain critical speed causes it to bend more and more and finally break. This means that a turbine-generator must be small for its output. Fortunately, with good design for ventilation, no trouble is experienced in keeping within the heating limit at these high speeds, but the other limit (the sparking limit) is more easily reached because of this otherwise economical use of active material.

The number of poles in a turbo-generator is limited to either four or six, and so the current collected per set of brushes, and also the current in one armature bar, is greater than is usually the case, especially if the turbine is of any considerable power. Again, as the machine is long and the speed is high, it follows that a much larger voltage than usual must be generated in one conductor, therefore the voltage between the ends of one armature turn is larger, and if we have even only one turn per commutator segment the voltage between two consecutive segments will exceed the usual allowance of 12. If it is found possible to double the number of commutator segments (generally it is not), this difficulty may be got over by using a ring winding, then the voltage between two segments is that generated in one bar, and not in one complete turn of two bars as before. Again considering the armature from the reactance voltage point of view, this will be high because of the large current in the conductors and the length of the turn, and a very strong reversing field should, therefore, be provided.

Coming now to causes which depend upon the commutator itself (where the sparking actually occurs), rather than upon the armature, we note that the commutator must also be of small diameter because of limits of peripheral speed, and it must not be too long, because (1) it is itself liable to fly to pieces, and (2) it adds to the total span between the bearings. With a small amount of collecting space available, and a large current to collect, one remedy for sparking is deprived us—we cannot use carbon brushes—and as the width of the copper gauze brushes which are used cannot be greatly increased, the time of commutation is diminished—*i.e.*, the frequency of commutation is increased and the "reactance voltage" is sent up still higher. To overcome these difficulties, some old devices have been revived which were first put forward from 10 to 15 years ago, when great advances were being made in continuous-current machinery, but which devices have gradually dropped out of use in ordinary designs because, owing to numerous improvements in matters of detail, they are no longer found necessary. Such devices are the Ryan and Deri windings, and the compensating poles (Menges and Thomson), many of which will be found fully described in Dr. S. P. Thompson's "Dynamo-Electric Machinery," seventh edition, pp. 262 to 267. The compound windings of Deri are also compensating windings, for they are wound across from one pole to another, and thus act in direct opposition to the distorting armature current.

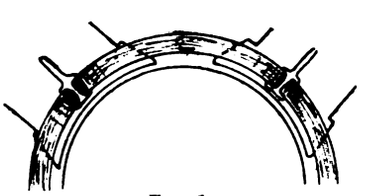

FIG. 1.

Fig. 1 shows the device applied to a four-pole machine. A slot is made in the centre of the pole face, and in this slot the compensating series windings are placed. In the sketch the hole is shown prolonged well into the pole. This acts as a reluctance to the distorting magnetomotive forces and thus limits the distortion. In Fig. 2 is shown another arrangement for the compensating winding. Here the field-magnet part is wound like the stator of an induction motor, the numerous thin coils which are shown being

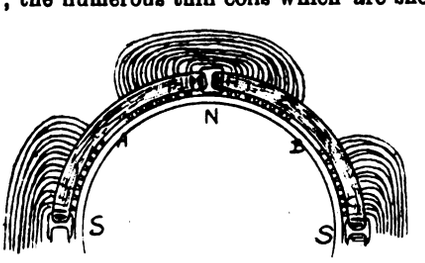


FIG 2.

the shunt coils, which being near down to the pole-face have greater effect in resisting the distorting action of the armature. The compensating coils are also shown as before. It will be further noticed that there is no break in the iron between the poles, but at A and B there are places with no windings. These are the compensating poles, for at these positions the current is collected, and when the machine is

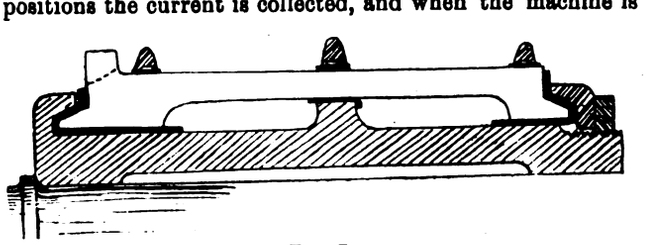

FIG. 3.

loaded, and the load current flows round the compensating coils, these regions are magnetised and a field is produced in which the current may be sparklessly reversed.

The commutator of a turbine-generator must be a very substantial mechanical job. Because of its great length it

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is liable to fly to pieces, and to overcome this difficulty steel rings are generally shrunk over it, as shown in the turbine-generator commutator (Fig. 3). The brush rigging should also be of a substantial design, being built up on a separate stand and not made to overhang from the bearing or the casing of the machine, as is usually the case. For actual examples in turbo-generator design reference may be made to "Dynamo-Electric Machinery," pp. 756-760.—HIGH SPEED.

*Answer to No.* 666 (*awarded* 7*s.* 6*d.*).—In order to obtain sparkless operation, experiment has shown that it is of chief importance to keep the reactance voltage of the commutated section below a certain definite value. This reactance voltage is the back voltage set up in a section owing to the magnetic flux produced round the section by the current in it, being first withdrawn and then reinserted in the reverse direction during the act of commutation.

Various methods have been suggested for calculating the reactance voltage of an armature, but most agree in assuming that it is proportional to the normal current per conductor, to the square of the number of turns per section, to some function of the length of the armature core parallel to the shaft, and inversely proportional to the time during which the short-circuiting of each section lasts. Now the time of short-circuit depends on the ratio of the brush width to the peripheral speed of the commutator, the time in minutes being:

$$\frac{\text{Brush width}}{\pi \times \text{commutator diameter} \times \text{revolutions per minute}},$$

and as in modern machines the width of a commutator plate is a fairly constant quantity, whilst the number of sections covered by a brush is usually between two and three, this expression may be considered as roughly equal to

$$\frac{\text{constant}}{\text{revolutions per minute}}.$$

Consequently the reactance voltage of an armature may be put down as approximately equal to

$$\text{Current per conductor} \times \left(\text{Turns per section}\right)^2 \times \text{Revolutions per minute} \times \frac{\text{Length of core parallel to shaft}}{} \times \text{Constant}$$

As the speed for which a machine of a given output is to be designed increases the current per conductor will usually increase, for the periodicity (or the number of poles) is fixed within well defined limits by the permissible iron losses in the armature core—the higher the speed the lower the number of poles—and assuming an ordinary parallel-coupled armature, the lower the number of poles the greater is the current per conductor.

The turns per section may be reduced up to a certain speed, but generally this speed is very little in excess of the present normal engine speeds, the winding then reaching the one-turn-per-section stage, below which, of course, no reduction is possible. The length of core parallel to the shaft will also increase, for the value of $\frac{\text{kilowatts output}}{\text{revs. per minute}}$ varies approximately as the square of the diameter of the core and directly as the length of the core, whilst for the same peripheral speed the diameter of the armature must drop directly as the speed increases, so that the length of core will increase approximately as the speed. Even allowing for special construction permitting a considerable increase in peripheral speed, the core length is sure to increase somewhat as the speed increases.

It is, therefore, clear that as soon as the speed is exceeded at which, for a given output, a winding with a single turn per section is found necessary from sparking considerations (and for 500-volt machines, at least, this occurs at quite moderate speeds) it becomes impossible to prevent sparking except by the introduction of artificial devices. For instance, the armature can be wound with two windings in parallel, the two windings being connected to alternate plates of the commutator, thus reducing the current per conductor by half. This remedy, however, is often found to introduce new difficulties due to internal currents circulating between the two windings, and so is seldom used. Another method consists in automatically shifting the brushes as the load changes. In this way, by gradually moving the commutated section more and more under the forward pole-piece as the load increases, a reversing E.M.F. just sufficient to overpower the reactance voltage at each load is obtained. The operation of the brush-shifting device is controlled by the amount of steam admitted, and this method is said to give satisfactory results.

The same effect may also be obtained by using compensating coils wound with their magnetic axes midway between two of the main poles, the coils lying in slots in

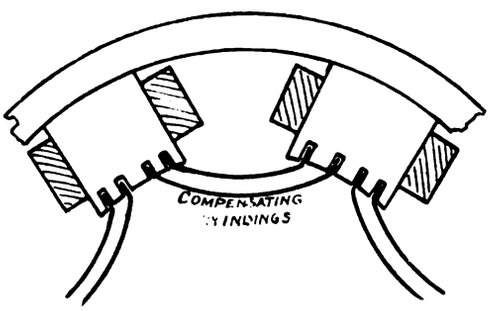


FIG. 1.

the pole-faces as in Fig. 1, or being wound round a small auxiliary pole as in Fig. 2. These windings are in series with the main current of the machine, and so produce a reversing field increasing with the output. It may be pointed out that the purely electrical sparking difficulties

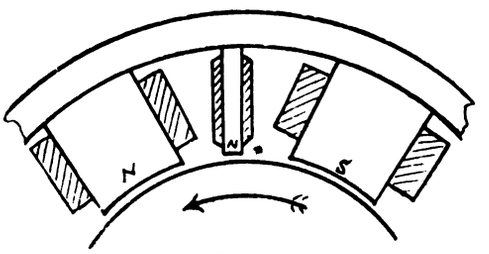


FIG. 2.

in the turbine-generator are much enhanced by mechanica difficulties. It is almost impossible to keep the surface of the commutator perfectly smooth at the high peripheral speeds involved, even if a special supporting ring is put round the centre of the commutator (Fig. 3), as is often done on commutators of any considerable length. On this account, it is sometimes even considered preferable to use copper gauze brushes in place of carbon ones, as the

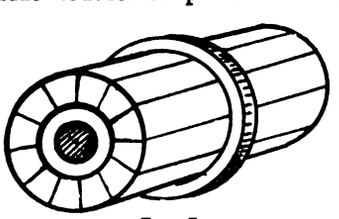

FIG. 3.

latter, owing to their hardness, are liable to be jerked right off a rough commutator at these high speeds unless excessive brush pressures are employed. Gauze brushes, owing to their flexibility, are not liable to this trouble, and can be worked with light pressures and correspondingly low friction losses. At the same time the use of copper brushes, of course, reduces the permissible reactance voltage, and makes the use of automatic devices still more imperative.—Q.

*Answer to No.* 666 (*awarded* 5*s.*).—Owing to the increasing demand for high-speed steam-turbines, considerable attention is being paid to the design and operation of suitable generators for direct coupling to them. Alternating-current generators are far simpler to design than continuous-current owing to the absence of commutators, as the high speeds now obtained on steam-turbines are now detrimental to good commutation, unless very special precautions are taken in their construction.

In the Parsons continuous-current turbine sets the generators are usually of the bipolar type, with smooth-core armatures. By using this type a considerable

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advantage is obtained, owing to the reduction of the periodicity and better commutation. Smooth-core armatures are more satisfactory as regards commutation, owing to the fact that the reactance voltage per coil is considerably less when the coil is not embedded in an iron slot, as is shown by Mr. Hobart in his paper before the Glasgow Congress in 1901. By keeping the periodicity as low as possible the core loss in the armature is reduced, since the hysteretic loss varies directly as the periodicity and the eddy-current loss as the square. In the power station at West Bromwich, Parsons steam-turbines are used throughout. The generators are continuous current and of the bipolar type. Among other turbine sets are two 250-kw. sets running at 3,000 revolutions per minute. These sets are used on the lighting or traction circuits, and in order to obtain satisfactory commutation when working on the latter circuit, a special automatic brush-shifting device is used. One end of a lever is fixed to the brush rocker, and the other to a disc which can move up or down in an iron cylindrical case.

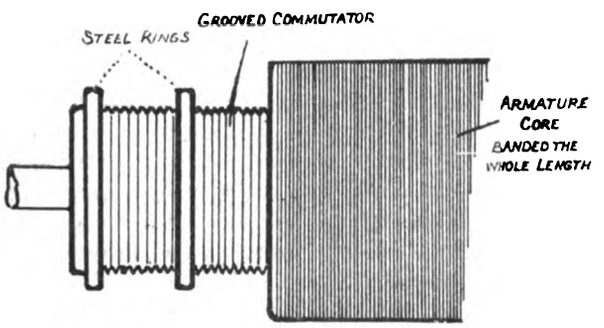


FIG. 1.

On the other side of this disc a spiral spring is fixed. A steam-pipe from the turbine cylinder enables the steam pressure in the latter to act on this disc, thereby compressing the spring and moving the lever, and consequently the brush rocker. If the pressure falls, the spring will expand and the brushes will be moved in the opposite direction. As the steam pressure in the cylinder is proportional to the load on the generator, the brush position will be altered in such a way that the brushes are always approximately on the neutral point, although this point is not fixed, but varies with the load, due to the distorting effect of armature reaction. This automatic device has been found absolutely necessary on the tramway circuit, due to the intermittent loads.

In Fig. 1 a sketch of the commutator is shown, and also part of the armature core. To prevent the commutator plates from flying out, due to the high centrifugal force, two steel rings (insulated from the plates) are shrunk on.

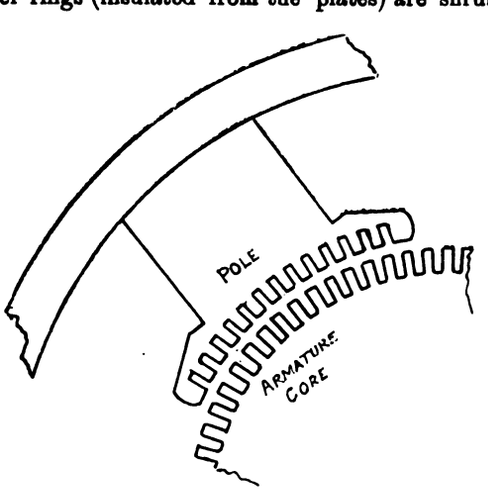


FIG. 2.

The surface of the commutator is grooved, as shown in the sketch, to allow for an increase in the brush contact, the brushes being built up from a large number of brass wires firmly held together in a suitable holder. Considerable pressure is put on the brushes to prevent them rising off the commutator, due to any slight unevenness on the latter. The whole length of the armature core is covered with steel binding wire to keep the conductors hard down on the core; ventilating gaps are made between the lugs connecting the armature winding to the commutator plates

On a 100-kw. generator, driven by a Parsons turbine at 3,500 revolutions per minute, four poles are used, this machine being designed and built by Messrs. Brown, Boveri, and Co. The peripheral speed of the armature is 12,600ft. per minute, and of the commutator 6,550ft. per minute. Gunmetal caps are placed over the end connections of the armature winding to keep them from moving, these caps being firmly fixed to the shaft. For a detailed sketch of this armature, see "Dynamo-Electric Machinery," p. 759, by Dr. Silvanus P. Thompson, 1904.

The Oerlikon Company on high-speed generators use a special construction of magnet pole (see Fig. 2). In each slot in the pole is placed copper strips, which are all short-circuited on one another, somewhat similar to a squirrel-cage rotor. This arrangement is used to prevent oscillations in the direction of the magnetic lines at the point of commutation. In these high-speed machines it is necessary to reduce the diameter of the armature and commutator as low as possible to reduce the centrifugal force. In constructing

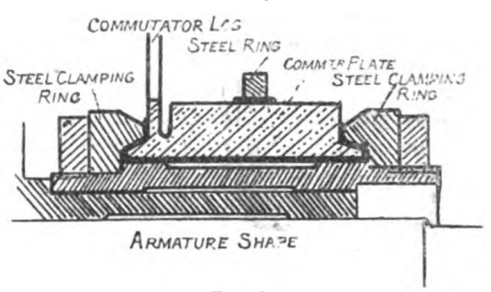


FIG. 3.

the commutator the plates should be held by steel rings as shown in Fig. 3, a stronger and more satisfactory result being obtained when two rings are used in place of one; in the latter case the first ring is cast solid with the shell.

In conclusion, the writer gives a list of the chief difficulties in the design of high-speed continuous-current machines: (1) commutator structure; (2) sparkless commutation, considering the great tendency for the commutator to wear unevenly and the high periodicity of commutation; (3) ventilation of the interior of the armature owing to the large amount of binding wire, etc., necessary to withstand the centrifugal force; (4) perfect balancing of armatures.—P.

## APPOINTMENTS VACANT.

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THE

# ELECTRICAL ENGINEER.

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## THE NATION AND TELEPHONY.

The discussion in the House of Commons on Tuesday on telephony was one of those which show this branch of the legislative assembly at its very worst. It arose upon the question of voting three million pounds for the purpose of the Telegraph Acts, the money being wanted for the purpose of extending and amplifying the present telephone service. Of course, the debate brought up the question of the purchase of the National Company's undertaking, and of all the silly notions in the world, it was suggested that "the House should be given an opportunity of pronouncing before any agreement was arrived at for the purchase of the National Telephone Company." Considering that this purchase will involve some millions of pounds, and that long, difficult, and delicate negotiations will go on before coming to an agreement, it is difficult to see where the House of Commons comes in previous to a settlement being made. Does Mr. Lough suggest that the Postmaster-General should draft a variety of terms of agreement and the House determine to which of these it accords approval, or if none fits their views will they draft the heads of agreement by means of a public debate? There are two parties to an agreement, and it does not hold that because Mr. Lough wants one thing, the Telephone Company will acquiesce in his views. The Telephone Company has, in our opinion, been badly and harshly treated, and if the idea of Mr. Lough is to prepare an agreement and compel the company to agree therewith he is very badly advised. Lord Stanley admitted that the principal question was that of the future arrangement to be made with the National Telephone Company, and, notwithstanding certain dangers which he foresaw, he thought purchase was the right thing to do, and that probably purchase by agreement would be cheaper than purchase by arbitration. There can hardly be two opinions as to the correct policy, and that it is purchase; nor can there be two sane opinions as to the method of purchase. It must be by negotiation, the crucial clauses of the agreement being settled before being publicly discussed. When these are agreed it would not matter much whether exact prices to be paid were absolutely agreed or arbitrated. Mr. Caldwell considered that the National Telephone Company's officials were far too clever for the Government officials; hence his view that the terms for the acquisition of the National Telephone Company's undertaking ought to be referred to a select committee. We might ask, how long has it been proved that a select committee is better for such negotiations than the officials whose lives are spent upon the work? Lord Stanley again deferred to these desires, and intimated that in his opinion a small select committee might be advantageous, not to negotiate, but to ——, and then we find an hiatus; no information was forthcoming as to what the committee was for. He went still further, and promised that no binding agreement should be made until "it had received the assent or ratification of the House." This promise may be the means of landing us still deeper in the mire of indescribable confusion. Assume for the moment that the negotiations have fructified in agreement, and then the House refuses to sanction the agreement, as it assuredly will do if rival parties are nearly balanced and the Opposition can snatch an adverse vote against the Government. What then? The agreement falls to the ground, and the Government may fall to the ground, too, leaving another Government to renew the negotiations or to reverse the policy of purchase altogether. The whole discussion was a pure waste of time so far as the portion relating to purchase was concerned. Whatever agree-

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ment be come to, the House of Commons can say yea or nay because money is involved; hence it was well known to every speaker that in a way the agreement could not be binding till ratified by the House. Our reading of the discussion, however, is that certain members want to have a hand in framing the agreement, and not merely to say yea or nay to a vote for money. The only honest solution of the problem is to meet the National Telephone Company in a fair spirit, to put huckstering and niggardliness on one side, and pay a fair price, not only because they have a system at work, but because they have proved such a system to be wanted throughout the length and breadth of the land; and the reason why the Government must purchase is that telephony is legally telegraphy, and telegraphy is a Government monopoly.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### ELECTRICITY AND FIRES.

SIR,—In a February number of the *Electrical Engineer* we notice an article entitled "Electricity and Fires," which article was evidently taken from the *Canadian Engineer*. For your information, we would advise you that the article which appeared in the *Canadian Engineer* was incorrect, and the following correction has been published in the March number of same paper: "In the article in the last issue, headed 'Electricity and Fires,' the statistics refer to the whole of the United States, and not to Montreal, as stated. The article was reproduced from a Montreal paper whose correctness was assumed. As a matter of fact, only one fire, traced to defective wiring, was recorded in Montreal during the three months in question."

As the Montreal Light, Heat, and Power Company is the only company in Montreal supplying light and power, we were naturally very much surprised at the insertion of the original article, and took up the matter immediately with the editors of the *Canadian Engineer*. Fires due to electrical causes are of very rare occurrence in Montreal, despite the fact that our system of distribution is mainly overhead.—Yours, etc.,

THE MONTREAL LIGHT, HEAT, AND POWER COMPANY.
Montreal, March 8, 1904.

## NATIONAL PHYSICAL LABORATORY INSPECTION.

The annual inspection of the National Physical Laboratory, Bushy House, took place on Friday afternoon last, when a large number of gentlemen interested in the work of the institution responded to the invitation of Sir William Huggins, president of the Royal Society, and Lord Rayleigh, chairman of the General Board of the laboratory, to meet the General Board. All the departments of the laboratory were thrown open for inspection, and Dr. R. T. Glazebrook, the director, with his competent staff of assistants, were untiring in their efforts to satisfy those in quest of information. The general equipment of the laboratory has already been dealt with in our columns, but apart from this there was on view a tide-predicting machine, designed by Lord Kelvin and Mr. Edward Roberts for the Indian Government. It is a marvellous piece of mechanism, whereby the tides round the coast of India are predicted with a degree of accuracy sufficient for practical purposes. The application of such a machine in England would doubtless be precluded by the erratic conditions obtaining, whereas in India the conditions which influence the tides are approximately regular.

There is no doubt that the institution is doing valuable work. This is abundantly apparent from the report for the past year, which also includes an outline of the programme for the present year. In the engineering department the research on wind pressure will be continued, also that on the mechanical properties of nickel steel undertaken jointly by Mr. Hadfield and the laboratory. A special feature of this investigation will be the series of experiments with the alternating stress-testing machine constructed in the laboratory. It is hoped by the aid of this machine, combined with the microscopical examination of the strained specimens, to investigate carefully the phenomena of elastic fatigue. As regards steam research, it is proposed to rebuild part of the present apparatus on a larger scale so as to admit of larger flows and higher pressures. But in its present form the apparatus has served to give preliminary values for the specific heat of superheated steam. When the extension has been effected, the same apparatus will be utilised to determine the latent heat of evaporation of water at high temperatures, and, finally, it is proposed to determine the relation between the pressure and temperature of superheated steam. A machine for the determination of the coefficient of friction of bearing surfaces has been designed, and the construction will be proceeded with early in the year.

In the physics department (electricity division) the experiments made up to the present with standard cells seem to show that differences remaining in the mercurous sulphate obtained from different makers, even when repurified in the standard manner in the laboratory, are the main cause in the differences observed between different standard cells. It is hoped that it may be possible to prescribe a standard method of preparing the sulphate which will eliminate these differences. At present the electrical test of purity is more sensitive than the chemical. At the request of the Electrical Standards Committee of the British Association, the laboratory has undertaken the construction of a standard ampere balance, designed by the late Prof. Viriamu Jones and Prof. Ayrton. The coils of the balance consist of helices of bare copper wire wound on marble cylinders, and its working depends very greatly on the accuracy with which these coils are wound and measured; for this work the laboratory is well equipped, and an experimental coil has been successfully wound and tested. The funds for this work are found by the British Association. When this work is completed it will be possible to go on with the construction of the Lorenz machine, which is to be given by the Drapers' Company.

The tests on insulating materials undertaken for the Engineering Standards Committee will be continued; the investigations now in progress relate to the distribution of temperature within the layers of the field coil of a dynamo or motor. Tests, as ordinarily made, give the mean temperature of the coils; it is desired to know by how much the maximum temperature may in practice differ from the mean. These experiments are being conducted in co-operation with Messrs. Cromptons, Messrs. Johnson and Phillips, Messrs. Mather and Platt, Messrs Siemens Bros., the British Westinghouse Company, and other firms. Much requires to be done to complete the equipment of this division. Large currents are frequently needed for testing meters, etc., both direct and alternating. For this it will be necessary to supply some large storage cells and a set of step-down transformers for use with Messrs. Siemens Bros.' alternator. The question of the automatic regulation of the current used for testing meters and similar apparatus is one of some difficulty, especially when the supply station is a small one and the load very variable. Considerable progress, however, has been made towards its solution, and it is hoped that the difficulty may shortly be overcome. The testing of electrical instruments has increased greatly during the past year, and there seems every reason to anticipate a continued increase. The accommodation provided is already becoming too small.

The work which it is proposed to undertake is the thermometry division includes a study of the thermo-electric force of junctions of platinum, platinum-rhodium and platinum, platinum-iridium, and of the effects of small impurities. For this research a good deal of material is in hand.

In the photometry section of the optical division the first piece of research is an investigation into the conditions under which the pentane lamp may be treated as standard. It is known that its intensity varies greatly with the

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quantity of aqueous vapour present, and also with the barometric pressure and with the carbonic acid. An examination into these causes of variation is now in progress; on its completion it will be possible to define the conditions under which the lamp may be used. The pentane lamp can, however, only be treated as a secondary standard; the next series of experiments will relate to the establishment of some primary standard—*e.g*, the radiation from a square centimetre of glowing platinum at a definite temperature, or that from a perfectly black body at a definite temperature.

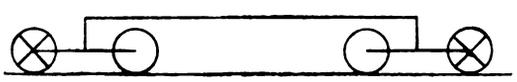
From the report of the experimental work accomplished during last year we learn that the research in connection with the mercury standards of resistance has been carried to a successful conclusion, and a full report is now ready for publication. We also gather that the division devoted to electrotechnics is being organised for the purpose of undertaking tests on electrical instruments, and arrangements are being made for dealing with heavy currents, both alternating and direct, as well as high voltages. In this connection it is interesting to note that a 5-kw. motor-alternator, presented by Messrs. Siemens Bros., has been put down and tested. Single-phase, two-phase, and three-phase currents can be obtained from this machine at frequencies varying from 20 to 120 alternations per second. Messrs. Siemens are also presenting three high-tension transformers to the institution. A quantity of other apparatus, including measuring instruments, etc, has been added to the equipment of the several departments, but these are still far from complete, many applications having been made for tests which it was impossible to undertake owing to lack of equipment. In the engineering department the need of a powerful testing machine was especially felt.

It may be added, in conclusion, that while the work of the laboratory has prospered, the financial position is one which gives rise to grave anxiety. The receipts for the year amount to £10,200. 4s. 3d., while the expenditure has been £10,306. 14s. 6d., thus leaving a deficit of £106. 10s. 3d.. Last year the corresponding figures were £9,314. 19s. 3d. and £9,235. 9s. 8d., giving a balance of £79. 9s. 7d. In addition to this a sum of £1,036. 6s. 11d. has been spent on equipment out of the accumulations of income transferred from the Kew Committee. The balance is now £2,379. 9s. 11d., as against £3,522. 7s. 1d. at the beginning of the year. Thus the laboratory is spending more than its income, and in the opinion of the committee a further increase in expenditure will be necesssry in the present year. To meet this a considerable increase in income is urgently required. By drawing on the balance it will be possible to continue for another year, but the time has come when the financial position must be reconsidered. This is the more necessary since the period for which the grant of £4,000 was originally made ends in September, 1904. In consequence of this the president and council of the Royal Society have been in communication with the Treasury, and it has been arranged that the grant of £4,000 shall be continued to April, 1905—*i.e.*, for the financial year 1904-5—and that the committee should prepare a scheme for the consideration of the Treasury. The Treasury have been asked when the scheme of the Executive Committee is received to carefully consider "the work and organisation of the National Physical Laboratory, with a view to laying down the lines that ought to be followed in the future," and have stated in reply that they "will be prepared to give careful consideration to the statement and proposals with regard to the future." At the same time, considerable encouragement is given by the fact that the number of tests made during the past year show a very satisfactory increase over the corresponding figures for 1902, the sum received in fees having increased in the same ratio.

## THE POSITION OF MOTORS ON BOGIE CARRIAGES.

BY B. PONTIFEX.

Where ought motors to be fixed on bogie cars, and where ought those cars to be placed on the trains? There is a great diversity in the practical answers to these questions, caused by taking as the chief consideration convenience of fixing the motors and connecting up the controlling cables. On steam roads, a new type of locomotive or fresh pattern of car is seldom adopted without consultation with the permanent-way engineer who is responsible for the track, but on electric roads, whatever may be the reason, the engineers apparently design their equipments without any advice from the one man in the railway world who could tell them how to arrange matters to produce as little undue wear as possible either on rolling-stock or track. The locomotive engineer does not usually grasp these points because he finds that, under the new conditions, there is no question of balancing reciprocating motion, and overlooks the fact that many arrangements of driving wheels are being tried afresh, after having been condemned for various reasons by railway engineers in the past.



⊗ Signifies Driving Wheels

Fig. 1.

Take first the position of the motors on eight-wheel cars which run without trailers, whether on enclosed tracks or on street lines. Four-motor equipments are out of consideration in this article, because there is no practical variation on "one axle, one motor," but with two motorcars there is plenty of room for discussion, though the third possible arrangement (both motors on the same bogie) has only been adopted on trains, yet the advocates of either of the other systems are each prepared to describe the opposition as N. D. G., or something equally affectionate. Motors on the outside axles—*i.e.*, leading on the leading bogie (Fig. 1)—act as follows: When a car like this enters facing

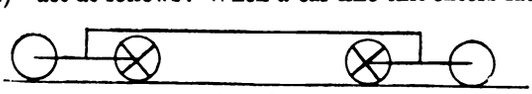


Fig. 2.

points, the leading wheels strike the curve with the momentum due to the whole car, because they are not idle, but are pulling the car behind them, and at the moment of impact there has not been any chance for the bogie to swing on its centre pin. The result of this is excessive hammer action, which causes the rails to wear faster than they should, and loosens any nut on the car which is in any way disposed to shift. On the other hand, when the motors are trailing on the leading bogie (Fig. 2) this is considerably decreased, an

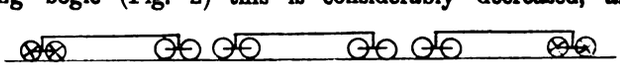


Fig. 3.

idle pair of wheels enters the points first, and the body of the car has begun to swing over towards its new direction before the heavy driving axle strikes the curve. This applies to maximum traction trucks also, but in a greater degree in proportion to the distance between the radius centre and the truck centre. Of course, when the trailing bogie reaches the points, the body of the car is fully swung over, and the only hammer is caused by the weight of the truck alone.

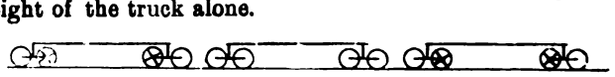


Fig. 4.

On tramlines it is often compulsory to run the motors on the leading axle of the front bogie, because tram tracks are not seldom a half-hearted attempt to use horse-car tracks in order to save capital expenditure, and unless the heavy driving wheels lead there is a great tendency for bogie cars to jump the track on a bad road. However, in the long run street tracks must inevitably be brought more into line with railroad practice. On trains, whether all cars are motorcars or not does not appear to alter the question of the position of the motors on the car itself. Take a very common arrangement, two motors on the leading bogie and none on the trailing (Fig. 3). If two men wanted

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to carry a log of wood, they wouldn't both take hold at the same end and allow the other to trail on the ground, but it doesn't seem unlike the arrangement shown in Fig. 3, when allowance is made for the difference in friction between the end of the log and the ground and between the truck and the rails. This (Fig 3) was tried on some experimental runs, but the results were not up to anticipation; the motors were then altered as in Fig. 2, giving the train arrangement shown in Fig. 4, when there was no difficulty in passing the tests, and it was also found that the track was less affected by the increased speed. Unfortunately, in "tube" railways the consideration of floor level prevents any other method than Fig. 3 because the motors must be grouped under the driver's compartments, as the diameter of the tunnels will not allow the floors to be raised throughout the train, and passengers would object to climbing over humps in the carriages, if the motors were distributed through the length of the train to obtain better acceleration.

There is another disadvantage entailed by placing two motors at each end of the trains and nowhere else—namely, that when crossing points at any speed above crawling, the rear motors must be cut out so that the train can be pulled and not pushed. This was proved in the early days of steam railways, when it was found that a locomotive could pull a train through points without derailment at a far higher speed than it was possible for the same engine to push the train over the same points, even on the best-laid track. The Central London Railway have recently rediscovered this, after changing over from the locomotive to the motorcar system, with two motors on the leading bogie of a seven-coach train and two on the trailing bogie; at each terminus the trains are now shunted by means of the leading motors only. The ideal system, both from the point of easy running and of acceleration, is to have motors on the inner axles of each carriage (Fig. 2), and to make up the trains of the required number of similar cars; but on a long train the control of 14 to 30 motors simultaneously would require expensive apparatus and cabling, and at present the cost of this prevents its adoption in a whole-hearted manner. The Liverpool Overhead Railway have approached this point, and at present hold the record for acceleration with the arrangement shown in Fig. 4. It will be of great interest to compare with this the results, when published, of the new service of electrically-driven trains on the Liverpool and Southport branch of the Lancashire and Yorkshire Railway, especially as the same firm of engineers, Messrs. Dick, Kerr, and Co., are responsible for the design and manufacture of the motors.

In conclusion, there appears to be an opening for discussion on this point, and the above article is chiefly written with the object of drawing it.

## THE FARADAY SOCIETY.

At an ordinary meeting of the Faraday Society, held on Monday, March 21, at the Institution of Electrical Engineers, Dr. O. J. Steinhart in the chair, a paper by Dr. F. M. PERKIN and Mr. W. C. PREBBLE on "The Electrolytic Analysis of Gold" was read in abstract by Dr. Perkin.

The object of the researches described was to arrive at an electrolytic method of estimating gold which should be perfectly accurate and yet far more rapid than the ordinary double cyanide method, which the authors, differing from Classen, consider inordinately long, even in hot solutions. Solutions of sodium thiosulphate, cyanide, sodium sulphide, potassium thiocyanate, and ammonium thiocyanate were all tried and the results compared. The first named was useless; of the others—which are all accurate—the thiocyanates gave the best results, and the ammonium salt was better than the potassium. With currents of 0·2 ampere per sq. dem. the deposition of 0·05 grm. to 0·08 grm. of gold was complete in five or six hours. With a current of 0·4 to 0·5 ampere 1½ to 2 hours sufficed. The presence of a little persulphate considerably reduced the voltage required. Experiments were also made to determine the best method of removing the deposited gold. Chlorine or bromine water were satisfactory, but slow; aqua regia was risky; the authors recommended a 2 per cent. solution of potassium cyanide containing a little hydrogen peroxide or a persulphate. One or two minutes then sufficed to remove the gold. An improved form of basin electrode for working with hot solutions was described. A lamp-wick siphon, from a small reservoir, supplies water to compensate for evaporation.

Mr. CHAS. R. DARLING then read a paper on "Thin-Film Electrolysis, and a proposed application to Printing," which was illustrated by experiments. While investigating a process for letterpress printing by electrolysis without the use of ink—an extension of Bain's well-known telegraphic printing—the author found that the final results of electrolysis, when the electrolyte forms only a thin film, often differ materially from those observed in an ordinary cell. In these experiments a carbon or metal plate (it was immaterial which) formed the anode; on this was placed an impression pad, consisting of some sheets of moist blotting-paper, upon this was the trial sheet carrying the electrolyte film, and on this the cathode type or coin. Voltages from 6 to 200 were employed. To obtain a clear image of the type, a certain minimum strength of solution is requisite. The first experiments were made with saline solutions. Silver nitrate gave a clear, permanent black image of the type, but the paper, of course, darkens on exposure; copper sulphate and nitrate yielded images that faded after a time; the same unexpected result occurred with lead, mercury salts, and bismuth. The best images were obtained with manganese salts. These, consisting as they did of the oxides or hydrates, were quite permanent; all purely metallic deposits, excepting silver, disappeared after a time. In the case of non-saline solutions the paper, which might consist of asbestos or pure Swedish filter-paper soaked in distilled water, acquired the properties of an exposed photographic plate, and on treating with a silver salt and developer, a perfect image of the cathode was obtained, even after a long interval. Reproductions of such "electrographs" are given in the paper. The latent images are not due to hydrogen peroxide, nor to metallic compounds, as they occur with carbon electrodes; but they reside in the surface of the paper in contact with or towards the cathode. The author ascribes them to a class of phenomena that have been investigated by Bose and termed "the response of inert matter to electrical stimuli," and thinks they are probably the result of some state of strain set up in the film by the current. As regards the fading of the metallic images, this may be simply due to recombination, although that explanation is not entirely satisfactory.

In the discussion which followed, Dr. H. BORNS asked whether the author had treated his latent images with any solutions before developing.

Mr. N. J. BLUMAN said that in some electrolytic printing that he had carried out they had used some organic solutions with good results.

Mr. FONTANA suggested that the latent images might be due to occluded hydrogen.

Dr. PERKIN thought this supposition could be tested by exposing the paper to an oxidising agent.

Mr. BAWTREE asked whether it were possible to get rid of the latent images. If so, some light would be thrown on their cause.

Mr. PRIDEAUX asked whether the author had tried developing anode images where carbon formed the anode, so that no metal went into solution.

Dr. STEINHART did not agree with the "strain" theory put forward by the author. All materials contain some trace of saline matter, and one was almost sure to get chlorine or some such substance given off on electrolysis.

Mr. DARLING, in reply, thanked the speakers for their useful suggestions, many of which he had not had time to follow up, but hoped to do so in the future. Referring to Mr. Bluman's remarks, organic substances eventually discoloured the paper. He did not think hydrogen the cause of the latent images; certainly hydrogen peroxide did not destroy the image.

## TRADE NOTICES AND NOVELTIES.

### Electromagnetic Track Brakes.

To meet the demand for a reliable tramcar brake the British Thomson-Houston Company, Rugby, have developed the device illustrated herewith. This device consists of suitable electromagnets which are mounted in proximity to the track, and which, when energised, are drawn in contact with the rails. The energising current is generated by the motors acting as generators, and the braking action is obtained both by the attraction of the electromagnets to the rails and by the direct retardation of the wheels due to the motors acting as generators. The brake shoe itself consists of a substantial steel casting with a cored recess into which the magnetising coil is placed. A brass cap or cover is placed over this coil, and so fitted as to form a water-tight protection. A steel core extends through the coil, providing two magnetic circuits, each of which is completed by the section of rail immediately under the brake-shoe. The terminals of the magnetising coil consist of well insulated flexible wires brought out through bushed holes in the top of the cast-steel frame of the shoe. They consist of two wires in duplicate, and are of sufficient length to extend from the end of the coil winding to the car underframing without a joint.

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Each shoe is provided with wearing plates for contact with the rails. These plates are steel castings, held in place by machined bolts so placed that the plates may be renewed without removing the brake shoe from the truck. The efficiency of the brake as an emergency and service brake has recently been demonstrated by a series of tests carried out under actual working conditions on one of the heaviest routes in the country. A four-wheel double-deck car with two motors was used, and

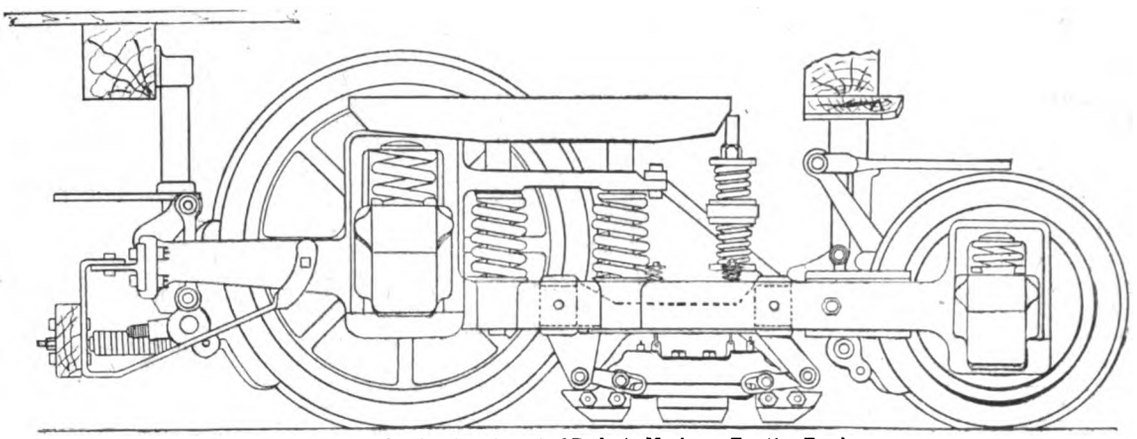


Diagram showing Attachment of Brake to Maximum Traction Truck.

some tests were made with the magnetic track brake with the following results:

*Emergency Stops.*

| Speed on applying brake. | Time to stop. | Distance to stop. | Grade. Down. |
|---|---|---|---|
| 5 miles per hour ..... | 4 seconds ..... | 25 yards ..... | {1 in 13 / 1 in 14 |
| 14 ,, ,, ..... | 1·6 ,, ..... | 5·3 ,, ..... | Level. |

*Speed Regulation Descending Grades.*

| Speed maintained. | Grade. | Current per motor. |
|---|---|---|
| 5 miles per hour ..... | {1 in 13 / 1 in 14} ..... | 4 amperes. |
| 5 ,, ,, ..... | 1 in 17 ..... | 3·5 ,, |
| 5 ,, ,, ..... | 1 in 45 ..... | 2 ,, |

The first test represents extreme conditions, such as a car running away down a steep incline, and, considering the gradient and the high speed, the stop was very rapid, being made in about 2½ car lengths. The second test would correspond to the case of a car travelling at a moderate speed and obliged to pull up suddenly. It will be seen that such a stop can be made in less than a car length. The second table is interesting, inasmuch as it shows that a low and even speed can be maintained when the car is coasting down the steepest grades, so that it is always under perfect control. If necessary, the car can be brought to a stop by further movement of the controller handle, and held at rest by the wheel-brake.

## Iron-Cased Bells.

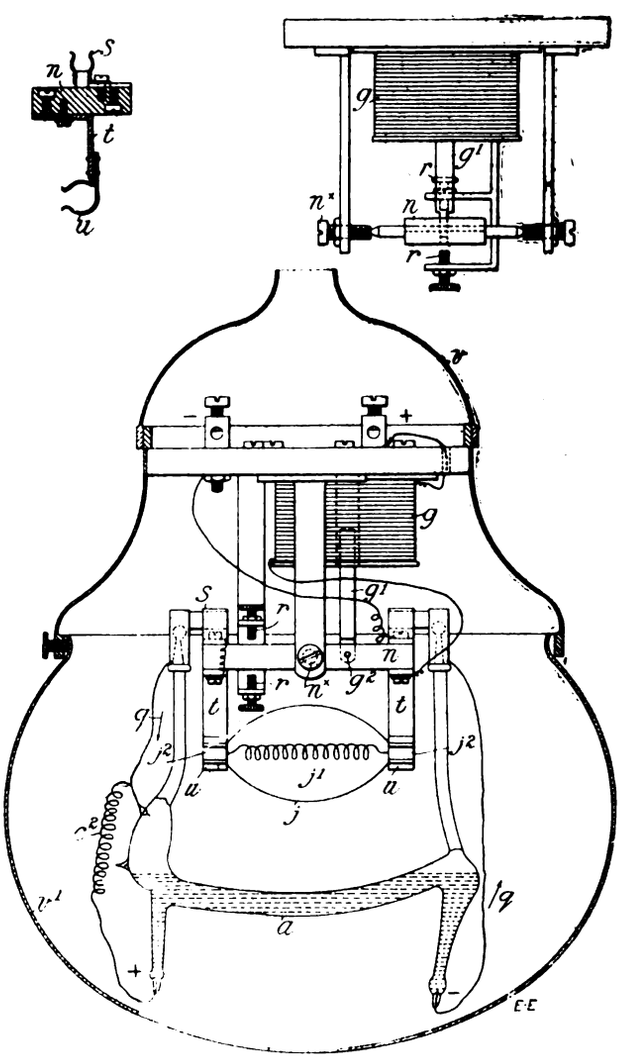
The International Electric Company, of 55, Redcross-street, Barbican, E.C., inform us that they have just brought out a gas and waterproof iron-cased bell, the main feature of which is that it can, without the insertion of a separate lamp or other resistance, be connected direct to any electric light supply up to 250 volts. Hitherto electrical protective devices, such as fire or burglar alarms, danger signals, etc., have been dependent on the satisfactory state of the battery, and if the battery should by some mischance be neglected or run down, even the best fire or burglar bell would be useless. The bells are stocked by the above-mentioned company for 100 or 110 volts and 200 and 220 volts, but they can be made to suit any voltage up to 250.

## The Latest in Hack Saws.

Messrs. Beanland, Perkin, and Co., School Close Works, Leeds, have sent us a sheet dealing with their new No. "0" hack saw, which they consider to be equal or superior to any of the small hack sawing machines at present on the market, while the low price will open a field for it in small workshops. The saw has a capacity up to 5½in. square. All sliding guides are dispensed with, the saw frame being swung on a rigid link motion. Less power is required owing to the swinging motion, and the slight rocking of the blade, causing it to keep working at different angles, results in increased speed of cutting.

## The "Bastian" Mercury Vapour Light.

Messrs. Rumney and Rumney have on view at 39, Victoria-street, Westminster, S.W., a very interesting mercury vapour lamp which has been perfected by Mr. C. Orme Bastian and Mr. A. E. Salisbury. The construction of this lamp is very simple. In the accompanying illustration it is shown in its normal position, but when the current is switched on, the series magnet, $g$, is energised and draws up the core, $g^1$. This causes the lamp, $a$, which is attached to the beam, $n$, to tilt, and the mercury, indicated by the dotted lines, is thus separated at the negative electrode, the short arc first formed being subsequently lengthened out along the tube by the pressure of the mercury vapour generated within the arc. Thus the arc is formed between two mercury contacts and maintained by the pressure of the vapour when the lamp has been started. Each lamp requires from 40 to 60 volts, and as many are arranged in series as the pressure of the supply may necessitate. Or when it is required to concentrate the light, a number of burners may be arranged in series within one lamp. We were shown a lamp provided with two burners in series, which was taking ·65 of an ampere at 100 volts pressure while yielding 160 (estimated) candle-power. But until the results of photometric tests are available it would be unfair to base conclusions as to the efficiency of the lamp, although




Connections to the Bastian Mercury Vapour Lamp.

this is apparently very high. Each lamp takes a starting current of about 1 5 amperes, but this is only momentary. In form the lamp is essentially handy. It is intended, we understand, primarily for street-lighting, but may also be adapted for interior lighting by supplementing the orange rays in the mercury vapour light. This is effected by inserting a carbon filament lamp, J, in series with the vapour lamp, a combination necessitating the resistance, $C^2$, which is automatically cut out

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when the mercury arc is sufficiently formed. Another point is that the voltage on the lamp may be varied as much as 25 per cent. either way without interrupting the lights. For the rest, this lamp certainly seems to offer great possibilities, and we shall watch its career with interest.

### Catalogue.

ELECTRIC OVERHEAD TRAVELLING CRANES. Chambers, Scott, and Co., Dalziel Engineering Works, Motherwell, N.B.—Pamphlet E.C., 1904, illustrated, describing electrically-driven cranes of various types.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 25.

**North-East Coast Institution.**—"Automatic Governing of Marine Engines," by Mr. H. M. Wilson.

**Physical Society.**—At 5 p.m., "Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance." by Prof. J. A. Fleming, F.R.S. "A Hot-Wire Ammeter for Measuring Very Small Alternating Currents," by Prof J. A. Fleming, F.R.S. "The Energy of Secondary Röntgen Radiation," by Mr. C. G. Barkla.

**Institution of Electrical Engineers, Manchester** (Students' Section).—"Photometric Testing," by D. Livingston Sands.

**Royal Institution.**—"Liquid Hydrogen Calorimetry," by Prof. Dewar, M.A., LL.D., D.Sc., M.R.I.

**Institution of Civil Engineers.**—Students' meeting at 8 p.m. "The Relative Advantages of Continuous and Alternating Current for Traction Purposes," by Mr. J. M. Kennedy, Stud.Inst.C.E. Mr. C. H. Wordingham, M.I.C.E., in the chair.

**Electro-Harmonic Society.**—At 8 p.m., last smoking concert of the season.

SATURDAY, MARCH 26.

**Royal Institution.**—At 3 p.m., Lord Rayleigh on "The Life and Work of Stokes" (Lecture VI.).

**Manchester Association of Engineers.**—At 7 p.m., "The Adaptability of Electrical Driving."

**West Ham Technical Institute.**—At 7 p.m., students' conversazione

**Glasgow Technical College Scientific Society.** — At 7.30 p.m., annual general meeting.

**Sanitary Institute.**—At 11 a.m., "Municipal Rehousing," by Mr. W. E. Riley, F.R.I.B.A., followed by visits to the London County Council estates.

TUESDAY, MARCH 29.

**Institution of Civil Engineers.**—At 8 p.m., "Lowering the Sill of the Ramsden Dock, Barrow-in-Furness," by Mr. Leopold Halliday Saville; and "Burntisland Harbour: Construction of the East Dock," by Mr. Robert Henderson.

**Institution of Electrical Engineers.**—Manchester Section: at 7.30 p.m., "Safety Devices for Electric Traction," by Mr. T. W. Sheffield.

SATURDAY, APRIL 2.

**Birmingham Mechanical Engineers.**—"Gas Measurement," by Mr. A. Cooke.

**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 23, Newcastle, May 6 and 7; Buxton, May 20 and 21.

## PERSONAL.

The Aberdeen Town Council have decided to increase the salary of Mr. J. A. Bell by two yearly increments of £100, making the maximum £700 per annum.

The Manchester City Council have decided to raise the salaries of 16 of the officers of the electricity department by sums ranging from £15 to £50, and amounting in the aggregate to £446. Increases were also granted to several officials of the tramway department.

The Barnstaple Town Council have increased the salary of Mr. J. W. Hadfield, the engineer in charge of the electricity department, to £200 a year, to include supervision of the laying of mains.

Mr. Chas. W. Lund, A.I.E.E., of the London and North-Western Railway electrical department, has been appointed by the Colonial Office to be assistant superintendent of telegraphs in Ceylon, and will leave London for Colombo by the P. and O. mail steamer "Australia" on May 13.

The Hammersmith Council propose, in consideration of Mr. G. G. Bell, the electrical engineer, having undertaken to prepare plans and estimates for the extension of the generating plant, thereby doing away with the necessity for employing the consulting engineer, and also in consideration of his past satisfactory services, to increase his salary from £500 to £600 per annum from the 1st prox., rising by two annual increments of £50 each to £700. The salaries and wages of over 30 officers and employés are to be increased, including the salaries of Messrs. R. H. Paterson, station superintendent, from £225 to £250 per annum, and W. Willcocks, A. T. Gordon-Smith, and H. Bell, electricians.

## WALSALL ELECTRICITY ACCOUNTS.

The accounts of the Walsall electricity department for the year ended Dec. 31, 1903, show that the total expenditure on capital account now amounts to £78,573. Abstracts are appended.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 3,018 | 15 | 10 |
| Repairs and maintenance of plant, etc. | 849 | 5 | 1 |
| Distribution of electricity | 322 | 17 | 9 |
| Attending and repairs to public lamps | 93 | 14 | 4 |
| Rents, rates, and taxes | 493 | 17 | 11 |
| Management expenses, salaries, etc. | 684 | 6 | 6 |
| Special charges—insurance | 34 | 15 | 6 |
| Total expenditure | 5,497 | 12 | 11 |
| Balance carried to net revenue account | 2 885 | 17 | 6 |
| | £8,383 | 10 | |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current for lighting and power, less discounts | 7,741 | 19 | 5 |
| Public lighting | 495 | 2 | 6 |
| Rental of meters | 146 | 8 | 6 |
| | £8,383 | 10 | 5 |

| Dr GENERAL BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Sundry creditors on open accounts | 7,775 | 4 | 3 |
| Deposits returnable | 85 | 16 | 6 |
| Amount due to borough treasurer | 22,980 | 6 | 6 |
| Sinking funds, less loans paid off | 5,969 | 9 | 3 |
| Reserve for discount on current | 130 | 13 | 6 |
| Balance at credit of reserve fund | 106 | 6 | 1 |
| Balance at credit of net revenue account | 69 | 13 | 4 |
| | £37,117 | 9 | 5 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Stock on hand | 106 | 13 | 10 |
| Sundry debtors for current, rent of meters, etc. | 2,953 | 12 | 0 |
| Amount in hands of engineer | 5 | 0 | 0 |
| Amount due from borough treasurer | 1,294 | 16 | 6 |
| Consolidated sinking fund | 966 | 16 | 7 |
| Consolidated loans fund | 3 027 | 11 | 1 |
| Balance at credit of capital account | 28,762 | 19 | 5 |
| | £37,117 | 9 | 5 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | |
|---|---|---|
| Quantity generated in B.T. units | | 897,009 |
| Quantity sold { By public lamps 29,708 / Private consumers by meter 593,121 } | | 622,829 |
| Quantity used on works | | 33 741 |
| Total quantity accounted for | | 656.575 |
| Quantity not accounted for | | 240,434 |
| Number of public lamps | | 19 |
| Total maximum supply demanded (kilowatts) | | 521 |

## HUDDERSFIELD ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account and general balance-sheet which form part of the accounts issued by the Huddersfield Corporation electricity department for the year ended Dec. 31, 1903.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 7,758 | 8 | 1 |
| Distribution of electricity | 935 | 6 | 9 |
| Public lamps, wages, repairs, etc. | 122 | 1 | 11 |
| Rents, rates, and taxes | 1,145 | 10 | 3 |
| Management expenses, salaries, etc. | 1,400 | 9 | 10 |
| Bad debts | 55 | 15 | 6 |
| Balance carried to net revenue account | 13,378 | 5 | 0 |
| | £24,795 | 17 | 4 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current, meter rents, etc. | 24,795 | 17 | 4 |
| | £24,795 | 17 | 4 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Mortgage debt | 143,268 | 6 | 1 |
| Floating liabilities | 3 468 | 13 | 4 |
| Depreciation and contingencies account | 11 853 | 11 | 7 |
| Excess of assets over liabilities | 33,483 | 1 | 5 |
| | £192,073 | 12 | 5 |

| Cr. Assets. | £ | s. | d |
|---|---|---|---|
| Buildings, machinery, plant, etc. | 173,507 | 11 | 3 |
| Steam motor wagon | 511 | 17 | 6 |
| Stores on hand | 312 | 9 | 2 |
| Sundry debtors for current supplied, etc. | 12,059 | 15 | 1 |
| Cash in hand | 5,681 | 19 | 5 |
| | £192,073 | 12 | 5 |

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# LEGAL INTELLIGENCE.

## DIXON v. THE ITO SYNDICATE, LIMITED.

**Mr. Justice Channell** delivered judgment at the resumed hearing of this suit in the King's Bench Division. His Lordship said that the agreement provided that the engineers were to certify as the work went on, and their final certificate was to be final. He now started with the certificate for the £7,401 in dispute, as being the amount which the plaintiff was entitled to for work done up to the point. The certificate was subject to any defective work, and it was admitted that there were certain things which would require to be done in order to remedy defects of a character which would prevent the Board of Trade passing the tramline. It was admitted on behalf of the plaintiff that some £300 would be required to put this in order, while on the other hand one gentleman put the amount at £8,000, although he thought the Board of Trade would disapprove of the design as well as of the work. If anything of that kind happened, the loss would not fall upon the contractor. What had to be decided upon was the difference, and his Lordship said he should do so as a juryman would do—viz., by not taking the precise view of either side. He was rather inclined towards the evidence produced on the plaintiff's side, and should think that the sum of £500 was the figure which ought to be allowed for the defective work. Then the most important point was—what amount of damage had the plaintiff suffered through what must be held to be a breach of contract, by the transference of the whole undertaking to another party, whereby the plaintiff was deprived of the remainder of the work. It was obvious that the plaintiff was to have received certain shares in the concern, and those would no doubt have had a substantial value. He had arrived at a lump sum as being his estimate of what profits the plaintiff would have realised, and he put that down at £5,000. Consequently there would be judgment for the plaintiff for the amount claimed, £7,401. 1s. 8d., and the £5,000 referred to, making a total of £12,401. 1s. 8d. He would allow £500 on the counterclaim. As to costs, though he made no order, he was of opinion that the greater part were caused by the claim, and not by the counterclaim. He granted stay of execution.

## PURCHASE OF SHARES.

The case of Hunt *v.* National Electric Traction Company, Limited, came before Mr. Justice Ridley and a common jury. The plaintiff sought recission of his contract to take shares in the City and Surrey Electric Railway Company, on the ground of misstatements in the prospectus. The defendants did not appear. Mr. E. H. Cannot (instructed by Messrs. Judge and Priestley) appeared for the plaintiff.

**Mr. Cannot** said the case was no longer defended. The prospectus offered for sale shares in the City and Surrey Electric Railway Company, which was incorporated with a capital of £150 000. On the faith of the prospectus and a circular which stated "that the railway company had already built a City terminus, electrically equipped with lifts, close to the Monument, that it had already constructed approach lines fully equipped for running, and that it had already built and electrically equipped a tunnel under the Thames," the plaintiff agreed to buy of the defendants 10 shares of £10 each in the railway company. It was now contended that the statements in the prospectus quoted were false and fraudulent, and that, in truth, the company had not built a City terminus equipped as stated.

An official from Somerset House having tendered evidence as to the history of the defendant company, judgment was given for the plaintiff, with costs.

# COMPANIES' MEETINGS AND REPORTS.

## WOKING ELECTRIC SUPPLY.

The directors' report for the year ended Dec. 31, 1903, states that the total revenue for the year was £7,960. 9s. 2d., and the expenditure connected with the generation and distribution of electricity and management expenses amounted to £4,043. 3s. 1d., leaving a balance on the year's working of £3,917. 6s. 1d., to which has to be added £575. 9s. 4d., the amount brought forward from last year, making a total of £4,592. 15s. 5d., which sum the directors propose to appropriate as follows: payment of interest on the 4½ per cent. debentures, £1,048. 11s. 11d.; payment of interest on temporary loan, £340. 10s. 8d.; payment of dividend on the 6 per cent. cumulative preference shares to Dec. 31, 1903 (six months to June 30, 1903, having been paid on Oct. 1, 1903), £792. 6s. 8d.; payment of a dividend of 4 per cent. per annum on the ordinary shares, £626. 5s. 7d.; to depreciation fund account, £750—leaving a balance to be carried forward of £1,035. 0s. 7d. Although the amount to be carried forward to next year is sufficient to pay the ordinary shareholders a much larger dividend, the directors feel sure that the shareholders will approve of the soundness of the policy of carrying forward such a large balance. During the year 136 new consumers were obtained, exclusive of the London and South-Western Railway Company's lighting of Woking Station, which was connected in December last, and which is already a very large consumer of electrical energy. The total number of lamps now connected is 25,010, and the number of consumers 660. The directors consider that the outlook for the future is most promising. During the year the directors have issued £3,850 4½ per cent. debentures, and £9,210 6 per cent. cumulative preference shares, and they are now looking towards issuing the balance of the debentures, preference, and ordinary shares. The expenditure on capital account on Dec. 31, 1903, amounted to £65,480. 4s. During 1903 a new engine-room has been built, a 400-kw. generator installed (more than doubling the generating capacity of the works), a new switchboard of the most modern type erected, and eight miles of cable laid down, including a special one between the works and the railway station. Further expenditure upon boiler power and other works will be required during the current year. The necessity for the increased capital expenditure is owing to the rapid and continuous growth of the business of the Company, which has largely exceeded the anticipations of the directors.

| Dr. Abstract of Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 2,735 | 19 | 5 |
| Distribution of electricity | 250 | 13 | 9 |
| Rents, rates, and taxes | 81 | 1 | 1 |
| Management expenses, salaries, etc. | 819 | 15 | 10 |
| Law and parliamentary charges | 54 | 4 | 0 |
| Depreciation in respect of plant, etc. | 750 | 0 | 0 |
| Special charges, insurance, etc. | 101 | 9 | 0 |
| Total expenditure | 4,793 | 3 | 1 |
| Balance carried to net revenue account | 3,167 | 6 | 1 |
| | £7,960 | 9 | 2 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter | 7,680 | 13 | 0 |
| Rental of meters, sale of lamps, etc. | 274 | 15 | 4 |
| Transfer and test fees | 4 | 14 | 0 |
| Bad debts | 0 | 6 | 10 |
| | £7,960 | 9 | 2 |

Abstract of Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 56,282 | 0 | 0 |
| Due from sundry tradesmen and others | 9,852 | 8 | 7 |
| Sundry creditors on open accounts | 0 | 11 | 3 |
| Balance at credit of net revenue account | 1,661 | 6 | 2 |
| Depreciation fund account | 2,870 | 18 | 8 |
| Dividend on preference shares accrued due | 505 | 11 | 2 |
| Loans | 2,050 | 0 | 0 |
| Bank overdraft | 1,325 | 19 | 0 |
| | £74,548 | 14 | 10 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 65,480 | 4 | 0 |
| Stores on hand | 1,476 | 19 | 1 |
| Sundry debtors for current supplied | 3 082 | 5 | 3 |
| Other debtors | 312 | 6 | 11 |
| Goodwill | 4,194 | 19 | 3 |
| Cash in hand | 2 | 0 | 4 |
| | £74,548 | 14 | 10 |

## MARCONI'S WIRELESS TELEGRAPH.

The report for the year ended Sept. 30 records an increase of profit, although no income has yet accrued from the stations for Transatlantic telegraphy, the commercial working of which is looked on as likely to prove the most profitable branch of the business. It is impracticable for the Company to carry on a Transatlantic service of any advantage without the assistance of the postal telegraph service, on which it is dependent for the collection and transmission of its messages. Such facilities, similar to those granted to the cable companies, have not yet been obtained. The course of recent negotiations seems, however, to offer some prospect of satisfactory arrangements. Should satisfactory arrangements not be offered by the British Government, the European station will be erected in one of those Continental countries which have already agreed to give facilities for inland distribution and collection of the Company's telegrams, similar to those which it is asking here. There are now 54 shore stations installed, commanding the principal shipping routes and available exclusively for communication with ships equipped with the Marconi system. Among them are stations worked by the British Admiralty, the Italian Admiralty, and Lloyd's. The factory at Chelmsford is now more fully employed than in any previous era of the Company's existence. Orders for apparatus on a large scale have been executed, and the work now in hand, without further orders, will keep the factory fully employed for many months to come. The powers taken last March for increasing the capital have not yet been exercised. The receipts for the year of £36 376 are £10,607 in excess of the general charges.

## DEVONPORT AND DISTRICT TRAMWAYS.

The report of the Devonport and District Tramways Company for the half-year ended Dec. 31 last, presented at the meeting this week, stated that the total revenue for the six months amounted to £13,573. After deducting all expenses chargeable to revenue, there was a profit of £3 687. Adding to that £181 brought forward from previous account, there was an available balance of £3,868. The directors had placed to depreciation and reserve fund £1,000, and recommended a dividend at the rate of 4 per cent. per annum, carrying forward £219. The increase in the receipts was due to two causes—the increase of traffic on the Company's lines, and the Company had also had the benefit for more than two months of receipts on the lines leased from the Corporation. A decrease in general expenses had been effected, although the route mileage had been substantially increased. Experiments with regenerative control having proved satisfactory, the Board had decided to proceed with the equipment of the cars. Debentures to the amount of £5,000 had been issued during the half-year, making £11,200 issued to date. The total expenditure to Dec. 31, 1903, amounted to £154,524.

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## BRUCE PEEBLES AND CO.

The directors' report for the year ending Dec. 31, 1903, shows that the net trading profit for the year, including interest and dividends received, and transfer fees, amounted to £17,125. 13s. 8d., which, after deducting the sum of £6,125. 3s. 3d. for directors' fees, managing directors' salaries, income tax, and interest to vendors, leaves a balance of £11,000. 10s. 5d., which the directors recommend should be disposed of in paying a dividend at the rate of 6 per cent. per annum, less income tax, on the preference shares, £2,497. 0s. 9d.; in paying a dividend at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, £2 958. 17s. 11d.; in carrying to special reserve fund, as provided by Article 5 of the memorandum of association, a sum not less than 10 per cent. of the net profits, £1,750; in carrying to general reserve fund. £1.250; in writing off preliminary expenses, £2,000; and in carrying forward a balance of £544. 11s. 9d. It is pointed out that the profit earned is better than last year, which the directors consider satisfactory, in view of the general depression in trade, the consequent reduction in prices, and the fact that the whole of the year's work was carried out in the old premises. The new works at East Pilton are now running, and the directors expect that a considerable saving will be effected in the carrying out of the Company's business, as these new works are equipped with the best known appliances for the quick handling of materials. Several large contracts have been entered into on favourable terms, and the present year promises to be very successful.

## NORTHERN COUNTIES ELECTRICITY SUPPLY.

The directors' report for the year ending Dec. 31, 1903, states that the progress made in the working operations is shown by the following figures relating to Blyth, Spennymoor, Alnwick, Hebburn, Thirsk, and Whitley, the three last-named places having been in operation for a portion of the year only: consumers connected to Dec. 31, 1903, 2,482; equivalent in 8 c.p. lamps connected to Dec. 31. 1903, 39,639; units sold for year ending Dec. 31, 1903, 344,781. The Ashington supply was commenced towards the end of the year, and the Hartlepool and Morpeth power stations have since been started. Up to date, therefore, nine stations or sub-stations are at work, and the Malton and Shildon generating stations and Felling sub-station will be in operation during the current year. At Ashington and Whitley the Company is taking its supply in bulk, and by agreement with the Cleveland and Durham County Electric Power Company, current will be supplied to the Company in bulk in the North-West Durham area, which includes Consett, Annfield Plain, Benfieldside, Stanley and Leadgate, and it is expected this area will be in operation during the current year. By means of these arrangements the cost of erecting generating plant is avoided. In addition to the lighting connections, both public and private, important power consumers have been obtained, and there are others in prospect. The directors therefore anticipate a business of considerable magnitude, with a steady reduction in cost of production as the load factor in each area improves. As already stated, the number of units supplied in the year just closed amounted to 344,781, and during the current financial year the directors expect such an increase in the Company's business as will command a substantial revenue. With regard to the operations of 1903, after an apportionment of charges between construction and revenue accounts, there remains a credit balance of £1,000. 12s. 4d., which the directors propose to carry forward, and trust that they may be able to pay a dividend for the year now entered upon. In accordance with the intention expressed in the previous report, the directors issued 50,000 new shares to the existing shareholders at par. Of these, up to date 35,463 have been taken up, leaving 14,537 still to be subscribed, which the directors do not doubt will be done by the shareholders themselves. In order to pay off existing loans and complete the stations at present in hand the directors propose to issue debentures.

## SWANSEA IMPROVEMENTS AND TRAMWAYS.

The half-yearly meeting was held on the 17th inst. The report, of which particulars appeared in our issue of the 11th inst., recommended that £1,000 should be placed to reserve fund and applied in reduction of advances due to the British Electric Traction Company; £295 to be paid in 6 per cent. dividend on 984 preference shares; £1,004 to be paid in dividend on other preference shares at 5 per cent.; and £3,250 to be paid on ordinary shares at 2½ per cent. This left £1,137 to be carried forward.

The **Chairman**, in moving the adoption of the report, said that the number of passengers carried was 2,560,509 in 1902 and 2 896,784 in 1903, so that there had been a substantial increase. With regard to local taxation, the Company was in an anomalous position. They paid £3,614 per annum, but had no voice in spending that money. The Company had not been able to turn the Palace Theatre to remunerative use.

The motion was seconded by **Mr. G. Ratcliffe Hulme**, and carried.

Mr. W. G. Bond was re-elected director, and votes of thanks were passed.

## CLEVELAND AND DURHAM ELECTRIC POWER.

A special meeting of shareholders was held at the offices of the Company, 5 Great George-street, Westminster, last Friday.

**Mr. W. S. B. McLaren, M.P.**, presided, and explained that the object of the meeting was to create a certain amount of debentures, authorised by the Companies' Acts of 1901 and 1903, in proportion to the amount of the ordinary share capital issued, and he proposed a resolution authorising the directors to make the issue in such amounts and at such periods as they might deem expedient. He added that the business of the Company had made considerable progress during the last few months, and the electric power stations at Bishop Auckland and Consett were nearing completion. It is expected that a supply of current from both stations would be commenced in about six weeks' time if required. Other stations in the district were contemplated, but these were not likely to be started until the present stations have been at work for some time, and results tentatively ascertained.

The motion for the issue of the debentures was seconded by **Sir R. H. Sankey**, and carried unanimously.

## HARROW ELECTRIC LIGHT AND POWER.

The eighth annual meeting of the Harrow Electric Light and Power Company, Limited, was held at the Company's offices, Harrow, on the 10th inst., Mr. J. N. Stuart (chairman) presiding.

The **Chairman** said the prospects of the Company were very much brighter than in previous years of its existence, and he had to congratulate the shareholders on its now steadily improving position. The dividend on the ordinary shares was 1 per cent. more than the previous year, and he had little doubt they would see a further increase in the current year. In view of the reduction in the charge for light, the directors did not consider it advisable to pay more than 3 per cent. The alteration in the system of charging for electricity, involving as it did a reduction in the rate, had had the very careful consideration of the directors, and they felt that the earliest possible opportunity should be taken to give them some concession, as the rate of 8d. per unit was the highest charge made by any electric light company in the kingdom. Consumers were beginning to be very restive under this high charge, and in very many instances of houses where electric light was installed, no use was being made of it. That there was a distinct check in the growth of consumption was shown by the comparative figures of the units supplied to customers in each year. The increase during the past year amounted only to 14,373 units, the previous year being 31,000 units, and the year before that 33,000 units, while the increase in consumption during 1903 was only brought about by the extra number of lamps connected. This confirmed the constant complaints of customers regarding the rates charged, and the directors felt that it was most unwise to estrange their clients if it could possibly be avoided. Accordingly they decided to meet them as much as possible, and by the introduction of the maximum demand system, which was so largely employed throughout the country, they were granting a substantially reduced rate to all regular consumers. He had now to propose that the report, accounts, and balance-sheet be adopted.

**Mr. G. W. Spencer Hawes** seconded the resolution, which was carried.

**Mr. F. E. Marshall** then moved that the remuneration of the directors be until altered at a general meeting, £150 per annum, with a commission in addition of 5 per cent. on the dividends paid to the shareholders, provided the ordinary shareholder's dividend is not less than 4 per cent.

**Mr. J. Bradley Smith** seconded and the resolution was carried.

## DIRECT SPANISH TELEGRAPH.

The ordinary general meeting of the shareholders of this Company was held on Tuesday.

The **Marquis of Tweeddale**, who presided, in moving the adoption of the report, said that the receipts for the past year showed a falling off of £1,797, which was accounted for partly by the general depression in trade which had prevailed throughout the period under review and partly by the interruptions to their cables, which lasted 77 days, recalling the misfortunes suffered by the Company in 1901, when, however, the interruptions lasted no less than 120 days. The cost of the repairs—£10,591—had been debited to reserve fund, which, on Jan. 7 last, amounted to £48,621. The telegraph conference which took place last May led to the reduction of the Company's rates to Spain, Portugal, and Gibraltar by ½d. per word. It would be seen from the accounts that there was a somewhat large increase—namely, £270—under the heading of salaries. This was due to the new offices at Arrigunaga. Happily, it was possible to effect considerable economies, both abroad and in London, thus reducing the net increase to only £95. The only other matter of interest to which he had to refer was the expiry of the Company's license on the shores of this country, which occurred on Oct. 31 last. The Board had since been in negotiation with the Government with a view to the renewal of the license, and it was hoped that before long an arrangement would be entered into which would be satisfactory both to the Government and themselves. He might mention that the license to land on the Spanish coast was without a limit.

**Sir J. Denison-Pender** seconded the adoption of the report, which was agreed to.

## VICKERS, SONS, AND MAXIM.

The annual general meeting of Vickers, Sons, and Maxim, Limited, was held at Sheffield on the 16th inst.

**Colonel T E. Vickers**, chairman of directors, presided, and, in moving the adoption of the report, stated that various rumours had been started, evidently with the object of knocking down the value of their shares. One was that they had discharged 17,000 men at Sheffield, whereas they had never employed more than 5,000. Another was that they had intended to issue new capital; that people were apprehensive that the large amount they were adding to reserve fund was to be issued as new shares. Nothing of the kind was contemplated, and never would be. The present reserve fund was invested in bricks and mortar, goodwill, or otherwise locked up in the Company. The directors thought it would be better to discontinue this class of reserve fund, and to wipe it off and start a cash reserve fund. He might also

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state that they had very much larger orders on hand now than at this time last year.

**Mr. Albert Vickers,** in seconding, remarked that, so far from the Company requiring further capital, that very day they had a million sterling cash in the bank or at call. The Company, he might state, now employed some 18,000 men. They had 13,370 shareholders.

A **Shareholder** enquired whether the Company had received any further orders for submarines from the Government?

The **Chairman** replied that they had launched two submarines last week, and had still others building. The further orders for submarines had not yet come out.

The motion was carried.

Messrs. J. M. Hay and J. Dunn were re-elected directors.

## CORK ELECTRIC TRAMWAYS AND LIGHTING.

The seventh ordinary general meeting of the shareholders of the Cork Electric Tramways and Lighting Company, Limited, was held on the 18th inst. at the Company's offices, 83, Cannon-street, Mr. A. R. Monks, chairman, presiding.

The report of the Company for the year 1903 stated the result of the year's working was as follows: Receipts, £46,434. 9s. 9d.; expenses, £30,332. 16s. 8d.—£16,101. 13s. 1d.; add balance brought forward from 1902, £711. 15s. 11d.—total, £16,813. 9s.; less interest on debentures, £9,954. 17s.—total, £12,858. 12s. Of this amount £5,500 was paid on July 1 and Jan. 1 for the half-yearly dividend on the £110,000 5 per cent. cumulative preference share issued; £43. 5s. 2d. written off as per revenue account, £1,000 to reserve for depreciation and insurance, and the directors recommend that the balance should be disposed of as follows: £5,500 to 5 per cent. dividend on ordinary shares; £1,101. 7s. 1d. to 10 per cent. reserved to the Board in accordance with resolution passed at extraordinary general meetings held on July 26 and Aug. 10, 1898; £704. 19s. 9d. to revenue new account—£12,858. 12s. The lighting and power business shows considerable progress, a large number of applications having been received, and the Company have connected up during the year more motors than in any previous year. The full benefit of these connections is not realised in the above accounts, as a large number were only recently connected up. The revenue from lighting and power for the coming year will show a large increase. To meet the increasing demand for current, extensive additions are being made to the power station, a 500-kw. Curtis steam-turbine and other plant being installed, and the Company is now in a position to connect additional consumers. The contract with the Cork Corporation for public lighting has been recently renewed for a further term of years The capital expenditure during the year amounts to £9,703. 11s. 2d., which has been expended on cable extensions connecting up additional consumers, two additional cars, and additions to the power station referred to above. To meet this capital expenditure additional debentures have been issued to the extent of £10,000. The small premium obtained has been placed to reserve.

The **Chairman,** in moving the adoption of the report, said that since they had commenced the supply of electrical power they had connected over 150 motors with their mains, 16 gas-engines having been sold by consumers and replaced by motors, and five of these consumers having retained gas-engines as a stand-by for running electrical motors. In addition, six consumers, who were some of their largest, had replaced steam driving plant by electrical motors. He was able to state that during the whole time they had been supplying electrical power—lasting several years—only two of their consumers had replaced electric motors by gas-engines. At the present moment they had motor installations in hand which in the aggregate amounted to 100 h.p. As regards their lighting undertaking, they had connected a number of lamps on an average exceeding those of former years, while to facilitate consumers who found it inconvenient to bear the first cost of the installation, they had devised a scheme of hire-purchase which had been in operation for about a year with successful results. Builders of the highest class in their new buildings had been wiring their houses, and had realised the increased letting value of these premises.

**Mr. H. C. Levis** seconded the adoption of the report, which was unanimously agreed to.

## CITY OF BIRMINGHAM TRAMWAYS.

The ordinary general meeting of the City of Birmingham Tramways Company, Limited, was held at the Grand Hotel, Birmingham, on the 17th inst., Mr. Emile Garcke, chairman, presiding.

The **Chairman,** in moving the adoption of the report, said that, although the future of the Company was surrounded by some uncertainty as a result of the decision of the Corporation to municipalise the tramways within the city, he was glad to be able to submit a report which was satisfactory with regard to the present position. During the past year they carried close on 50,000,000 passengers, an increase of 2,000,000 over the preceding year. The receipts were £264,556, an increase of about £10,000, and the net earnings £81,978, an increase of very nearly £30,000. The fact that the net earnings showed so large an increase was due to an amount of nearly £20,000 having been charged against revenue in the preceding year in respect of exceptional repairs and to renewals. Out of the net profits £12 000 was paid for debenture interest, about £12,000 for dividends on preference shares, and £8,400 as a dividend of 10 per cent. on the ordinary shares. This left a surplus, after adding the balance brought forward, of £51,559 which was carried to reserve, thereby increasing that fund to £242,744. During the year they had in various ways improved the services, and additional facilities, chiefly in the form of workmen's early morning cars, had been provided. It was not the desire of the directors to put any difficulties or obstacles in the way of municipalisation, but the Company could not afford to sacrifice any of its established interests in order to make municipalisation practicable. The Company would have a not inconsiderable mileage of tramways outside the boundary of Birmingham, even after the leases from the city have expired. The intention of the directors was to construct the newly-authorised lines and to convert all lines outside the city as soon as possible to electric traction on the overhead system. They would endeavour to make arrangements with the Corporation for through running powers. By the Act of Parliament obtained last year they were empowered to make working arrangements with other companies, and the directors were of opinion that some scheme of combined working with the neighbouring companies would result in economy and increased efficiency. Nothing had yet been settled, but conferences were taking place between the various companies concerned.

The resolution was then put by the Chairman, and carried unanimously.

## LANARKSHIRE TRAMWAYS.

The fifth ordinary general meeting was held on the 17th inst.

**Mr. A. R. Monks,** the chairman, formally moved the adoption of the report, which stated that the receipts had been very satisfactory. The profits, after deducting interest on debentures and contributions payable to local authorities, amounted to £5,219. 1s. 6d. Of this amount £1,000 had been placed to reserve for depreciation, £385. 6s. 4d. written off as per revenue account, and the directors recommended that the balance be disposed of as follows: £3,482. 17s. 5d. to dividend at the rate of 4 per cent. per annum on issued capital from date of opening—viz, July 22, 1903—to Dec. 31, 1903, and £350. 17s. 9d. to revenue new account. The Company's power station not being quite ready for running at the time of the opening of the line owing to the effect of certain subsidencies, current was purchased temporarily from the Corporation of Motherwell. The difficulties occasioned by these subsidencies had been greatly exaggerated. Their power station was now complete, and a considerable reduction in the expenses was anticipated. The directors, finding the present number of cars insufficient to cope with the traffic, were ordering an additional 10 cars, which would be delivered during the summer. The important extensions authorised by the Lanarkshire Tramways Order, 1903, being likely to be highly remunerative, it was intended to proceed shortly with the construction of certain lines.

The report was adopted.

## HOVE ELECTRIC LIGHTING.

The twelfth annual meeting of this Company was held last Friday.

**Colonel Filgate** moved the adoption of the report (which appeared in our issue of the 11th inst.), and said that during the year £20,611 had been expended on capital account, about £16,500 of which was for the new generating station and plant. It was estimated that the further sum needed after Dec. 31 last to complete the new station and the plant under order would be about £5,000. In order to provide the necessary capital £8,230 additional debenture stock had been issued, increasing the issue to £44,600. Two thousand new shares were offered to the present shareholders at £7. 10s., and all were at once taken up. There had been an increase of £1.473 in the gross revenue, and the bill for coal showing a reduction the gross expenditure was only £301 more than in 1902.

**Mr. C F. Tuffnell** seconded the motion, which was agreed to, and a final dividend of 10 per cent., making 8½ per cent. for the year, was confirmed.

## TYNEMOUTH AND DISTRICT ELECTRIC TRACTION.

Mr. W. A. Smith presided at the annual meeting of the Tynemouth and District Electric Traction Company held at Cullercoats. Particulars of the report appeared in our last issue.

The **Chairman** said the year had been most satisfactory, traffic receipts increasing £720, while general expenses showed a decrease of £295. The Company was arranging with the Tyneside Tramways Company for the extension of their line so as to save passengers from walking from one terminus to another. They hoped soon to get started with the line to Whitley Sands. The directors proposed to create 4,000 new ordinary shares at £5, and to issue 3,000 of them.

The report was adopted, a dividend of 7½ per cent. being agreed to.

## OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The seventh ordinary general meeting was held at Hamilton House, Victoria-embankment, Mr. Emile Garcke presiding.

The Chairman moved the adoption of the report (which appeared in our last issue), which was seconded by Alderman T. Heginbottom, and carried unanimously.

## SLOUGH AND DATCHET ELECTRIC SUPPLY.

The directors in their first annual report state that the Company commenced to give a supply of electricity on July 3, 1903. The present capacity of the generating station at Chalvey is 510 h.p., and a further set of 380 h.p. is on order, and will be erected during the year to meet the increasing demand for current. The number of 8 c.p. lamps and motors connected up to Dec. 31, 1903, was 3,126, of which 422 represented the motor power. Since that date orders have been received for about 400 additional lights. In order to meet the increase in the capital expenditure, the directors have recently offered to the shareholders *pro rata* to their holdings a further 10,000 shares, the whole of which have been taken up. The total revenue from the sale of current was £605. 14s., and adding to this the other receipts, amount-

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ing to £411. 10s. 7d., and deducting the expenses, the net profit amounted to £605. 17s. 8d. Out of this the directors recommend that the whole of the preliminary expenses, amounting to £310. 19s. 11d., be written off, which will place the Company on a very sound basis, and that the balance, amounting to £294. 17s. 9d., be carried forward. The price charged for electricity is 7d. per unit for lighting and 3½d. for motor power, but the directors have the revision of prices under consideration. The Great Western Railway Company has been approached with a view to a siding being constructed into the Company's generating station at Chalvey. This will probably be erected shortly, and should result in a more economical production of current.

| Dr. Abstract of Revenue Account | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 197 | 7 | 0 |
| Rents, rates, and taxes | 13 | 10 | 0 |
| Management expenses, salaries, etc. | 149 | 3 | 9 |
| Law and parliamentary charges | 13 | 3 | 2 |
| Special charges, insurance, etc. | 38 | 3 | 0 |
| Total expenditure | 411 | 6 | 11 |
| Balance carried to net revenue account | 373 | 10 | 5 |
| | £784 | 17 | 4 |
| Cr. | £ | s. | d. |
| Sale of current by meter and in bulk | 605 | 14 | 0 |
| Rental of meters and other apparatus | 12 | 3 | 4 |
| Transfer fees | 2 | 0 | 0 |
| Revenue from other sources | 165 | 0 | 0 |
| | £784 | 17 | 4 |

| Dr. Abstract of Balance-Sheet. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 25 042 | 10 | 0 |
| Sundry creditors | 7,967 | 19 | 2 |
| Balance at credit of net revenue account | 605 | 17 | 8 |
| | £33,616 | 6 | 10 |
| Cr. | £ | s. | d. |
| Capital account—amount expended for works | 31,252 | 9 | 0 |
| Stores on hand | 66 | 0 | 10 |
| Free wiring and motors and other apparatus | 920 | 10 | 10 |
| Sundry debtors for current supplied | 380 | 17 | 9 |
| Other debtors | 529 | 16 | 1 |
| Preliminary expenses | 310 | 19 | 11 |
| Balance at bank | 151 | 15 | 3 |
| Cash in hand | 3 | 17 | 2 |
| | £33,616 | 6 | 10 |

The first annual meeting of the shareholders of the above Company was held at the Company's supply station at Chalvey on the 16th inst., Mr. Tonman Mosley, the chairman of the Company, presiding.

The **Chairman,** in moving the adoption of the report and accounts, said that they had an elaborate station fitted up with the very best machinery. In regard to the 10,000 additional shares, he mentioned that the Board had that day made a further call of 5s. per share, and the balance would probably be required in the early autumn. The directors hoped that next year they would be able to declare a dividend of 4 per cent., or something like that. With a view of securing more consumers they had decided to reduce the price of current, and had adopted the same scale of reduction as adopted by the Windsor Company. This would reduce the price of the current from 7d. to 6d. per unit. The directors had given their services gratuitously.

The adoption of the report was then agreed upon. Mr. Thornton and Mr. Jackaman were re-elected directors.

## WINDSOR ELECTRICAL INSTALLATION.

The eighth annual general meeting of the shareholders in the above Company was held at the offices, Peascod-street, on the 16th inst. Mr H. L. Prior, the chairman of the Company, presided.

The report and accounts (which have already appeared in our columns) were adopted. Mr. de Salis and Mr. A. W. Shipley were re-elected directors, and £350 voted to them for their services. Mr. Rawkins was re-elected auditor. The proceedings concluded with a vote of thanks to the chairman for presiding.

## NEW COMPANIES REGISTERED.

**Belgravia Garages, Limited.**—Capital, £1,000. Objects: to carry on the business of garage proprietors, manufacturers of and dealers in motor engines, etc.

**Electric Heating Corporation, Limited.**—Capital, £25,000. Objects: to acquire the business carried on at 34, Leadenhall-street, E.C., as the Electric Heating Corporation; to construct, deal in, and repair electric stoves for heating, cooking, and other purposes, etc.

**Velox Engineering and Autocar Company, Limited.**—Capital, £2,000. Objects: to adopt an agreement with the London Pioneer Syndicate, Limited, to manufacture and deal in motors, launches, vehicles, and carriages of all kinds, and to carry on the business of electricians, mechanical engineers, etc.

### Lien Registered.

**Electric Supply Company of Victoria, Limited, Liverpool.**—Lien registered March 15, for £35,000 5 per cent. debentures (holder: British Insulated and Helsby Cables, Limited), part of £200,000; amount previously issued, £40,000; charged on the undertaking and all the property and assets, including any uncalled capital.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Debreczin.**—The Hungarian Government Tobacco Factory require tenders for a dynamo by March 28.

**Paris.**—The Colonial Office, rue Jean-Nicot No. 4B, require tenders for 1,000 iron telegraph poles for Senegambia and Niger by March 29.

**Plasencia (Spain).**—The Municipality require tenders for installing and working an electric lighting undertaking concession. Tenders by March 28.

**Liege.**—The Provincial Government require tenders for the construction of electric tramways and for taking over two lines already existing by April 2.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Edinburgh.**—The City Council invite tenders for 12 months' supply of electricity meters. Specifications from the Resident Electrical Engineer, 5, Dewar-place. Tenders by April 4.

**Dundee.**—The Town Council invite tenders for the supply of electricity meters for Dudhope power station. Specifications from the City Electrical Engineer. Tenders by March 26.

**Edinburgh.**—The Council invite tenders for extension switchboard panel and steam and exhaust pipework. Specifications, etc., may be obtained from the Resident Electrical Engineer. Tenders by April 23.

**Madrid.**—The Post and Telegraph Department require tenders for a central telephone station at San Lorenzo de El Escorial, and substations at Cercedilla and San Rafael, and the installation of the telephone system by April 2.

**Rugby.**—The Urban District Council invite tenders for the construction and erection of a refuse destructor. Specifications, etc., may be obtained at the office of Mr. D. G. Macdonald, A.M.I.C.E., surveyor to the Council. Tenders by March 28.

**Leeds.**—The Tramways Committee invite tenders for the supply of various tramway materials during period ending March 25, 1905. Particulars may be obtained from Mr. J. B. Hamilton, Tramways Office, City-square, Leeds. Tenders by 12 noon on April 6.

**Withington (Lancs.).**—The Guardians of Chorlton Union invite tenders for one electric bed lift, to be erected in the new pavilions. Specifications, etc., may be obtained from Mr. James B Broadbent, A.R.I.B.A., 15, Cooper-street Manchester. Tenders by April 5.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Sunderland.**—The Corporation invite tenders for the supply of indiarubber-covered cables from April 1, 1904, to March 31, 1905. Specifications, etc, can be obtained from the Borough Electrical Engineer. Tenders by March 31. See advertisement in former issue.

**Manchester.**—The Corporation invite tenders for two 750 kw. turbo-generators, and for alterations and additions to high-pressure steam piping and valves. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department. Tenders by April 13.

**Swansea.**—The Corporation invite tenders for (Contract No. 16) open-type street arc lamps including accessories, and (17) converting the existing gas lamps to Nernst lamps, including accessories. Specifications, etc., from the Borough Electrical Engineer. Tenders by noon on April 2.

**Partick.**—The Town Council invite tenders for one 500-kw. steam dynamo, 76-kw. steam balancer (dynamos only), and extensions to main switchboard. Specifications, etc., can be obtained from the Town Clerk's Office. Tenders before noon on April 12. See advertisement.

**Acton.**—The District Council invite tenders for (a) two 200-kw. motor-generators, balancer, and booster, (b) switchboard, (c) cables and arc lamps, (d) accumulators, (e) 10-ton crane. Specifications, etc., can be obtained from Mr. W. H. Trentham, 39, Victoria-street, S.W. Tenders by April 12.

**St. Annes-on-Sea (Lancs.).**—The Urban District Council invite tenders for the supply, delivery, and erection of surface-condensing plant and natural-draught cooling tower. Specifications, etc., may be obtained from Mr. Jas. H. Clothier, engineer, Electricity Works. Tenders by 26th inst.

**Handsworth (near Birmingham).**—The Urban District Council invite tenders for supply and delivery of permanent way, pavement, roadwork, and overhead equipment. Specifications, etc., can be obtained from Mr. H. Ward, clerk, Council House, Handsworth. Tenders by 30th inst.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Walthamstow.**—The Urban District Council invite tenders for the extension of their electric generating station. Specifications, etc, may be obtained on application to the Council's engineer, Mr. G. W. Holmes, A.M.I.C.E., Town Hall, Walthamstow. Tenders before 5 p.m. on Friday, April 8.

**Manchester.**—The Corporation invite tenders for supply, delivery, and erection of synchronous motor-generators at sub-stations and flue-fired superheaters at Dickinson-street station. Specifications may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall. Tenders by noon on April 7.

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**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Reading.**—The Corporation invite tenders for the supply and delivery of six double-decked bogie electric tramcars and one electrically-driven water-cart. Specification, etc., may be obtained from Mr. Walter Binns, engineer and manager, Tramways Office, Mill-lane, Reading. Tenders by 12 noon on April 2.

**London County Council.**—The Council invite tenders for erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Specifications, etc., may be obtained at the Architect's Department (Highways Section), Trafalgar House, 13, Charing-cross, S.W. Tenders by 10 a.m. on April 26.

**Manchester.**—The Lancashire and Yorkshire Railway Company invite tenders for the supply of various articles during 12 months ending April 30, 1905, including signal, telegraph, and electric light wires and fittings. Particulars may be obtained from Mr. Duffin, Stores Department, Osborne-street, Manchester. Tenders by 10 a.m. on April 4.

**London, S.W.**—The Westminster Electric Supply Corporation invite tenders for the supply, delivery and erection at their Duke-street sub-station of high-tension switchboard and low-tension switchboard Specifications, etc., may be obtained from Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders before 10 a.m. on April 18.

**Glasgow.**—The Corporation invite tenders for mains, cables, switchboard, distribution boards, wiring, and accessories for transmission of electric power to motors, and for lighting at Dalmuir outfall works. Specifications, etc., may be obtained at the Office of Public Works, City Chambers, 64, Cochrane-street. Tenders by 10 a.m. on 28th inst.

**Middlesex.**—The Visiting Committee of Napsbury Asylum, near St. Albans, Herts, invite tenders for the wiring and plain fittings required for about 2,500 points. Particulars from Mr. Wm. H. Massey, M.I.C.E., of 25, Queen Anne's-gate, Westminster, S.W. Names of contractors desiring to tender to be sent to the Clerk of the Committee by April 6. See advertisement.

**Swindon.**—The Corporation invite tenders for the supply, delivery, and erection of a continuous water-softening plant, a 60-kw. motor-generator and switchgear; also for supply for one year from 31st inst. of incandescent lamps, cables, lubricating oils, direct-current meters. Specifications, etc., may be obtained on application to Mr. J. G. Griffin, A.M.I.E.E, Electricity Works, Swindon. Tenders by 31st inst.

**Govan.**—The Corporation invite tenders for the purchase of three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery, and balancer, also for three-wire booster by the British Thomson-Houston Company, Limited. Particulars may be obtained from the Burgh Electrical Engineer, Helen-street, Govan. Tenders by March 29. See advertisement in former issue.

**Poplar.**—The Council invites tenders for the supply and erection of five three-phase alternating-current motor-generators, three switchboards (three-phase, alternating and direct current), hand travelling cranes. Specifications, etc., may be obtained from Mr. P. N. Hooper, A.M.I.C.E., M.I.E.E., Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 9 a.m. on March 26. See advertisement in last issue.

**Christiania.**—The Board of Trade have received from H M. Consul-General at Christiania a dispatch reporting that tenders are invited for the supply to the Norwegian State Railways of 464,450 sole-plates and 123,000 spiral washers. A copy of specification, etc., may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders by 3 p.m. on April 8. Apart from the usual customs duties a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

**Yorkshire.**—The holders of an order for the construction of a light railway in an agricultural district in Yorkshire are prepared to consider the question of transferring the same on terms. The district proposed to be served by the railway is a very wide one, and at present without railway facilities. The prospective amount of passengers and merchandise traffic will, it is expected, be amply remunerative. The capital required will, it is estimated, be about £100,000. For further information apply Railway, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, London, E.C.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto, at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Swindon.**—The Corporation have accepted the tender of F. Webb and Sons, Leicester, at £173. 15s., for wiring school for electric lighting.

**Swansea.**—The Telephone Committee have accepted the tender of Messrs. Henley for the cable to connect the exchange with the National at £306.

**Walsall.**—The Town Council have accepted the tenders of Thomas Parker, Limited, for a dynamo at £180, and Bumsted and Chandler for an engine at £227.

**Hackney.**—The tender of the Chain Belt Engineering Company, of Derby, for a destructor elevator, at £33. 8s. 6d., has been recommended for acceptance.

**Ipswich.**—The Town Council have accepted the tender of Messrs. Reavell and Co., at £3,572. 10s., for new generating set, with the Electrical Company's dynamo.

**Calcutta Electrical Supply Company.**—Messrs. Crompton and Co., of Chelmsford and London, have received an order from the above company for electrical machinery to the value of £40 000.

**Croydon.**—The Town Council have accepted the following tenders: Callender's Cable and Construction Company, for supply of cables for the ensuing year; Babcock and Wilcox, for pipework in connection with condensing and cooling plant, £298.

**Harwich.**—The Admiralty have accepted the tender of the Westminster Engineering Company, Limited, Victoria-road, Willesden Junction, for the electric light and power installation at the Royal Naval Hospital, Shotley Point, Harwich. The three 50-h.p. oil-engines are to be of Messrs. Gardener's make.

**May-Oatway Fire-Alarm Wiring.**—The Scottish Office of the May-Oatway Fire Appliances have accepted tenders for wiring following installations for direct connection with the fire brigades: Aberdeen University Press—Aberdeen Electrical Engineering Company; Darien Press, Edinburgh—Wm. Douglas, Limited; Lyon's Printing Works, Glasgow—Carrick and Topping.

**Foreign Tenders.**—Electricité et Hydraulique, of Charleroi, Belgium, and Jeumont, Nord, have obtained an order for 40 electrical equipments for the Lyons tramways, comprising motors of 27 h.p. each. An order has also been placed with this firm for 16 motors, each of 125 h.p., for traction purposes on the Metropolitan Railway of Paris, these being controlled on the multiple-unit system.

**Brighton.**—The Town Council have accepted the following tenders: Messrs. Virgo (£24. 15s.) and Galliers (£28. 10s.) for installing the electric light respectively at the Freshfield-road police station and at the Middle-road, Preston, police station; Rowland Bros., Horsham, for erection of a new converter house, cable culverts, etc., adjoining the electricity works, North-road, £5,699.

**Metropolitan Asylums Board.**—The Works Committee recommend that the tender of Gent and Hurley, 44, Belvoir-street, Leicester, for the supply and fixing of fire-alarms and telephones at the Caterham Asylum, at £322. 15s, be accepted. The Board have accepted the tender of Vickers, Son, and Maxim, Barrow-in-Furness, at £55,525. for building a new training ship, reference to the electrical equipment of which is made in another column.

**Fulham.**—The Borough Council have accepted the following tenders for the supply of electrical stores for the year ending March 31, 1905: Vacuum Oil Company; W. H. Willcox and Co.; British Thomson-Houston Company, lamps only; General Electric Company, except lamps; Brush Electrical Company; W. Woods and Co., house cutt outs only; British Insulated and Helsby Cables, Limited, exceptions cut-outs; General Electric Company; W. F. Thomson and Co.

**London.**—The British Westinghouse Electric Manufacturing Company report an order from the Sir Hiram Maxim Electrical Engineering Company, Limited, for one 100-kw. gas-engine and generator, one 100-kw. gas-engine direct-connected to two 50-kw. generators, one balancer-booster set, one switchboard; and from Frank Suter and Co., Limited, London, contractors to the Walthamstow Urban District Council, for three additional 250-h.p. producer-gas engines to be used in the extension of the Walthamstow plant for the new tramway service.

**Brighton.**—The Town Council have received the following tenders for erection and completion of proposed new converter house, cable culverts, etc.:

| | |
|---|---|
| Rowland Bros., Horsham (accepted) | £5,699 |
| Foster Bros., Norwood Junction | 5,875 |
| W. A. Field and Co., Brighton | 5,884 |
| R. Cook and Sons, Crawley | 5,939 |
| Hockley and Co., Grantham | 5,950 |
| J. Parsons and Sons, Hove | 6,090 |
| Sattin and Evershed, Brighton | 6,150 |
| F. Gough and Co., London | 6,154 |
| F. G. Minter, Putney | 6,237 |
| J. Longley and Co., Crawley | 6,389 |

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**Battersea.**—The following offers for the supply of materials have been recommended for acceptance: Mackenzie Bros., arc lamp pillars and brackets, £172. 10s.; Gilbert Arc Lamp Company, Limited, arc lamps complete with hoisting and lowering gear, £187. 1s.; Simplified Underground Conductor Company, Limited, telephones for switch pillars, £16. 19s. 6d.; G. M. Marchant, valves, £73. 10s.; Venner and Co., one special meter, £25. 10s. For one year's supply: De Grelle Houdret and Co., carbons for arc lamps; Cockerell and Co., coals; Willcox and Co., Limited, oils and engine-room stores; Chamberlain and Hookham, Limited, electricity meters (ampere-hour), and the British Thomson-Houston Company, Limited, electricity meters (watt-hour); Mather and Platt, Limited, to supply and fix electric pumps and pipes required in connection with the extension plant at the central electric generating station, for the sum of £825; Babcock and Wilcox, Limited, to supply and fix complete two water-tube boilers similar to those previously supplied, one being fitted with hand-fired furnace, for the sum of £2,300; C. A. Parsons and Co., supply of a spare armature for the steam turbine-dynamo, at £700

**Camberwell.**—The Council have received the following tenders for the new engine and dynamo in connection with the lighting of the Camberwell Baths:

| | | | |
|---|---|---|---|
| Royce, Limited (part only) | £317 | 0 | 0 |
| Woods and Co. | 335 | 0 | 0 |
| Durtnall and Pries | 338 | 0 | 0 |
| Davey, Paxman, and Co. (part) | 338 | 0 | 0 |
| Johnson and Phillips | 340 | 0 | 0 |
| Alliance Electrical Company* | 355 | 0 | 0 |
| R. Murray (part) | 375 | 0 | 0 |
| T. S. Anderson | 470 | 0 | 0 |
| Witting, Eborall, and Co. | 485 | 0 | 0 |
| British Westinghouse Company | 490 | 0 | 0 |
| Bakewell and Co. | 530 | 10 | 6 |
| Ditto | 548 | 15 | 6 |
| Brush Electrical Engineering Company | 550 | 0 | 0 |
| Sunderland Forge, etc, Company | 560 | 0 | 0 |
| Mossop and Co. | 572 | 0 | 0 |
| Goddard, Massey, and Warner | 599 | 0 | 0 |
| Mather and Platt | 634 | 0 | 0 |
| Geipel and Lange | 645 | 0 | 0 |

*Recommended for acceptance, subject to the company making an allowance of £80 for the old engine.

# BUSINESS NOTES.

## TRACTION.

**Lorenzo Marques.**—The electric tramway system has now been opened for traffic.

**Perth.**—The Corporation have published formal notice of their intention to seek powers for extension.

**Rawtenstall.**—The Town Council are considering the question of running a motor 'bus between Waterfoot and Water.

**Lewisham.**—The Borough Council have decided to support the London County Council's Bill for acquisition of the local tramway.

**Weston-super-Mare.**—The receipts for last week were £22, against £25 last year, and a period of 10 weeks yielded £222, being a decrease of £19.

**Tipton.**—The District Council have resolved to insist upon the tramway company electrifying the line from Dudley to Wednesbury forthwith.

**Liverpool-Southport.**—This newly-electrified line on the Lancashire and Yorkshire Railway Company's system was formally opened on Tuesday.

**Isle of Thanet Co.**—The traffic returns of the electric tramways show receipts amounting to £254 as against £336 for the corresponding week of 1903.

**Eston.**—The inhabitants are lamenting the decision of the Imperial Tramways Company that it would not pay them to run their cars through to Eston at present.

**Bath.**—The Bath Chamber of Commerce have memorialised the Board of Trade with a view to ensuring the public safety in connection with the Manvers-street route.

**Gildersome (Yorks).**—The Board of Trade have granted the British Electric Traction Company an extension till March next to construct the proposed light railway.

**Merthyr.**—The tramway receipts for last week were £184, being £3 more than for the corresponding week last year. Aggregate receipts 10 weeks, £1,875; aggregate increase, £154.

**Garstang.**—The promoters of the light railway to Blackpool have not abandoned their project, but are biding their time. An application is to be made in May for an extension of time.

**Motorcar Act.**—More than £5,000 has been received by the London County Council in connection with the Motorcar Act, which came into operation at the beginning of this year.

**South London Tramways.**—A meeting convened by the Mayor of Camberwell unanimously approved the London County Council's proposals for extending the tramways over the bridges.

**Leith.**—The Commissioners are proceeding with the enquiry into the provisional order for the acquisition, extension, and electrification by the Town Council of the tramways within the burgh.

**Broughty Ferry.**—The Dundee Town Council have now definitely resolved to give their support to the proposed railway, and have appointed the Lord Provost to represent them at the enquiry.

**New Lancashire Railway.**—It is stated that the South Lancashire Tramways Company intend to shortly lay lines in Worsley and Little Hulton, connecting them with the Farnworth Council's system.

**Ashton.**—The Urban District Council have published notice of their desire to take over from the Manchester Southern Tramways Company the portion of the latter's undertaking within the district.

**Manchester.**—The zone system of railway travelling has been adopted by the Great Central Railway at Manchester, as an experiment to meet the severe competition of the electric tramway service.

**Swansea.**—The receipts for last week were £431, being a decrease of £22 compared with the corresponding week last year, but the aggregate receipts for the past 10 weeks were £4,557, being an increase of £161.

**Portsmouth.**—A new cable is to be laid from the power station to Fratton-road, as the demand for power is increasing. Tenders are to be invited for the timbering of the lockers for the new works at North End depôt.

**Ossett.**—It was announced at the last meeting of the Town Council that the Wakefield and District Light Railway Company had intimated their intention to proceed with the construction of the tramway from Horbury to Ossett.

**Hanley.**—At Tuesday's Town Council meeting a letter was received from the Potteries Electric Traction Company stating that the directors were unable to come to a decision as to the construction of the light railway to Providence-square at present.

**Heaton Norris.**—The Urban District Council have appointed a deputation to wait upon the Manchester Corporation for the purpose of expressing disapproval of the overcrowding of their cars, and desiring that notices be exhibited on cars when full.

**British Electric Traction Co.**—The receipts of all the associated companies for the week ended 11th inst. amounted to £20,749, as against £19,089 for the corresponding week last year. Aggregate receipts to date, £209,484—increase, £24,838.

**Plymouth.**—In connection with the runaway tramcar incident the other day, it now appears that the mishap was not attributable to failure of the brakes, but to an error of judgment on the part of the driver, who failed to apply the hand and slipper shoe brakes.

**Huddersfield.**—The County Borough Council's tramways showed an increase of £356. 9s 11d. on the past month's passenger traffic. The total receipts were £4,485. 15s. 2d., the mileage 125,405 and the passengers carried 856,626, the average receipts per mile being 8·41d.

**Musselburgh.**—The promoters of the electric tramways have reported to the Town Council that they have abandoned the idea of proceeding with the surface-contact system and have decided to proceed forthwith with the trolley system, and hope to make a start within a month.

**Wandsworth.**—The suggested lines to Streatham and Clapham have been postponed, if not abandoned. The Borough Council, however, have decided to request the London County Council to receive a deputation on the subject of tramway construction within the borough generally.

**Liverpool.**—The City Council have decided to recognise the act of heroism of Ellen McCoy, the girl who a few weeks ago lost her life in the effort to save her pet puppy dog from being run over by an electric tram in Heywood-street, by granting a compassionate allowance of £25 to her father.

**Harrow-road and Paddington Tramways.**—The preamble of the Bill for street widening in connection with the doubling of the line has been proved. The Bill contains protective clauses in favour of the Gaslight and Coke Company and the Metropolitan Electric Supply Company.

**Bristol.**—Compliance with Standing Orders has been dispensed with in connection with the Bristol Tramway Company's proposed extension, provided that tramways Nos. 7 and 9 are deleted from the Bill, and also Nos. 3 and 5 unless the consent of the Warmley Rural District Council be obtained.

**Hastings.**—It is stated that the trams will be started in Queen's-road three months hence. There is a proposal that the Corporation shall borrow money for the wood paving of Queen's-road, and it is understood that Mr. Murphy is ready to lay his lines conjointly with the laying of the wooden blocks.

**London County Council Tram Accident.**—A driver was fined £3 at Southwark Police Court on Monday for furious driving in Waterloo-road. A woman was knocked down by the car, and the magistrate ordered the County Council to pay her £8 compensation, beyond £2 previously given her.

**Newcastle.**—The Committee of the House of Lords resumed on Wednesday the consideration of the Corporation Bill. Counsel for the promoters stated that words had been added restricting the use of the electrical power outside the city to their own tramways. Evidence was given of the demand for the proposed tramways.

**Ayr.**—With reference to the note in our last issue as to the expenditure of £40,000 on tramway extension, the Corporation have published notice of their intention to apply for powers to construct four new tramways in the parishes of Prestwick and Monkton, and to substitute a double for the single line of tramway on a portion of the existing system.

**Canada.**—The development of electric traction in Canada is well illustrated by the returns of the Department of Railways for the last fiscal year. The mileage increased by 201 miles during the year, showing a total of 729; the number of passengers grew from 137,641,402 to 155,662,812; while the net earnings were £575,170. 12s. 6d., as compared with £559,071. 11s.

**Scarborough.**—The Corporation have referred the question of laying tramlines on the approach road to the Marine-drive while the road is being constructed to the Streets Sub-Committee. The Board

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of Trade is to be requested, in the interests of public safety, to inspect the Aquarium, over which it is proposed to construct the railway, and the roofs of which it is intended to strengthen.

**Tynemouth.**—The receipts of the Tynemouth and District Electric Traction Company, Limited for the week ending March 11 amount to £192, as against £225 for the corresponding week of last year. Two more cars have arrived. It is expected that one part of the line, from Benton to New Bridge street, will be opened at Easter or shortly after. These cars bring up the number now at the Central to eight.

**Bradford.**—In the course of a lecture the other evening Mr. C. J. Spencer, manager of the Corporation's tramways, remarked that since the opening of the service in 1898 the capital expenditure had increased from about £80,000 to nearly £800,000, while the receipts had risen from £12,000 to £198 000. The system now extended over 50 miles, the cars numbered 230, and about 1,000 men were employed.

**Swinton** —The Town Council have resolved to apply to the Board of Trade for sanction to raise £24,689, the price of purchase from the Manchester Carriage and Tramways Company as fixed by the arbitrator, and £2,200, the costs of arbitration. The Salford Corporation have to pay the money, but it has to be found by the Town Council. The offer of £56. 5s. from the Corporation for restoring paving has been accepted.

**Third-Rail v. Overhead Construction.**—Mr. George Westinghouse is credited with the prediction that there will be a right-about change of opinion in favour of the overhead wire erected in a more substantial manner than has been customary in the States. He claims that the overhead system is much safer, and declares that there never was any good reason in favour of the adoption of the third-rail in preference.

**Paris Underground Railway.**—We learn that great progress is being made with the excavations for the Paris Underground Railway. Underneath the Place de l'Opera now there has been scooped out a great clearing of 324 square yards, which will soon be lighted by electricity. This space is to be a huge hall for the ticket and other offices for the three main lines which are to have their junction under the Place de l'Opera.

**Ipswich.**—The ecclesiastical authorities will, at the next Consistory Court, formally grant a faculty to enable the Corporation to run their system over a portion of the churchyard in connection with the Fore Hamlet widening. The demands of the Board of Trade in regard to the Stoke Bridge crossing have been complied with, and if the Board's inspector raises no further objection the running of the cars by this route will begin in a day or two.

**Leeds.**—The Corporation Tramways Committee have laid down in Boar-lane a set of electric points to secure the simultaneous automatic adjustment of points on the rails and overhead wires by merely using the ordinary driving regulator. The continuance of the current opens the points, while the shutting off of the current leaves them unaffected. The manufacturing and patent rights of this invention are held by Messrs. Dixon and Son, Boar-lane.

**Brighton.**—The Town Council have approved the erection of a tramway shelter at the bottom of Church-street at a cost of £140. A further development of the tramway system has been projected—a cross-section of line to connect New England-road with Lewes-road, which will provide a link between the north-western quarter and the race hill. The permanent way is already laid, and the service will be available as soon as a supply of cars has been obtained.

**London United Tramways Co.**—At the resumed hearing of the company's appeal against the assessment of the Brentford authorities, Mr. Robert Hammond deposed that the figures given by the company were carefully compiled and perfectly fair, and added that it was somewhat difficult to arrive at the average cost of repairs, etc., of this undertaking, as there was no undertaking in the world, or at least in the United Kingdom, with which it could be compared.

**Belfast.**—At a special meeting of the Belfast Corporation last week a letter was read from the tramway company offering to sell its undertaking on terms to be arranged by a Board of Trade arbitrator plus 3½ years' purchase based on the profits of the past seven years. The Corporation decided to offer three years' purchase based on the profits of the past five years. An amicable arrangement is probable, in which case steps will be immediately taken to electrify the service.

**Tyneside.**—Consideration of the Tyneside Tramways and Tramroads Bill is proceeding before a Select Committee of the House of Lords. Mr. McClelland, manager to the promoting company, said the company did not ask to be allowed an exclusive service on any of the Corporation lines. Questioned as to the precedents of applications to Parliament for compulsory running powers, he said he could only instance Manchester and Bournemouth. When the company's cars got into Newcastle, he added, they would be in the hands of the Corporation officials.

**Soothill.**—The Urban District Council's Tramway Bill has passed the Select Committee of the Commons. The measure comprises the Rhondda clause, with power to the District Council to lease for 42 years. The petitioners against the Bill were not represented by counsel, thus reserving their right to further oppose the measure in the House of Lords. The petition of the Yorkshire Electric Power Company will be withdrawn, the District Council having agreed to eliminate from the Bill the powers to supply electrical energy outside their own district.

**Nottingham.**—The tramways have now been open about three years, and up to the present none of the rails have had to be renewed through wear. It is only on the curves that the rails show any signs of wear, the worst being those at the corner of Long-row and Queen-street. These will be renewed within the next few days. Some idea of the traffic over these rails may be gathered from the fact that on Saturday 44 cars passed round that corner in each direction every hour—Nottingham-road 10, Mapperley 10, Sherwood 12, and St. Ann's Well-road 12.

**Blackpool.**—The Palatine Court has sanctioned the reduction from £150,000 to £125,000 in the capital of the Blackpool Electric Tramways (South) Company, Limited. The Blackpool, St. Anne's, and Lytham Tramways Company, Limited, who have acquired a controlling interest in the former company, supported the application. With regard to the Promenade tramways, it is stated that so far as the electrical equipment is concerned, all the poles and overhead equipment will be fixed and ready for service not later than Tuesday, the 29th inst.

**Newport.**—The plans of the Stow Hill tramway scheme having been sanctioned by the Board of Trade, the Electricity and Tramways Committee of the Corporation have considered and recommended a number of tenders for the materials. The work will be carried out by direct labour. It is expected that, if fine weather prevails, the line and equipment will be completed in about three months. As, however, a portion of St. Woolos' churchyard has to be cut away and some of the graves interfered with, a faculty will have to be obtained for this, and it is possible that a little delay will be caused thereby.

**Buenos Ayres and Belgrano Tramways Co.**—The Buenos Ayres and Belgrano Electric Tramways Company have announced a dividend of 3s. per share on the ordinary shares. For the previous year nothing was paid on the ordinary, but the company managed to clear off the arrears on the "B" preference shares. On this occasion the directors are able, after again placing £5,000 to the renewal fund, to strengthen the position of the company by writing £4.500 off the capital expenditure, and to place £2,500 to the sinking fund for the redemption of debenture capital, besides appropriating £500 to the accidents insurance fund.

**Underground Railway Electrification.**—The District Company's main generating station is in course of construction at Chelsea. There will be 20 sub-stations, which are being excavated along the line from East Ham in the east to Hounslow in the west. The subways are 40ft. below the ground, and will carry the power cables. The President of the Board of Trade stated in the House of Commons last week that both the Metropolitan and the Metropolitan District Railway Companies had informed him that the equipment of their lines for electric traction traction was progressing rapidly, and that they expected to be able to run the trains early in next year.

**London, Deptford, and Greenwich Tramways.**—The arbitrator has made his award in the case of the London, Deptford, and Greenwich Tramways Company and the County Council. The figures are not yet available, but it is understood that the award is given at less than half the amount the company claimed, and only £2,000 or £3,000 beyond the sum offered by the County Council. It is anticipated that the County Council will soon consider the best method of electrifying the lines and bringing them into harmony with those in Southwark, and so enable the people of Bermondsey to travel with far greater facility through South London.

**Baker-street and Waterloo Railway.**—The House of Commons Committee has found the preamble to this Bill proved. The secretary to the company stated that they had spent £1,552,000, leaving a balance under the contracts of £1.574,000 still to be expended. It was estimated that £1 486,510 of this was still needed, and, therefore, the company would only have a balance of £87,490 left, out of which any further interest during construction would have to be paid, and to which the contractors would look for their profits. Considerable obligations had been imposed upon them by the Board of Trade since the Paris fire with regard to fire precautions.

**Camberwell and Dulwich Tramway.**—At its meeting last Wednesday, the Borough Council received a communication expressing surprise at the action of the Council in opposing the electrification by the company of this line, and requesting the Council to reconsider its decision, and endeavour to come to some arrangement with the company, whereby costly parliamentary opposition will be saved, and tramway facilities afforded to the residents. The Tramways Committee recommended that the Council agree to contribute one-third towards the actual cost of street widenings for tramway purposes for the borough of Camberwell, authorised in the London County Council Tramways and Improvements Bill, 1904.

**Rowley.**—At Tuesday's meeting of the Rural District Council the Tramway Committee reported that satisfactory terms had been arranged with the Birmingham and Midland Tramways Company for the construction of the new line from Old Hill to Blackheath. The Board of Trade had approved of the position of the poles, and the rails would be obtained from Barrow-in-Furness. It was recommended that the loan to cover the cost of the proposed tramway should be increased from £27,600 to £28,000 owing to additional improvements being required, and that the sanction of the Board of Trade be obtained to the proposed alteration. The Chairman stated that the rails would be supplied by British manufacturers.

**Walsall.**—The following are further particulars of the working of this new line: Jan. 1 to week ending Jan. 30, 1904, number of passengers, 385,210; receipts, £2,081. 6s. 11½d.; car miles run, 63 416·40; receipts per car mile run, 7·87d. Four weeks ending Feb. 27, 1904. number of passengers, 328,786; receipts, £1.801. 11s. 7d.; car miles run, 54,765 52; receipts per car mile run, 7 89. The Town Council have decided that the tramway lines from Milton-street to The Bridge and from the Wisemore to Green-lane, Bloxwich, be re-equipped, electrically, at an estimated cost of £2,600, and that the Tramways Committee be authorised to obtain tenders and to enter into a contract. Reduced fares for scholars have been adopted.

**Coney Island (U.S.A.).**—It is stated that Coney Island is to have a new pier, which will be the "longest in the world," and a new railway, which will run the length of the pier and some distance inland. The constructors claim that a speed of five miles per minute will be possible on this line. By a system of electric magnets brought into action by the locomotive, they explain, the weight of the train may

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be practically taken off the rails so that friction and resistance are reduced to a minimum. It is claimed by Prof. Albert C. Albertson, of the Electric Electromagnetic Construction Company of Manhattan, that, inasmuch as the entire power of the locomotive is devoted to speed without friction and weighty coaches, a speed of five miles per minute, or 300 miles an hour, can be attained.

## LIGHTING AND GENERAL.

**Halesworth.**—Steps are being taken towards the erection of a local telephone service.

**India.**—We understand an electrical engineer, at Rs.700 a month, is required by the Punjab Command.

**Bexhill.**—Application is to be made for sanction to the borrowing of a sum of £3,500 for electric lighting purposes.

**New Address.**—Messrs. Newton Bros., electrical engineers and contractors, Alfreton-road, have removed their offices to 21, Market-place, Derby.

**Dalkeith.**—The Town Council are asking Messrs. Crompton and Co. to make the charge for lighting public buildings 3d. per unit, the same as the street-lighting.

**Electric Share Market.**—Although the tone in the electric share market has on the whole been firmer during the past week, dealings have been on a very small scale only.

**Camberwell.**—The offer of the London Electric Supply Corporation, Limited, to supply the electrical current required at the baths at the rate of 3¾d. per unit has been accepted.

**Direct United States Cable Co.**—An interim dividend of 3s. per share, tax free, being at the rate of 3 per cent. per annum for the quarter ending March 31. 1904, will be payable on April 26.

**Change of Title.**—We are informed that Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King street, Manchester, will in future practice under the title of Lacey, Sillar, and Leigh.

**Eastern Telegraph Co.**—The directors announce an interim dividend of 1¼ per cent. on the ordinary stock of the company, free of income tax, in respect of profits for the quarter ended Dec. 31, 1903.

**Calcutta.**—The much-needed telegraph office extension at Calcutta has, according to *Indian Engineering*, to be kept in abeyance until the new buildings at Hastings for the medical store department are completed.

**Grimsby.**—The Lighting Committee have received a report showing that 335 consumers of electric light were connected up to Dec. 31. During February 72,082 units were sold, an increase of 11,841 units over February last year.

**Aberdeen.**—The Postmaster-General is about to erect telephone poles, wires, etc., along the public road from Maud Junction to Brucklay Castle, and along the public road to Peterhead and Maud, *viâ* Longside and Mintlaw.

**Shildon.**—The Urban District Council are discussing an agreement drafted by the Northern Counties Electric Supply Company, according to which the latter would supply a generating station and refuse destructor on or before Jan. 1 next.

**Margate.**—It is reported that Lady Decies has already received about £100 in small sums towards the £250 needed to provide an electric apparatus for the treatment of lupus and tubercular affections at the Royal Sea Bathing Hospital.

**Walsall.**—The total number of consumers supplied on Feb. 29 last was 329. The engineer has been instructed to purchase from Messrs. Bumsted and Chandler two exhaust heads for the engines at a cost of £47, and also a second-hand lathe at a cost of £35.

**Beeston.**—The committee who have the electric light scheme in hand having reported that a canvass of the parish had resulted very satisfactorily, the Urban District Council have decided that the new Council be advised to take the matter in hand at an early date.

**Hackney.**—The Council have decided upon laying a 0·1 T.C.C. distributor from the existing mains in Upper Clapton-road, eastward to a point 320 yards down Moresby-road, which it is estimated will cost £175 and a 0·1 distributor from Windsor-road at an estimated cost of £85.

**Agency.**—The Rhodes Electrical Manufacturing Company have established a branch office at 35, McAlpine-street, Glasgow, for the sale of their manufactures (electric motors and dynamos) for the whole of Scotland, under the management of Messrs. James T. Donald and Co., Limited.

**Watford.**—The electrical engineer's last report states that the number of applications amount to 324, of which 321 are connected. There is an application for 350 lights to one mansion and stables. The electrical engineer has been directed to proceed with the work of connecting the hospital.

**London Gazette.**—A winding-up order was made on the 15th inst. in the estate of the Automatic Telephone Company, Limited, 72 and 74, London-street, Greenwich. Mr. C. Bussey, Norwich, has been appointed liquidator for the winding-up of the Norwich Mutual Telephone Company, Limited.

**Rochdale.**—The joint conference of representatives of the Gas and Electricity, Paving and Sewering, and Health Committees, now considering the question of utilising the steam raised at the sanitary works to generate electricity, have asked Dr. Kennedy to advise as to the situation of the new generating station.

**Swansea Telephones.**—The telephone chairmanship dispute has been temporarily settled by the appointment of Mr. Davies as chairman of the committee, and Mr. Solmoon as vice-chairman, this arrangement being come to in the hope that the friction would be put an end to, when it is understood Mr. Solomon will again resume his duties as chairman.

**Swansea.**—In presenting the minutes of the Electric Lighting and Tramway Committee, Mr. Sinclair, the chairman, said last week that the consumption of current would be quite 60 per cent. increase on last year, and although the price per unit would not come out so well, the committee would be able to pay their interest and charges and have a little to spare.

**Gillingham.**—The Town Council have decided to borrow £20,000 for electric lighting purposes. In consequence of a memorial from local tradesmen, asking that the flat rate of charging might be adopted, it has been decided to adopt both the existing system of 7d. and 2d. and the flat rate at 4½d., as well, and also to reduce the charge on slot meters from 6d. to 5½d.

**Cardiff.**—Consideration on the town clerk's report as to the best course to be pursued in order to obtain the necessary powers to enable the Corporation to purchase electric motors for hiring purposes, and to carry out electric wiring, will shortly come before a special meeting, together with the relative advantages derivable from the use of incandescent lamps for public street-lighting.

**Mansfield.**—The engineer in his last report states that the number of units sold during the quarter ended Dec. 31 was 50,276. His report as to time switches as a means of improving the load factor of the works has been approved, and further consideration of the matter referred to a sub-committee. Application is to be made for sanction to the borrowing of £15,000 for the purposes of the undertaking.

**Heckmondwike.**—The District Council at their last meeting, after hearing a report of a canvass of shopkeepers and others likely to become customers, decided to reduce the price of electricity for lighting purposes to 4 d. per unit. A month ago a similar resolution was made conditional on the local co-operative society undertaking to take the whole of its supply of current from the town, but subsequently the society declined to comply.

**Telephones to France.**—A *Standard* telegram, dated Paris, Tuesday night, says the postal authorities of France and England have come to an agreement by which telephonic communication, which has hitherto existed only between Paris and London, shall be extended to the chief English provincial towns, including Manchester, Liverpool, Birmingham, Hull, Cardiff, Leeds, and Southampton. The price for a three minutes' conversation will be 10fr.

**Govan.**—The Chairman of Ways and Means in the House of Commons having reported that the Govan Burgh (Electricity) Order was of such a character that it ought to be dealt with by private Bill, the Town Council have passed the requisite resolution to proceed with the order as a private Bill. Steps are to be taken to improve the lighting of certain streets. In the House of Lords on Monday the Burgh (Electricity) Bill was read a third time and passed.

**Basingstoke.**—The electric light scheme has been in a very indefinite position since the withdrawal of the parliamentary Bill, the primary object of which was to enable the scheme to be carried out by the National Electric Construction Company with capital provided by the Corporation on the security of the local rates. It is proposed to ascertain the opinion of the burgesses by ballot whether the work should be carried out by the Corporation or by a private company.

**Southend.**—The electrical engineer (Mr. W. E. J. Heenan) in his last report stated that during February 20 consumers were connected to the mains, with the equivalent of 794 lamps, bringing the total number of lamps connected to 32,313. The committee have been authorised to extend the electric light feeder to a point in Crowstone-road, and to provide a spare way for future requirements at a total cost of £2,028, and to extend other mains in Leigh-road at a cost of £668.

**Musselburgh.**—The promoters of the electricity scheme intimated to the Town Council on Wednesday that the work in connection with the installation of the local electric tramway and lighting schemes will be begun on April 6. The estimate furnished for public lighting is based on a charge of 2¾d. per unit, but this includes cleaning of the lamps and supply of carbons. The Council have agreed to a contract with the company for the lighting of about a mile of street with 20 arc lamps.

**Local Telegrams.**—The Postmaster-General, in reply to a correspondent who advocated cheap local telegrams at the rate of 3d. for a radius of one mile, states that he would not be justified in proposing the change. Lord Stanley points out that, even at the present rate, the service is not remunerative, and that a 3d. rate would result in a great loss. The Postmaster-General adds that the cost of delivery within the mile radius costs more than 1d., and that, however short the message, the counter and office work are the same.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Metropolitan Railway Company's scrip (fully and partly paid) of £500,000 3½ per cent. convertible preference stock; National Telephone Company, Limited, scrip (fully and partly paid) of a further issue of £1,000,000 4 per cent. debenture stock; and also to allow National Telephone Company, Limited, further issue of £89,593 4 per cent. debenture stock to be quoted in the official list.

**Liverpool.**—The Corporation have made a net profit of £85 301 since they commenced their electric light business a little over three years ago. The electric light reserve fund is at present £104,277, notwithstanding that £2,000 is annually contributed to the city fund and £29,910 granted in relief of the general rate since the commencement of this branch of business by the Corporation. Last year the total supply of electricity for lighting, power, and tramway purposes provided by Liverpool Corporation was 26,015,062 units, the average price per unit being about 1¾d.

**Blackpool.**—The borough electrical engineer in his last report states that the returns for February showed a very slight increase in the works output of 2,190 units, as compared with the corresponding month (February) last year, made up as follows: private lighting,

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1903, 113,987 (1904, 114,480)—increase, 493; Corporation tramways, 67,118 (62 360)—decrease, 4,758; Lytham and St. Annes tramways, increase 6 455; total increase for month, 2 190. The work in connection with the extension of flues to the new chimney is being pushed forward with all speed, and he anticipated the work will be completed before Easter.

**Fife Power Company.**—At a meeting of the Fife Electric Power Company in Edinburgh a site for a generating station for the West of Fife was agreed to, which is situated between the Town Loch and the West of Fife Mineral Railway. The original site was departed from in consequence of the probability of subsidence, that area being undermined by disused coal workings. The contract both for the buildings and plant was given to Bruce Peebles and Co., Edinburgh, and the estimated cost of the undertaking is anything between £20,000 and £30,000. The work, it is understood, will be commenced in a fortnight or three weeks' time.

**Huddersfield.**—The Electricity Committee have appointed Councillor Chatterton chairman for the remainder of the municipal year in succession to the late Alderman Calvert, J.P. The engineer in his last report shows that in March the number of consumers was 1,902 as against 1,898 in February, an increase of four; the lamps connected in March numbered 133,165, as against 132,910, an increase of 253. The number of units metered in February last was 180,952, as against 159 917, showing an increase of 21,035, equal to 13·2 per cent. It was decided that the extension of Mountjoy-road be carried out, and accounts for £540. 8s. 8d. were passed for payment.

**London County Council.**—At the meeting on Tuesday tenders for the supply of an electric jib crane for the Greenwich electricity generating station (tramways), and for the erection of refreshment-house, conveniences, etc, at Hackney Marsh were referred to the committees concerned. It was agreed to lend the Westminster City Council £52,226 for various purposes, and Shoreditch Borough Council £1,286 for dust destructor purposes. Sanction was also given to the borrowing by the Hackney Borough Council of £26,000 for electric lighting, street-lighting, and dust destructor, and the St. Pancras Borough Council £19,000 for electric light installation.

**Saffron Walden.**—The Board of Trade have agreed to the provisional order, subject to the omission of Clause 8. The plans and specifications for the electric installation, prepared by Messrs. Foote and Milne, Limited, show the cost of the works (exclusive of the price of the additional land) to be £9.150, which sum includes the complete equipment of the undertaking, the contractors taking all the further responsibility. Particulars of the proposed expenditure are to be obtained from the firm in question, and the plans and detailed specifications submitted, if terms can be arranged, to Messrs. Preece and Cardew, as consulting engineers, to advise the Council thereon.

**Glasgow.**—The Electricity Committee of the Corporation have received a further deputation from the Pollokshaws Town Council with reference to the application which has been made to the Board of Trade by the Clyde Valley Electrical Power Company, Limited, to dispense with the consent of the burgh to the granting of a provisional order. The deputation desired to know as soon as possible whether, and, if so, upon what terms, the Corporation would in the event of the burgh successfully opposing the company's application and themselves obtaining an order from the Board, be prepared to take a transfer of that order, and thereafter supply electricity within the burgh. The matter has been remitted to a special sub-committee.

**Mexborough.**—The electric lighting of the Mexborough and Swinton railway stations and of the adjoining locomotive shed and goods yards was inaugurated on Thursday. Current is supplied from the Urban District Council's electricity works, of which Mr. J. Senior, formerly of Huddersfield, is now the chief electrical engineer. The wiring work has been carried out by the Great Central Railway Company's own staff of electricians, and the installation consists of 44 arc lights and 351 incandescents, a supply which the company will extend in the near future. The town's refuse destructor supplies the steam required to supply the demands of this new consumer, together with the entire street-lighting of the town, as well as that of considerably over 100 private consumers.

**Electricity Provisional Orders and Bills.**—The amount of money to be raised for the purpose of works of railways, canals, tramways, and the supply of electricity, gas, and water in respect of private Bills, 1904, is £37 825 761, as compared with £75,287.015 last year. This includes 17 Bills relating to electricity (13 in England and two each in Scotland and Ireland), with a total capital of £12,216.444—£9,880 444 in shares and £2 336 000 in debentures or loans. The Tramway Bills number 39; 228 miles are projected, at a total capital of £5,323 971—£1,219 000 share and £4,104,971 loan. The applications for provisional orders number 119, including 74 for electric lighting, with a capital of £1,167,598, and 15 for 41 miles of single line of tramways, with a capital of £307,380.

**Llandudno.**—At the last Urban District Council meeting the engineer reported, with regard to coal tests, that the coal obtained from Messrs. B. Thomas and Sons, Swansea, at 18s. 6d. per ton delivered, proved excellent, and he calculated that by its use, instead of coke, a saving of £185 a year would be effected, and that there would also be less wear and tear on the boiler furnaces and tubes. He also stated that the cost of laying a cable for supplying current to the Vicarage, Conway-road, would be £100, and it was agreed to do the work, provided that the vicar would undertake to pay the usual 20 per cent. on the outlay for a period of three years, the cost of current to merge in such charge, which would be reduced *pro rata* as the cable proposed to be laid might be utilised for public or private lighting.

**Electricity in Mexico.**—Two thousand men are now at work on the Necaxa Falls electric power plant, a hundred miles north-east of the city of Mexico. The capital, 7,000,000dol., put into the enterprise comes mostly from Canada, less than one-third being raised in America, England, and Germany. On the Necaxa River there are two falls, one of 700ft. and one of 400ft. Forty thousand horse-power will be generated at this plant, and it is proposed to develop 32,000 more at another spot on the river. To provide sufficient water during the dry season there is building one of the largest reservoirs in the world. The dam will be 150ft high, and will hold back 16,800,000,000 gallons of water, enough to supply the plant for three months. The power will be taken to the city of Mexico, a hundred miles away, and to the mining camp at El Oro, 60 miles further. It is expected that the construction will be completed in a year.

**Frome.**—The men employed in excavating and in laying the cables for the new electric installation came out on strike on Monday morning. *Keene's Bath Journal* says the point in dispute was that they wanted a uniform payment of 5d. per hour, instead of a few being paid that sum and the rest 4½d. The contractors (Messrs. Edmundson) declined to accede to the request, and paid the men off. On Tuesday a number of men were imported from Trowbridge, but on finding that a strike was in progress they refused the employment and returned home. Later in the day a batch arrived from Bristol, and they, after considerable persuasion, were induced to start work. They were greeted by the strikers with cries of "blacklegs," but the police, who were present in considerable force, several having been drafted into the town from the country, prevented any disturbance by keeping the crowd which had assembled continually on the move. One man, who was more obstinate and demonstrative than the others, was taken into custody. It is believed the contractors have now seen the end of their trouble.

**Hanley.**—At Tuesday's Town Council meeting the Electric Lighting Committee reported the receipt of a letter from the Local Government Board with reference to the Council's application for sanction to borrow £17,600 for the purposes of the electricity undertaking, stating that the Board would defer giving the sanction for the £5,000 for new generating plant, £600 for superheaters, and £200 for new switchboard, until the tenders and full particulars had been submitted to them. The Board learned that the proposed loan included a large sum for excess expenditure, a part of which was incurred as long as seven and eight years ago. They had, however, decided to sanction a loan in respect of this excess expenditure, subject to the deduction of £649, approximately the amount of principal which would have been repaid if the loan had been raised at the date of the execution of the works. In accordance with this decision the Board formally sanctioned a loan for £11,151, to be repaid within a period of 24 years. The letter was referred to the Finance Committee with a request to raise the amount sanctioned.

**St. Pancras.**—The Council have received a communication from the Finance Committee of the London County Council, stating that they have considered the application of the Borough Council for sanction to the borrowing of £28,580 for electric lighting mains, and, having regard to lower prices having been obtained for the execution of the work than were contemplated when application was made, the committee propose to recommend the County Council to sanction a loan of £13,000 for the work, and if the Borough Council find that any further sum is required to complete the work a fresh application can be made for it. In view of the recent action against the Council for vibration, etc., in connection with the Council's electricity undertaking, it is proposed to convene a conference of local authorities and companies owning electricity undertakings in London and the provinces with the object of petitioning the Board of Trade to obtain parliamentary powers on behalf of the undertakers for the following purposes: (*a*) compulsory powers of purchase; (*b*) the repealing or modification of Clause 71 of the electric lighting order and Clause 17 of the Electric Lighting Act, 1882, relating to actions against the undertakers for nuisance and damage.

**Hammersmith.**—A loan of £10,640 is required to defray the expenses incurred or agreed to be incurred in the laying of new mains and providing the additional plant comprised in the following statement: mains, £2,701. 10s. 6d.; street boxes, £168. 15s. 9d.; culverts, £345. 5s. 1d.; trenching work, £283. 2s. 4d.; reinstatement of ditto, £271. 3s. 7d.; sub-stations, £785. 14s. 9d.; transformers, £1,245; switchboard, £909. 7s. 1d.; setting to work, £34. 7s. 5d.; clerk of works, £121; engineer's charges, £100; consumers' services, £3,677. 2s. 2d.; and it is proposed that application be made to the London County Council for sanction to the borrowing and for the advance of a loan of £10,640 for the purposes named. On Wednesday night it was reported that since the previous Council meeting 16 additional consumers had been connected, making the present number 1,430. In December last the electrical engineer submitted the following report: "In my progress report you will notice that we now have a total equivalent of 77,993 8-c.p. lamps connected to our mains, which, together with the public lighting, makes a possible maximum demand upon the station of 85,625 8-c.p. lamps. When laying down the last extensions, Mr. Preece stated that the plant would then be able to safely deal with a maximum demand of 50,000 8-c.p. lamps alight at one time, and still have sufficient stand-by. We have this evening had to meet a maximum demand equivalent to 46,420 8-c.p. lamps, and as the present plant will be unable to cope with very much more evening load, it will be necessary to immediately take up the question of providing more machinery. The chimney and boilers are already loaded up to their utmost capacity, and it will be necessary for another large chimney to be provided if the new boilers are to be worked under the same conditions—viz., natural draught. The new boilers should be in complete working order not later than August next year." The Electrical Committee are of opinion that the time has arrived for extending the generating station and plant, and recommend that plans and estimates for the proposed extension should be at once prepared by Mr. Bell, the borough electrical engineer. This arrangement will involve the appointment of a draughtsman in the engineer's office for a year or so. The cost of the extension immediately required is roughly estimated at £40,000.

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**Dundee.**—A number of the millowners of the city are at present considering the advisability of adopting electricity in place of steam as the motive power for driving their machinery. The *Dundee Advertiser* says a short time ago an electric installation was fitted up in the large establishment of the Messrs. Cox at Lochee, and is understood to be working satisfactorily. It is now learned that another firm having works in the west end and in the east end of the city (Messrs. James Scott and Sons) have decided to replace their steam driving power by electricity. Altogether dynamos capable of producing 2,000 h.p. are to be introduced for the purpose of working all their machinery. Instead of taking their current from the Corporation they are to provide their own generating plant, and for this purpose Westinghouse gas-engines are to be used. The proprietors of a large jute-manufacturing establishment in the centre of the city are also at present considering the advisability of taking a similar step.

**Honley.**—On Monday the electricity works, which the Urban District Council have erected at an estimated cost of £2,400, were opened by the chairman, Mr. E. Crowther, with a gold key presented by Mr. A. B. Mountain, the electrical engineer to the Huddersfield Corporation, who has superintended the carrying out of the work. The building containing the generating plant forms part of the gas-works, and has been converted into electricity works by Messrs. E. Holroyd and Sons, joiners and contractors, Honley. The main plant consists of a 22-kw. Westinghouse dynamo, driven by a 35-b.h.p. Westinghouse double-cylinder vertical gas-engine, and is capable of generating 40 kw. There is also a small dynamo of similar design for supplying lights during the period of light load. This has been manufactured by the Alliance Electrical Company, Thurstonland, and has an output of 8 kw. It is driven by the engine which runs for pumping purposes for the gasworks, thus practically obviating attendance. The switchboard was supplied by the Alliance Electrical Company, and is capable of regulating the energy generated by the three dynamos and controlling the supply for three feeders and the street lights. The mains, which were supplied and erected by the Alliance Company, consist of overhead bare copper wires, supported by steel poles. The pressure of supply is 200 volts. The plant is capable of supplying 2,500 8-c.p. lamps. Subsequently a dinner was held at the Wheatsheaf Inn, at which Mr. E. Crowther presided.

**Strathmore.**—A report has been sent to the Blairgowrie Water Trust by the engineers of the promoters of the Benachally electric scheme. The following are the chief points: From the rainfall recorded at Ballintuim and the area draining into the loch and the Baden Burn above its level, which would be taken in, and allowing for loss by evaporation and floods, the engineers calculate an average flow into the loch per day of 5,250,000 gallons. One hundred acres of ground would be required to be submerged to provide storage for 160 days a year when the rainfall was under average. The depth would be 15ft. The promoters propose setting aside 1,000,000 gallons a day as sufficient for both Blairgowrie and the riparian proprietors. Blairgowrie gets 300,000 per day at present. It is calculated there would be 3,250,000 gallons left, which it is proposed to carry two miles over an almost horizontal channel and then down a steel pipe to the generating station on the Lunan Burn at Butterstone, where turbines and dynamos would be erected 700ft. below the level of Loch Benachally. The current would be taken at a high voltage to Blairgowrie, and supplied at 2d. per unit for light. Factories and mills in Blairgowrie, Coupar Angus, and Alyth, might, it is thought, also use electricity for power. Altogether the engineers calculate there would be a good return for the capital invested. If the company get the water they expect they will have at Butterstone about 700 b.h.p. for a 12 hours' day, running 300 days a year. The cost of the total works, including transmission to Blairgowrie, Rattray, and Coupar Angus, is estimated at over £42 000, a proposed first instalment, which can be extended, costing £34,000.

**Acton.**—The Board of Trade have decided to defer consideration of the question of revoking the Acton Electric Lighting order, 1891, until Dec. 31 next, for the purpose of enabling the District Council to carry out their obligations under that order. In these circumstances, the Board do not propose to proceed with the provisional order applied for this session by the Metropolitan Electric Supply Company, Limited. The question of the erection of poles and fixing of wires has now been settled. Some time ago the Council informed the Postmaster-General that they would consent to all the applications for poles, etc. (subject to a plan being submitted and approved) upon an undertaking being given that when the wires on the poles number 20, or 10 subscribers, the wires be laid underground. The Postmaster-General replied that he considered that the Telegraph Acts, 1863 to 1899, impose sufficient restrictions upon him, and afforded sufficient protection to road authorities. Having regard to his statutory rights and to the restrictions already imposed upon him by the Telegraph Acts, the Postmaster-General would not accept a consent containing a condition limiting the use to be made of his telegraph poles, and if the Urban District Council of Acton did not withdraw the condition he would be compelled to take other action. The letter, however, contained a statement to the effect that although he could not accept a consent containing a condition that the wires are to be placed underground when their number reaches 20, yet he was willing that the consents should be granted on the understanding that when the wires on the poles became numerous the question of placing the lines underground would receive further consideration. The Council have been given to understand that the Post Office considered 30 wires numerous, at their last meeting agreed that consent be given to each application where plans had been submitted and were satisfactory.

**Battersea.**—The Lighting Committee reported on Wednesday: "We have had under consideration the Electric Lighting (London) Bill, which has been reintroduced in the present session of Parliament with a view to providing for the adjustment of the changes of boundaries effected under the London Government Act, 1899, so as to make the areas within which local authorities and companies are authorised to supply electricity coterminous. It appears that out of the 21 areas transferred to and from the parish of Battersea there are only three areas which would not be transferred without question under the provisions of the Bill. We may remind the Council that as a result of the conference with the Board of Trade upon the Bill last year the Board intimated that it would be most essential that an agreement should be arrived at, if possible, between the Council and the County of London and Brush Provincial Electric Lighting Company, Limited, as to the transfer of these three areas. We have been in communication with the company as to the arrangements to be made, and have ascertained the further works carried out in the areas above referred to by the County of London and Brush Provincial Electric Lighting Company, Limited, and the Council. Having in view the desire of the Council that their area should be coterminous for all purposes, as far as possible, and to the urgency of the matter, the committee recommended that the common seal of the Council be affixed to an agreement to be prepared upon terms approved by them In consequence of a letter from the Poplar Borough Council drawing attention to the case of Colwell and others *v.* St. Pancras Borough Council, in which proceedings were taken to restrain the Borough Council from committing a nuisance in respect of vibration in one of their electric lighting works, and also from emitting noise, smell, and dust from their destructor works, it was agreed to approach the Board of Trade with a view to the abolition of the 'nuisance clause' in the provisional orders authorising the undertakings, and that a clause should be substituted giving power to the undertakers to acquire property compulsorily. The following particulars relative to applications for the supply of electrical energy to premises with the borough, including the Council buildings, were submitted. Consumers—quarter ended March 15: applications 569, actual consumers 534; Dec. 15: 511 (473); increase 58 (61). Energy applied for, March 15: 43,172 8.c.p.; actually supplied 38,351 8 c.p.; Dec. 15: 40.315 (35,423); increase 2,857 (2,938). Motor power, March 15: 585½ h.p. (418⅛ h.p.); Dec. 15: 434½ h.p. (368⅝ h.p.); increase 151 h.p. (49½ h.p.). This includes 43 amperes for charging accumulators applied for and 28 amperes connected; 78 amperes for heating and cooking applied for and 48 amperes connected; 10 amperes for medical apparatus applied for and connected."

**St. Marylebone Lighting.**—The London County Council on Tuesday adopted a report of the Finance Committee dealing with the difficulty which the borough of St. Marylebone have experienced in raising the necessary money for the purchase of the undertaking of the Metropolitan Electric Supply Company in the borough. The committee stated that the Borough Council had now asked that the County Council would, subject to the passing of the Bill, undertake to advance to it a sum of £1,365,000 for the purchase-money and compensation payable to the company, and had intimated that it would also apply for sanction to the borrowing and for the advance by instalments of a further sum of £460,000 for the purchase of a site for the erection of buildings in connection with the undertaking, the laying of mains, etc. The committee stated that they were strongly of opinion that the present system of finance, under which the Council practically provided the funds required on loan by the local bodies of London, was the best in the interests of London as a whole. They would view with grave apprehension any departure from that system in the direction of the creation of separate local stocks. It had consequently been their policy to assist the local authorities by advancing loans to them at the lowest rate of interest possible without loss to the Council, thus giving them the benefit of the credit of the whole of London. Being anxious to continue that policy, and to uphold the present financial system, they had given the most careful consideration to the request of the St. Marylebone Borough Council. In the present state of the money market, however, they were of opinion that it would be unwise to attempt an issue of stock. They were so much impressed, however, with the desirability, in the interests of London, of maintaining the principal of one central stock for all loans required that they were prepared to advise the Council to seek powers in its Money Bill of 1904 to raise temporarily, in the event of the Borough Council's Bill becoming law, the loan of £1,365,000 by means of a special issue of London County bills not exceeding £1,500,000. At a future date, when the financial situation became sufficiently favourable, the Council would replace those bills by stock, in order to provide for the permanent loan to the Borough Council. A recommendation in accordance with these views was agreed to. On Monday in the House of Commons the St. Marylebone Electric Lighting Bill was before a Select Committee of the House of Commons, Sir Alexander H. Brown presiding. Petitions against the Bill have been deposited by the London County Council, the Metropolitan Electric Supply Company, and the Gaslight and Coke Company. At the last Borough Council meeting, Councillor E. White's resolution, "That the engagement of Mr. A. Wright, the electrical expert, be determined, and that the necessary notice be given him terminating his engagement," was defeated.

**Egypt.**—The British Chamber of Commerce of Egypt in their last report consider that the trade in electrical appliances occupies a prominent position among the various fields of enterprise in that country which offer opportunities in the present, and which are susceptible of indefinite extension in the future. Egypt is not and never will be—at all events in the immediate future—a manufacturing country, and the lack of natural water power has hitherto stood in the way of the use of electricity, even for such industrial purposes as cotton ginning, pressing, seed crushing, etc. But for traction, lighting, and telegraphic and telephonic communication there is a constant and ever-increasing demand for electrical machinery, apparatus, instruments, tools, and fittings. Cairo and Alexandria have long been served by electric tramways, and the latter city is now extending its electric system over the railway line connecting it with the

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suburb of Ramleh. The use of electric light as an illuminant is daily becoming more general in palaces, public buildings, private houses, works, etc., not only in chief cities, but in many towns in the interior, such as Mansurah, Tantah, Zifta, etc. Several, of these towns light their streets by electricity, though the Cairo and Alexandria thoroughfares are still supplied by gas. Assiout the Fayoum, and Zagazig are instances of places which are about to establish an electric light system of their own. Electric power will be employed more and more in drainage and irrigation works. The demand for telegraphic and telephonic material is constantly increasing; trunk telephone lines now connect Cairo and Alexandria, and similar lines are being laid down for interurban communication in the interior. In wiring for all purposes Great Britain is not in the market; plain copper wire is imported almost entirely from France and Belgium, and covered wire from Italy, English products being at least 20 per cent. dearer. With regard to telephone apparatus, after referring to the premier position held by the Ericsson wall instrument, the report says: "A table apparatus of similar excellence has not, however, yet been put on the market, and we recommend inventors and manufacturers to devote their energies to the production of this much-needed article. For petty fittings such as insulators, bells, lamps, etc., British manufacturers, though recognised as the best, are ruled out of the Egyptian market, which always prefer a cheap article when it can get it. British firms frequently execute orders for low-priced fittings by supplying foreign-made goods. They still carry on a good trade in brackets, electroliers, etc., made of brass and other metals, but there seems opportunity for development generally, not only in the direction of the production of cheaper goods, but in that of the advertisement, the representation by agents and travellers, and the demonstration of the superiority of British manufactures." It is recognised that British manufacturers are in many departments the best, but their high price and inaccessibility often stand in the way of their employment. Swiss firms are the best known in Egypt for the production of dynamos, though those of English manufacture are extensively in use; there appears room for more active competition in this department from British manufacturers, such as has already been forthcoming from German firms.

**Metropolitan Asylums Board.**—The following supplemental report of the committee, submitted last Saturday, on the new training ship, referred to in our "Tenders" column, will be found of interest. The committee stated: "Electric lighting, heating, and ventilation.—Since the meeting of the Board when our last report with regard to the new ship was considered, we have given careful consideration to the question raised at that meeting as to the desirability of placing the electrical plant on board the new ship In this connection, Messrs. Biles, Gray, and Co., the naval architects, have caused a complete inspection of the existing shore plant to be made by their consulting electrical engineer (Mr. A W. Stewart), and in the result it appears to be evident both that the existing plant would be insufficient for future requirements, and also that it could not be run much longer without considerable repairs, and would require to be renewed in the near future. The time is therefore a favourable one for considering the question as to where the plant should be located. The advantages of placing the plant on board the ship appear to be: (1) That the great risk of corrosion to the bottom plating of the vessel by introducing electric cables would not be incurred. (2) That in any case a part of the plant would necessarily be placed on board in connection with the heating of the ship, and considerable simplification both in arrangement and in working expenses would be effected by having the whole plant on board. The economy in working expenses is calculated at about £350 per annum. (3) Reduced first cost and cost of maintenance due to having no cables from the shore. (4) More efficient control of the plant and lighting. (5) In the event of the ship being moved from her present moorings to any other place either temporarily as for docking or permanently, the plant would remain serviceable and efficient, which would not be the case if it were to be on shore. (6) Increased opportunities would be afforded for instructing the boys. On the other hand, we have not neglected to consider certain disadvantages which have presented themselves in the event of the proposed course being adopted. They appear to be chiefly the question of danger from fire. As has been pointed out, some of the plant must be placed on board, and the proposed addition would not, we are advised, add appreciably to the risk. It is further proposed to fix a spark-catcher on the funnel from the engine-room to prevent the risk from sparks or pieces of clinker falling over the awnings or deck. Then again there is the question of the vibration and noise, but this, we are advised, would be overcome by the use of turbine engines, which also by being run noiselessly at night would obviate any need for accumulators. The plant will be placed forward on the orlop deck and the compartment shut off so that there will be no likelihood of the bilges becoming fouled therefrom. All the expert advisers of the committee, including the engineer to the Board, who has been consulted, are strongly in favour of the adoption of the proposal to place the plant on board the ship, and after full consideration of the matter we concur in their view. The cost of the new plant required is estimated at £2,500. We have also considered proposals by the architects for a combined system of heating and ventilation by hot air in lieu of heating the ship by the hot-water pipes system. This plan, we are informed, has been found to answer admirably on board ship, and as we are satisfied that the trunks having the air can be so made as to be easily opened in sections for thorough cleaning, we are generally satisfied with the scheme. We have further informed the architects that the approval to these proposals is conditional upon their conferring with the engineer to the Board and obtaining his concurrence in the details of the methods by which the proposals are to be carried out."

**Wisbech.**—The Town Council in committee last week discussed a report of a sub-committee on offers from Edmundson's Electricity Corporation, Limited, and the National Electric Construction Company, Limited. Messrs. Edmundson stipulated (1) that the Council would adopt electric lighting in all the streets through which mains were laid. The charges for so doing would be for each 80-c.p. Nernst lamp, burning for 2,700 hours per annum, £3. 15s. For each 40-c.p. Nernst lamp, burning for same time, £2. 10s., these prices to include all charges for maintenance and renewals. [N B.—The present contract prices paid to the Wisbech Lighting Company are: for incandescent lamps, £3. 3s.; ordinary lamps, £2. 19s.] Messrs. Edmundsons estimated that they would require (in order to light the whole lighting area) say, 100 lamps at 80 c.p. and 200 at 40 c.p. Their charge for private lighting would be those named in Clause 18 of their draft contract—viz., not to exceed 7d. per unit the first hour and 4d. per unit afterwards. They said that they were not prepared to allow the Council's engineer to prepare plans and specifications. They would expect to receive by way of contractors' profit a percentage of 25 per cent. upon the total value of the land, building, plant, apparatus, and other articles supplied. They would require the Council to put down more mains (in the first instance) than those contemplated in Mr. Hammond's report, and for this work a sum of about £3,000 would have to be added to the £19,600 named in such report. The Corporation being themselves manufacturers, they would not be prepared to invite tenders for any sections of the work. (2) The National Electric Construction Company, Limited, would extend the time up to the two months within which the Council are to find a site for the generating station. They agreed that the plans and specifications might be prepared by the Council's engineer, and that for the engines, boilers, accumulators, generators, and the engine-house tenders might be invited from a few good firms for each respective section of the work, and that the lowest tenders should be accepted. The proposal further contained the following clauses: "As to the cables, they were willing that the British Insulated and Helsby Company should be asked to tender on the basis of a schedule of rates prepared by the Council's engineer. All tenders to be sealed and to be sent to the contractors, but not to be opened by them except in the presence of the Council's engineer. The contractors are wi hin nine months from the raising of the loan by the Council, to equip and complete the generating station and lay down the mains. The company are to receive by way of contractors' profit a percentage of 17½ per cent. on the capital expenditure, as against 25 per cent. expected by Messrs. Edmundsons—that is to say, 7½ per cent. on the contract price of the engines, boilers, and the other articles tendered for, and the cables, plus 10 per cent., payable under Clause 4 of the contract. The company are prepared to fix the charges for private lighting on the maximum demand system of 7d. per unit for the first hour and 3d. per unit afterwards, with a stipulation or condition that under no circumstances would a private consumer be called upon to pay more than 5½d. per unit per hour. Any customer would, moreover, have the option of taking a supply on the flat-rate system of 5½d. per unit per hour. For cooking and heating, the company would agree to reduce the charges to 4d. for the first hour and 1d. afterwards. For public lighting they would charge 2½d. per unit, and they are prepared to quote the following inclusive charges: for each 80-c.p. Nernst lamp burning for 2 700 hours per annum, £3. 7s. 6d.; for each 40-c p. Nernst lamp burning the like time, £2 5s.; these prices to include all charges of erection, maintenance, lighting, cleaning, and trimming, and are made conditional on at least 40 lamps being so lighted. The company also agree that tenders might be asked for all plant, etc., required for extensions in a similar way to the plant and goods required for starting the concern. The Town Council may at their option determine the agreement at the expiration of the seventh, tenth, fifteenth, or twentieth years. If determined at the seventh year, the Council would pay the contractors a premium of 12 per cent on the capital expenditure. If determined at the tenth year, a premium of 7½ per cent., but no additional premium would be payable if the agreement be determined on the expiration of the fifteenth or any subsequent year. The above periods were to date from nine months from the day when the loan was raised. The provisions for free wiring are similar to those granted by Messrs. Edmundsons but neither that corporation nor the Electric Construction Company will require the Town Council to promote a Bill in Parliament to acquire powers to do free wiring. All matters in dispute are to be referred to the arbitration of an engineer to be appointed by the president of the Electrical Engineers' Institute." The sub-committee recommended the acceptance of the terms of the National Electric Construction Company, Limited.

## PROVISIONAL PATENTS, 1904.

MARCH 14.

**6188. Improvements in and relating to electrically-operated apparatus for communicating between passengers and guard and other similar purposes upon railways and the like.** William Robert Pether and Richard Crispin Gulliver, 94, Fernlea-road, Balham, London.

**6201. Improvements in receiving apparatus for wireless telegraphy systems.** Riccardo Arno, 7, Southampton-buildings, Chancery-lane, London.

**6218. Automatic suspension device for the suspension of electric arc lamps and other objects.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Deutsche Waffen and Munitions Fabriken, Germany.)

**6230. Improvements in or relating to electricity meters.** Boris Kalinowski, 18, Buckingham-street, Strand, London.

**6233. Improvements in lamp fittings.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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**6237. Improvements in and pertaining to overhead electric conductors.** James Henry Liebrecht Bishop, 46, Lincoln's-inn-fields, London.

MARCH 15.

**6251. Improvements in ploughs for conduits and the like traction for electric tramways and the like.** William Alfred Bristow, 53, Lausanne-road, Peckham, London.

**6280. An electrical time and cash check for registering billiards or similar games.** Joseph Robinson, 14, Ashfield-terrace, Ryton-on-Tyne, Durham.

**6305. Improvements in electric arc lamps.** Heinrich Beck, 27, Chancery-lane, London.

**6319. Improvements in electric conductors.** John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**6322. Improvements in and connected with terminals of electrical storage batteries or accumulators.** Percy Dove, 322, High Holborn, London.

**6333. Improved strut piece for electric switches.** The General Contracts Company, Limited, Edward Samuel Cook, and William Howard Chipperfield, 149, Strand, London. (Complete specification.)

MARCH 16.

**6348. Improvements in electric light, power, or other service boxes filled with switch and earthing device.** Alfred John Beanmont, 16, Stonegate, York.

**6382. Improvements in section insulators to be used in connection with the conductors of electric tramways or railways.** Hugh Godfrey Nicholson, 11, Queen Victoria-street, London.

**6401. Improvements in alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6402. Improvements in insulating compounds.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6403. Improvements in insulated electric conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**6411. Improvements in brush-holders for electric motors or generators.** Herbert Cooch, 4, South-street, Finsbury, London.

**6425. Improvements in electrical candle fittings.** Oscar Thomas Banks, 49, Mortimer-street, Regent-street, London.

**6429. Improvements in elastic insulating clutches for electric dynamos and motors.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Luigi Risso, Italy.)

**6433. Improvements in electric switches.** The London Electric Supply Corporation, Limited, and Gerald William Partridge, 46, Lincoln's-inn-fields, London

**6446. Improvements in connection with electric switches.** William Harding Scott, 47, Lincoln's-inn-fields, London.

MARCH 17.

**6452. Improved combination for electrical tumbler switch.** William H. Jinks, 16, Oakland-road, Handsworth, Birmingham.

**6496. Electric lamp and socket.** Albert Norton Soden, 65, Chancery-lane, London. (Complete specification.)

**6523. An improved system of electric lighting especially intended for use on road vehicles.** Charles Prescott Tolman, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901. July 30, 1903, being date of application in United States.) (Complete specification.)

**6566. Improvements in automatic electric switches.** Claude William Atkinson, 1, Queen Victoria-street, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 7, 1904.*

1903.

**5891 Electric batteries.** Portalier. (Date applied for under International Convention, Sept. 13, 1902.)

**5913. Trolley rope guard for tramcars.** Karslake.

**6494. Means for controlling the division of load between synchronous electric motor-generator sets.** Carolan. (General Electric Company.)

**6723. Electric ignition for internal-combustion motors.** Dawson and Dawson.

**7387. Standards and supporting devices of the trolley or current-collecting poles of electric vehicles.** Turner and Isherwood.

**7966. Telephonic apparatus.** Graham.

**10388. Means for electrically igniting miners' safety and other lamps.** Sedgwick and Smith.

**11000. Electric crucible furnaces.** Reynolds.

**11001. Electric crucible furnace.** Reynolds.

**11002. Method of melting steel and the like in electric furnaces.** Reynolds.

**13937. Electric apparatus for therapeutic use.** Fisher.

**16294. Electric arc lamps.** Beck.

**16583. Construction of electric railway and vehicles for transporting letters and other light loads at high speeds.** Monnier.

**18754. Semi-automatic telephone systems.** Faller.

**21208. Alternate-current meters.** Compagnie pour la Fabrication des Compteurs et Materiel d'Usines a Gaz. (Date applied for under International Convention, Dec. 16, 1902.)

**23120. Storage battery plates.** Bijur.

**23574. Wireless signalling systems.** Shoemaker.

**24310. Magnetic inductors or magneto-electric machines.** Aktiengesellschaft "Mageta" (Electrische Uhren ohne Batterie und ohne Contacte). (Date applied for under International Convention, Jan. 20, 1903.)

**26174. Couplings for electric cables.** Howorth. (Everhart and Dossert.)

**26659. Magneto-electric ignition devices for internal-combustion engines.** Masson.

**26849. Telephone systems.** Fairweather. (Stromberg Carlson Telephone Manufacturing Company.)

**26961. Switching mechanism for double-filament electric lamps.** McCullough. (Date applied for under International Convention, Dec. 10, 1902.)

1904.

**2466. Clockwork electricity meters.** Aron.

**3847. Dynamo-electric machines.** Allison. (Hooven, Owens, Rentschler Company.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3¾-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1¾-2¼ |
| —— 5 per cent. Debentures ..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures ..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1½ 1⅝ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 8¾ 9 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 90 100 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 12-13 |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ xd |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18¼-19¼ |
| —— 4 per cent. Debentures ..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance ..... | 12 | .. | 35-36 xd |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,301-101,300 .. | 1 | .. | ⅞-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 115-118 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary ..... | 5 | .. | 10¼-10⅜ |
| —— 7 per cent. Preference ..... | 5 | .. | 9⅜-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14¼ |
| —— " £10 Ord. .... | 6 | .. | 10⅜ |
| Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 101-103 |
| Chelsea Electricity Supply ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary ..... | 10 | .. | 10¼-10⅜ xd |
| —— 6 per cent. Cumulative Pref. ..... | 10 | .. | 13-14 xd |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary ..... | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5⅜ 6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5⅜-6⅝ |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7½-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 103-106 |

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| Name. | Amount paid. £ | Last price. £ |
|---|---|---|
| Kensington and Knightsbridge and Notting Hill | 100 | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | 9½-10⅛ |
| London Electric, Ordinary | 5 | 1-1½ |
| —— 6 per cent. Pref. | 5 | 4¼-6 xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 95-98 |
| Metropolitan Ordinary | 10 | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | 108-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | 98-101 |
| —— Preference | 4 | 100-103 |
| Notting Hill Electric Lighting | 10 | 13-14 |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | 99-102 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | 5¼-6 xd |
| —— 4 per cent. Debenture Stock | 100 | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | 96-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | 85-90 |
| South London, Ordinary | | 3-3½ xd |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | 14-15 |
| —— 7 per cent. Pref. | 5 | 8-9 |
| —— 3½ per cent. Deb. | 100 | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | 4¾-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | 4¾-5¼ |
| Westminster, Ordinary | 5 | 12¼-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | 5-6¼ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 92-95 |
| —— 4 per cent. Pref. | 100 | 98-101 |
| —— " " deferred | 100 | 86-89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-113 |
| City and South London, Consolidated Ordinary | 100 | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | 123-126 |
| —— " " " '96 | 100 | 119-122 |
| —— " " " '01 | 100 | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | — | 13-13½ |
| —— Ordinary, 1-50,000 | — | 7¼-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 102-104 |
| Waterloo and City, Ordinary | 100 | 88-91 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | 4¾-5 |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | 3¾-4¾ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | 90-93 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | 103-105 p.c. |

| Name. | Amount paid. £ | Last price £ |
|---|---|---|
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | 8¼-9⅛ |
| —— 6 per cent. Cm. Pf., 50,001-60,000 | 10 | 9¼-10½ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | 120-123 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 2¾-3½ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 4⅜-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-107 |
| —— Prov. Cert., all paid | 100 | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1¼-2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅜-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— Debentures | 100 | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12¼-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 22-22¼ |
| —— 6 per cent. Cum. Pref. | all | 14¼-15¼ |
| —— 4½ per cent. Deb Stock | 100 | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 11-11¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 101-103 |
| Metropolitan Electric Trams., Deferred, 1-300 001-1,314,016 | 1 | 5/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | ⅜-1⅛ |
| New General Traction, Ordinary | 5 | ¼ |
| —— 6 per cent. Cum. Pref. | 5 | 1¼-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,715 (Regd.) | 100 | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 10¼-10⅜ |
| —— 5 per cent. Cum. Pref. | 10 | 11¼-12¼ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | 8¼-9⅛ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 99-101 |
| —— Deferred Stock | 100 | 73-76 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 13¼-14½ |
| —— 5 per cent. Non-Cum. Third Pref. | 5 | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 94-96 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 96-99 |
| Oriental Telephone and Electric Company | 1 | ⅞-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 19 | 1,081 | 825 | + 256 | +10,051*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 12 | 158 | 173 | - 15 | + 156 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,089 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 19 | 40 | — | — | — | 1½ | | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 19 | £90 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 18 | 767 | 670 | + 97 | + 2,210 | 24 | 24 | March 25*a* | 40,964 | 7,234,105 | 886,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 17 | 293 | 354 | - 61 | - 392 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 19 | 181 | 203 | - 22 | - 127 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 20 | 1,615 | 1,676 | - 61 | + 8,867 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 15 | 874 | 847 | + 27 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 20 | 3,572 | 3,321 | + 251 | +20,095 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 20 | 722 | 776 | - 54 | + 2,410*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 18 | 4,603 | 4,244 | + 359 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 19 | 885 | 672 | + 213 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 20 | 287 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 19 | 1,795 | 1,675 | + 120 | +23,301 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 19 | 161 | 152 | + 9 | + 258 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 19 | 7,052 | 7,142 | - 87 | + 677*h* | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 20 | 2,973 | 3,039 | - 66 | - 594*h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 17 | 414 | 433 | - 19 | - 98 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 18 | 202 | 208 | - 6 | - 293 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 19 | 165 | 177 | - 12 | - 139 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 20 | 93 | 97 | - 4 | + 60*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 18 | 3,701 | 3,805 | - 104 | — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 18 | 729 | 724 | + 5 | | | | | | | | | | | |
| Dundee City Tramways | ,, 16 | 764 | 771 | - 7 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 19 | 624 | 581 | + 43 | + 8,780 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 19 | 13,322 | 12,569 | + 753 | +51,883*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 9 | 2,096 | 2,165 | - 69 | + 6,205 | 31⅔ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 19 | 1,103 | 1,083 | + 20 | — | 34 | 34 | March 31 | 56,631*h* | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 19 | 2,020 | 1,756 | + 264 | + 8,037 | 25 | 19 | ,, 31 | 87,707*h* | 21,965,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 16 | 127 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 16 | 191 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 19 | 4,993 | 4,863 | + 135 | +15,538 | 77 | 77 | March 25*g* | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 5 | 9,004 | 9,078 | - 74 | + 3,045 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 20 | 1,512 | 1,547 | - 35 | + 297*h* | 15½ | 15½ | June 30 | 79,252 | 10,166,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *e* |
| London County Council | ,, 12 | 10,129 | 8,604 | +1,525 | +31,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 12 | 122 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 19 | 94 | 59 | + 35 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 19 | 3,444 | 3,079 | + 365 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 19 | 1,441 | 1,393 | + 48 | + 5,610 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 21 | 104 | 108 | - 4 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 17 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 21 | 3,659 | 3,003 | + 656 | +52,112 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 20 | 4,325 | 4,136 | + 189 | +18,249 | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,312,043 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 17 | 806 | 855 | - 48 | — | 11 | 11 | ,, 31 | 35,874 | 9,984,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 20 | 1,064 | 1,010 | + 54 | + 2,975 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,967 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 19 | 575 | 540 | + 35 | + 3,930 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 17 | 291 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single trask. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Warsaw Exhibition.**—The Home Office announces that notice has been received to the effect that the electrical exhibition which was to have been held in Warsaw during the present year has been postponed.

**Wireless Telegraphy.**—It has been freely stated the last few days that the Admiralty have practically completed arrangements for the establishment of a fully-equipped Marconi signalling station in the vicinity of New Frenchman's Bay Fort at Marsden, between the Wear and the Tyne.

**Iron and Steel Institute.**—The annual meeting of this institute is to be held at Westminster on May 5 and 6, when Sir Andrew Carnegie, the president for the year, will take the chair. We understand that the Bessemer gold medal will be presented to Mr. R. A. Hadfield, of Sheffield, for his researches of steel alloy and the creation of the manganese steel industry. An interesting programme has been arranged for the meeting. Amongst the papers promised is one by Prof. Louis on the making of pig iron from ore briquettes. In the success of the process to be described is entirely bound up the development of the iron ore deposits in the north of Sweden.

**Electricity in Coal Pits.**—The Home Secretary was interrogated in the House of Commons the other day as to whether he could yet say when the rules respecting the application of electricity to coal mining would be settled and published. In response, Mr. Akers-Douglas stated that the rules suggested by the committee on this matter had been circulated in the various mining districts, and were now being considered by the coalowners, whose views he expected to receive shortly. Having regard to the number and complexity of the rules, he deemed it fair to give some time for consideration and for the suggestion of amendments before formally proposing them in accordance with the provisions of the Coal Mines Regulation Acts.

**North-East Coast Institution.**—The *Transactions* of this institution issued this month have just reached us, and contain reports of the second and third general meetings These include the report of the Educational Committee, which has already been referred to in our columns, and a discussion on the same. In Mr. Max Wurl's excellent paper on "Technical Education in Germany" some interesting statistics are given in a graphical form, which enable the time spent by engineering students in both England and Germany to be readily followed. These diagrams are contributed by Mr. G. W. Spence. The volume also contains the paper on "Notes on the Construction of Stability Cross Curves from Balanced Paper Sections," by Mr. John Heck.

**London Chamber of Commerce.**—The annual meeting of the London Chamber of Commerce, whose report was dealt with in our last issue, was held on the 24th ult., and in the evening the annual dinner took place at the Hôtel Metropole. In the course of the speeches that were subsequently delivered, the Lord Chief Justice said he would ask if there could be anything more important to these islands than the right understanding of the true and sound limits of municipal trading. He had been taken to task in the past for saying that this was a subject worthy of enquiry. All he said was that if the chambers of commerce could throw light on this subject, assist in making stable the credit of our local communities, and encourage them to expend money where it should be spent and restrain them from embarking on enterprises on which they should not embark, they would fulfil a great public duty.

**Leeds Local Section.**—At the annual general meeting of this section of the Institution of Electrical Engineers, Prof. G. D. A. Parr presided. The meeting was held at the Yorkshire College. Mr. W. Emmott, of Halifax, and Mr. H. Dickinson were elected chairman and vice-chairman respectively for the ensuing session. At the conclusion of the annual general meeting, Mr. W. B. Woodhouse, of the Yorkshire Electric Power Company, Limited, read a paper on "Power Companies and the Supply of Electricity in Bulk." Mr. Woodhouse argued strongly in favour of power companies operating from one large station as against a number of small stations scattered throughout an area. In the course of his paper, Mr. Woodhouse gave figures to show that on its present scale of charges the Yorkshire Power Company could supply electricity to small towns cheaper than they were now supplying themselves, and that they could even compete with large towns like Leeds, Bradford, Huddersfield, or Halifax in power supply.

**The World's Fair.**—We understand that the De Forest Wireless Telegraph Company is making good progress in the erection of signalling stations in connection with the World's Fair at St. Louis, which are intended to show what the company can do with its system. There will be three signalling stations within the exhibition, from which signals are to be transmitted to Omaha, Kansas City, Buffalo, Chicago, and Cleveland For distances up to 100 miles 2 kw. or 3 kw. only are needed from the sending transformer, but for the longer distances a 90-kw. transformer will be used. The tallest tower will be some 300ft. high, and will be used as a passenger platform, from which a good view of the exhibition and the surrounding country can be obtained. A 60ft. mast on the top of this will carry the sending wires. It remains to be seen whether the interference between the rival wireless telegraph companies at the exhibition will render all these preparations useless, as was the case with the work in connection with the last race for the America Cup.

**Telephonic Communication with France.**—The 11th inst. will witness the inauguration of the extended Anglo-French telephonic service, by means of which subscribers to the Central, Western, Victoria, Putney, and Mayfair exchanges of the Post Office in London will be able to communicate with Amiens, Armentières, Bethune, Bordeaux, Boulogne, Caen, Calais, Cambrai, Chartrés, Denain, Dieppe, Dijon, Douay, Dunkirk, Elbeuf, Havre, Lens, Lille, Lyons, Marseilles, Nancy, Orleans, Paris and suburbs, Roubaix, Rouen, St. Etienne, St. Quentin, Tourcoing, Tours, and Valenciennes. Communication will at the same time be available between the post offices at Birmingham, Bradford, Brighton, Bristol, Cambridge, Cardiff, Derby, Hull, Ipswich, Leeds, Leicester, Liverpool, Lowestoft, Manchester, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton, and Yarmouth, and renters of wires into those offices on the one hand and Paris and certain of the above-named French towns on the other. Particulars of the service can be obtained from the local postmasters, or the Secretary, G.P.O. The charge will be 8s. for a conversation of three minutes, except in the case of conversations exchanged with Bordeaux, Lyons, Marseilles, and St. Etienne, in which case the charge will be 10s. for three minutes.

**The Kelvin Compass.**—In the marine world the Thomson compass still holds its own, and its users apparently have not even yet got used to the change in name from Sir William Thomson to Lord Kelvin. We notice, however, that the most recent patent compass issued by Messrs. Kelvin and James White, Limited, bears the name of Lord Kelvin. The feature in connection with the

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design of this which calls for special attention is the improvement in the means of suspension, in order to secure a steady card in spite of the greater vibration due to higher speed in steamships. Another feature is the illumination of the compass at night entirely from the underside. This can be done either with electric light or by means of oil lamps. In either case adjustment in the intensity of the light is provided, as this has been found particularly useful when taking bearings from stars or other faint ights. A new form of helmet is now introduced having rifle sights upon the top. This helmet moves round freely in any direction, and bearings of the sun, lights, buoys, or other objects are taken instantaneously and read directly upon the compass card. Bearings by azimuth mirror in the usual way can also be taken by day or night without removing the helmet. These facilities for taking bearings smartly and conveniently are being greatly appreciated by shipmasters and navigating officers.

**London Electric Lighting Bill.**—This Bill, which is to provide for the readjustment of the electric lighting areas in London, in accordance with the areas arranged under the Borough Councils Act, has been read a second time and referred to a Select Committee. This is the third year that the Bill has been under consideration, and, owing to the large number of private interests involved, the Select Committee will have to consider a large amount of evidence before coming to a decision on the matter. The chief difficulty involved is that the systems of electric lighting in the areas to be so transferred differ in several instances. In consequence of this, the value of a certain area to the present occupier, as far as electric lighting is concerned, is more than it will be in the first instance to the new authority to whom it is to be transferred. We notice that in the discussion on the subject in the House of Commons last week Mr. John Burns supported the Bill. He remarked that it should not be made the means of transferring from a local authority to a private company any area of supply which the local authority might, from the ratepayers' point of view, more profitably occupy. This shows another difficulty in the way of a satisfactory solution, and a further cause for the lengthening of the proceedings before the Select Committee. We trust, however, that the subject will be dealt with and settled during the present session of Parliament.

**Liverpool and Southport Railway.**—We have received from Mr. John A. F. Aspinall copies of information which he is circulating amongst the travelling public on this line. From it we gather that the electric service is likely to be inaugurated immediately after Easter. In order that the stopping time at the stations may be minimised, instructions are issued asking passengers always to enter the cars at the rear end and to leave them at the front end. In this way the confusion between the passengers entering and leaving the cars will be avoided, and the duration of the stop much reduced. The new time-table of the trains on this section is in a portable form, and includes what may be termed a sliding rule for the purpose of determining the stopping times of stations intermediate between Crossens and Liverpool. All the express trains on the card are given in red figures, and the circular slide has also red and black figures, from which the information required can be deduced. The time-table only gives the arrival and departure times for Liverpool, Hall-road, Southport, and Crossens. Another interesting feature which is being circulated is a map of the line, with the various districts indicated in distinctive colours. For each of these there is given in a marginal table the rates and water charges for a £30 house. The difference between the rates on a moderate-size house in the districts close to Liverpool and those farther away goes a good way towards paying the cost of a season ticket.

**St. Marylebone.**—After considerable discussion the House of Commons Committee presided over by Sir A. Hargreaves Brown passed on the 24th ult. the preamble of the St. Marylebone Electric Lighting Bill. The alterations required by the committee in the clauses are considerable. Thus, the period for the repayment of the loan was fixed at 38 years, but the committee wisely allowed a suspension of repayment of capital for the first three years. This will give the Council time to get their undertaking into working order before having to pay the heavy capital charges on the large sum required for the purchase of the undertaking. The committee refused permission to add to the Bill a clause which would give the Council the power to lease the undertaking to a new company. This is in accordance with other decisions in similar cases, and will prevent all trafficking with the undertaking. The accounts clause as drafted in the Bill was passed. The measure having now been amended in accordance with the committee's decision, the Bill will be reported to the House for its third reading. In the course of the evidence it was stated that an arrangement had been come to with the London County Council whereby, after the passing of the Bill, the Council would make such provision in their Money Bill for 1904 as will enable them to lend to the St. Marylebone Council the capital required. As stated in our last issue, £1,365,000 of this will be a temporary loan on bills, while £100,000, required for work to be put in hand, will be a permanent loan.

**Electric Lighting Depreciation.**—In the *Financial Times* last week some interesting figures were presented to show the depreciation which the various electric lighting companies in London have allowed in their last year's accounts. Comparative figures are also given for the previous three years. The author responsible for the tables takes 2½ per cent. as the depreciation which should be allowed. On this basis seven of the companies provide an adequate allowance, and in four instances considerably more than 2½ per cent. is allowed. The actual figures for these seven companies are as follows: St. James's and Pall Mall, 3·45; Westminster, 3·29; Brompton and Kensington, 3·28; Kensington and Knightsbridge, 3·03; South London, 2·66; Chelsea, 2·52; and City of London, 2·47 per cent. of the average capital employed during the year. In the remaining six instances the appropriations are inadequate, the figures being: Charing Cross and Strand (West-end areas only), 1·23; Metropolitan, 0 93; London Electric, 0·63; Notting Hill, 0·63; Blackheath and Greenwich, 0·52; County of London (metropolitan areas only), 0·43. On behalf of the Metropolitan Company it is urged that, having sold part of its undertaking to the St. Marylebone Borough Council, it has no need to depreciate to the extent it would otherwise do, but we are afraid that the company cannot plead this for neglecting to write down its plant in earlier years. This question of depreciation is clearly bound up with the dividends, as several of the companies in the last list are distributing what they ought to be using for depreciation. It will be seen that the average figure put aside each year is not far different from what municipal authorities have to pay in sinking fund charges on their loans.

**Western Society of Engineers.**—The February issue of the *Journal* of the Western Society of Engineers, published at Chicago, contains some useful information for electrical engineers. Amongst the papers in this issue is one on "Heating from a Central Station," which deals with an art not practised to any considerable extent in this country. The paper on "Some Performances of

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Boilers and Chain-Grate Stokers, with Suggestions for Improvement," by Mr. A. Bement, will be of great interest to central-station engineers. In it a number of trials of the Heine boiler are given and compared with tests made of boilers of the Babcock and Wilcox type. The feature of the Heine boiler, to which special attention should be called, is that there is a tiled roof of firebrick for the furnace, which enables more perfect combustion to be obtained. The figures given of trials occupy more space than we can give at present, but the following statement is worthy of special notice: that with the improved Heine boiler the furnace gases left at a temperature of only 92deg. above that of the steam when the boiler was evaporating 4·17lb. of water per square foot of heating surface per hour. As compared with these figures, those given by Prof. Kennedy for a Thornycroft boiler are of interest. These figures, remarkable for high efficiency, show that 86·8 per cent. of the heat was absorbed when evaporating 1·24lb. of water per square foot of heating surface per hour. With this boiler the conditions of combustion are about the same as with the improved Heine. The author states that the arrangement of the tiled roof for the furnace enables the boiler to be worked satisfactorily with a smaller quantity of air without impairing the combustion. We gather, however, that the boiler on certain trials was not quite so efficient as the Babcock, although the superior efficiency of the furnace more than made up for this.

**London County Council Tramway Improvements.**—In commencing the debate in the House of Commons upon this Bill, Sir F. Banbury moved an instruction to the committee on this Bill to omit Tramway No. 2, which asks powers to continue the tramways over Westminster Bridge, and thence along the Embankment to Waterloo Bridge. In doing so, he said he was simply asking the House to affirm what it had always resolved ever since 1891. In addition to the reasons which had been formerly advanced, he urged that until the Royal Commission on London Traffic had reported no steps should be taken by Parliament in the matter. The promoters of the Baker-street and Waterloo Railway informed him that that railway would be opened either at the end of this year or the beginning of next, that there would be a station in Westminster Bridge-road, three-eighths of a mile from the bridge, and that passengers in South London could most conveniently get out of the tramcars and proceed by the tube railway to Charing Cross, and thence proceed to any part of London. Those who desired the tramway spoke as if there were no facilities for getting over Westminster Bridge, but they had it on the authority of the statistical officer of the London County Council that 218 omnibuses crossed the bridge each way per hour. In opposing the instruction, Captain Norton said that the London County Council had the interests of London to serve, Westminster Bridge was of ample width, and the Embankment was intended to relieve the pressure of traffic in Parliament-street and the Strand. Sir G. Bartley asked for delay in the matter until the report of the Traffic Commission had been issued. On a division, the motion was carried by a majority of 28. Mr. Whitmore then moved that it be an instruction to the committee on the London County Council (Tramways and Improvements) Bill to omit tramway No. 2A, a short connecting tramway line to link up the Battersea and Wandsworth trams with the system. The motion was carried, the majority being 38. The proposal to bring the tramways over the bridges is thus again defeated.

**High-Tension Disruptive Charges.**—At a recent meeting of the Académie des Sciences, at Paris, a note was presented by Mr. J. de Kowalski on some experiments carried out by him with high-tension direct currents. He used for the purpose three Thury dynamos, each able to give one ampere at 25,000 volts. With these in series he was able to obtain easily a potential of 70,000 volts at the terminals of the machines. He found by employing a high resistance in circuit with a large capacity that he could obtain a discharge of disruptive sparks much in the same way as MM. Simon and Reich had with 5,000 volts. If he diminished the resistance beyond a certain limit an arc was produced. This critical resistance varies with the capacity of the condenser used. The phenomena can be easily explained from first principles. In order that an arc may be produced it is necessary from theory that the cathode should reach a very high temperature, which temperature depends on the number of discharges in a given time, and on the energy expended in these discharges. The author's experiments verified this theory. He also carried out a series of experiments on high-voltage arcs, from which the following results were arrived at. (1) The high-tension direct-current arc with small current behaves, in a general way, the same as the alternating-current arc used by MM. Guye and Monasch. Thus he was able to distinguish a stable zone and an unstable zone, but he could not obtain the critical zone which these observers had noticed with the alternating-current arc. (2) In the stable zone the ratio between the length of the arc, the fall of potential in the arc, and the current strength were found capable of expression by a linear equation. (3) The limit in length of the stable arc depends on the current strength, and on the difference of potential at the terminals of the machine as indicated by the following figures: with 20,500 volts and a current of 0·023 ampere the limit of length was 1·45cm.; with a voltage of 40,000 and a current of 0·032 ampere the length over a stable arc was 5·15cm. Other figures are given, which need not be reproduced. In the unstable zone the continuous-current arc presents two sets of phenomena. This seems to be due to the exceedingly rapid fluctuations of the arc over different parts of the anode.

**The American Institute.**—In the *Transactions* of the American Institute of Electrical Engineers just received we notice a good departure, in that they printed beforehand abstracts of the papers read on March 25 at New York. The feature of these papers is their remarkable conciseness, they being intended merely as leads to interesting discussions on technical details; in fact, in the explanation at the beginning of this issue of the *Transactions*, it is stated that these introductory papers are written in order to provoke discussion, and that there should be no hesitancy in attacking them if those participating in the discussion do not agree with the opinions of the contributor. It is hoped in this way to enlarge the scope of the discussions, and, in consequence, to elicit a more general statement of opinion. The first subject dealt with is "The Relative Fire Risk of Oil and Air Blast Transformers," contributed by Mr. E. W. Rice, jun. Taking the 1,000-kw. transformer as the basis, the author shows that in an air-blast transformer there will be about 800lb. of inflammable material, against 7,300lb. in an oil-cooled transformers. With the air-blast transformer, however, there is the feature that the passage of air conduces to extremely rapid combustion in the event of a short-circuit or ignition through overheating. This combustion could, however, be checked by interrupting automatically the flow of the air to the transformer if a predetermined temperature were exceeded in the outlet. The principal fire risk in the oil transformers is the large mass of inflammable liquid, which, under certain conditions, may spread fire to other parts of the station. The author concludes

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that where transformers have to be placed in sub-stations, near to switchboards and other apparatus, such as rotary converters, the air-blast type is to be preferred. This type is, however, limited to pressures of below 30,000 or 35,000 volts, as at much higher pressures the static discharge tends to break down the insulation. With all transformers the fire risk can be practically eliminated by placing them in suitable fireproof buildings, which should be again sub-divided, and by providing proper drainage for the oil in a concrete base. The author concludes with a statement that fire risk is extremely small, and that it can be and is reduced to a negligible quantity by the adoption of suitable precautions, some of which he has indicated. The other subjects presented for discussion were: "The Use of Group Switches in Large Power Plants," by Mr. L. B. Stillwell; "Oil Switches for High Pressures," by Mr. E. M. Hewlett; and "Terminals and Bushings for High-Pressure Transformers," by Mr. Walter S. Moody.

**Pneumatic Trolley Pole.**—In the *Street Railway Journal* for March 12 there is given a full description of the power stations and rolling-stock of the Pacific Electric Railway Company, which owns a large number of lines, involving the transmission of electrical energy over some 130 miles at 15,000 volts. The details of the whole equipment are well worthy of study, but we wish to confine our attention to a pneumatic trolley-pole controller used on the Long Beach cars by the company. This controller is operated by compressed air at any pressure above 60lb., supplied from the air-brake reservoir of the car, the consumption of air being very small. It holds the pole in firm contact with the trolley wire and keeps the same tension at all positions or altitudes, enabling cars to take curves at high speeds. It is stated that in actual tests, and during several months' operation, the trolley never runs off at any speed up to 60 miles per hour on standard overhead construction unless there is a decided defect in the overhead work. Even if it does come off, it lowers itself instantly and automatically to a safe position below any spans. When it is desired to replace the trolley, the conductor throws a three-way valve, and the pole goes up with a very light pressure, and assumes its normal pressure when the valve is thrown back. It has been demonstrated that the cost of operating the pneumatic trolley is practically nothing, as the damage resulting from burnt trolley wheels, broken or bent poles, and broken overhead work and car roofs, is almost entirely eliminated. The controller is very highly recommended by the officials of the Pacific Electric Railway Company, whose recommendations are backed up by the results of many tests. It is said to have repeatedly carried 350 amperes during a run of seven miles at 60 miles per hour with less than five volts drop and 27lb. pressure at the trolley wheel. During a 20 days' continuous service test, conducted under the direct observation of Mr. R. S. Masson, consulting electrical engineer of the company, without a moment's attention, on a car speeded at 50 miles per hour on a level, straight track, carrying from 200 to 300 amperes when running and as high as 800 amperes on starting, travelling over 5,000 miles, it left the wire but once, and this was due to a loose inverted bell hanger. Its wheel was not scored or burned; no spark was even visible at the contact of wheel and wire. At present the controller wire is not on the market, but is being developed in the shops of the Pacific Electric Railway Company. It will probably be installed on all the cars of the company. With the high currents successfully carried there seems a good prospect for the pneumatic trolley for railway working. High-speed experiments are being carried out on this line at which speeds up to 69 miles per hour have been obtained. The engineers are experimenting with wind shields, and have been able to greatly reduce the resistance of the air pressure at these high speeds. It seems likely that the driver will have quarters found for him in the projections which act as wind shields.

**The Adaptability of Electrical Driving.**—At the meeting of the Manchester Association of Engineers on Saturday last, Mr. B. Longbottom read a most interesting communication on the above subject. The value of the paper is much enhanced by the fact that actual figures of practical tests are given, rather than estimates evolved from the accumulated experience of an individual. In this way the reader of the paper is able to avoid errors consequent on adopting average figures. Mr. Longbottom commences his investigation by dividing the mechanical forms of power distribution into two distinct sections. In the first of these a large number of small engines are used to drive individual machines or departments by means of shafting, gears, belts, or ropes. In the second, a single engine drives the whole of the works in a similar manner. Owing to steam condensation and the inefficiency of small steam-engines, electrical driving is shown to be exceedingly adapted for replacing steam driving in the first case. The alternative method of mechanical distribution, however, requires more investigation before it can be shown that electrical driving is more favourable. For this purpose Mr. Longbottom has carried out a number of mechanical tests to show the ratio between the indicated horse-power of engines at certain works and the effective brake horse-power delivered to the machines. The balance between these gives the horse-power absorbed in the engine, shafting, and belts. In seven cases, the details of which are given exceedingly fully, the effective power varies from 49·7 up to 75·5 per cent. of the indicated horse-power of the engine. The mean figure taken from these tests shows about 55 per cent. The investigation then carried out by the author show that with high-speed steam-engines and dynamos, with motors of normal efficiency, driving groups of tools, at least 60 per cent. efficiency can be obtained by electrical means. A great deal depends upon the arrangement of the machines in groups or with individual motors, and also on the average load at which the plant is worked. Thus, in one particular instance, when the plant is working at full load, there is a saving, on the author's figures, of 12 per cent. of the steam required if electrical driving is adopted. If the same plant is working at three-quarter load the saving rises to 19 per cent., and to 29 per cent. at half load. These figures would be even more favourable if it were assumed that certain groups of plant were entirely shut down. Some of the tests carried out on group driving clearly show both how this should be arranged, and in other cases how much power can be wasted by employing a long length of shafting in order to get a number of machines driven by one motor. The author draws attention to the great advantage which electric power supplied from corporations and supply companies at 1d., or even 2d. per unit, is to new firms requiring their available capital for other purposes. With such supply their power costs them comparatively little more than if they had laid down a plant of their own. Mr. Longbottom's paper is an exceedingly valuable addition to our literature on the subject he has so ably treated.

**London Traffic Commission.**—The Royal Commission resumed its enquiry last week, when further evidence was tendered by Mr. Yerkes. He advocated tube railways as cheaper and more convenient than shallow tunnels. When lines were built in the suburbs, or new streets, they should be of the newest pattern of tramline,

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and these lines should be located so as to be feeders to the tube lines. The perfection of railway transportation in London and its suburbs, in his opinion, would be that a person could travel from one point to another for one fare, making connections from one line to another, to attain which an amalgamation of the railways was indispensable. Control should vest in Parliament, and not be transferred to the proposed traffic tribunal. He thought that all railways should be built by private enterprise. A company could purchase its material much more cheaply than a municipal corporation; it could get its work done more intelligently and cheaply; and if it was not a success the loss did not fall on the ratepayers. On the chairman remarking that a municipality was under the direct control of the ratepayers, while a combination was not, Mr. Yerkes adhered to the views he had expressed, contending that municipalities should not build railways or engage in industrial businesses, as there was nothing more calculated to make such bodies arrogant than the knowledge that large bodies of employés were subject to them. Another witness, Alderman W. Ivey, chairman of the Tramways and Electric Lighting Committee of the Corporation of West Ham, recommended a complete and comprehensive scheme of tramways in the form of a wheel, with radiating spokes, all crossing near, but not at, a central hub, the hub being the City, each spoke line in turn to be linked up by a series of lines forming inner, outer, and extra outer circles. The whole system should be planned with a view to future extension. He advocated the adoption of the overhead trolley system, both for economy and efficiency. He suggested that all street tramways and light railways should be dealt with by a permanent board or commission of, say, seven members, similar to the Light Railway Commissioners, but with wider powers, to consist of three commercial men, one legal, one with tramway experience, both in construction and working, one with electrical and one with mechanical experience. The principle only of the schemes should come before a parliamentary committee for confirmation. Sir James Weeks Szlumper, engineer to the Great Northern, Piccadilly, and Brompton Railway, considered that the time had passed for any entirely new comprehensive scheme of underground railways to be arranged without unfair detriment to the underground railways now in course of construction. He remarked that, in addition to the three tubes now under construction, there was a scheme for a tube joining the lower end of the Great Northern and Strand Railway at the Strand, running south, passing under the River Thames, through Southwark, Walworth, Peckham Rye, and Dulwich, to the Crystal Palace and Croydon. He was convinced that an increase to 13ft. 6in. in the internal diameter of tubes would be disastrous, as in case of panic the side exit into such a confined space would be a death-trap. Electric Tramway Bills should be allowed to proceed to a parliamentary committee without the assent of the local authority. Whenever new streets were constructed arrangements should be made for the provision of shallow tramways. The only proper method of providing London with a satisfactory underground transit was by deep-level tubular railways. He agreed that in all new streets subways or tunnels should be made for gas, water, and other pipes.

**Marine Turbines.**—The Cunard Company some time ago appointed an exceptionally strong and representative committee to consider the advisability of using turbines for the new fast steamers which are to be built under agreement with the Government. This committee included Mr. J. Bain, the superintending engineer of the Cunard Steamship Company, as chairman; Sir W. H. White, late director of naval construction for the Admiralty; Rear-Admiral H. J. Oram, deputy engineer-in-chief of the navy; and a number of expert engineers taken from leading commercial firms. The secretary of the committee was Lieutenant W. H. Wood, R.N., who for the past three years has acted as secretary to the Admiralty Boiler Committee. The work carried out by the committee has included experiments on turbines both on land and at sea. Two series of comparative trials between reciprocating engines and turbines of much the same output were made at the Neptune Bank station of the Newcastle-on-Tyne Company. At these works consumption trials were made at various outputs, so as to obtain relative figures for widely varying outputs. Still more valuable experiments were carried out on the steamships "Arundel" and "Brighton," which are used on the Newhaven-Dieppe route. These ships are practically identical with the exception of their machinery, the "Brighton" having turbines and the "Arundel" reciprocating engines. The two vessels were run side by side from Newhaven to Dieppe and back (one of them being on the ordinary service), thus eliminating the possibility of errors by variants of weather and tide. Afterwards trials with the "Brighton" running at different speeds were carried out in the Solent. Complete records of these trials accompany the committee's report to the directors, thus placing at the service of the company trustworthy information both as to the performances of turbine engines on land and also of turbines fitted in ships. During the whole period of their investigations the committee have realised that fitting turbines of the dimensions necessary to propel the new Cunard ships at the speed contemplated involved a very great step in marine propulsion, the largest turbines at present in use afloat being those in the steamship "Queen," engaged on the Calais-Dover service. The committee, therefore, have devoted much attention to the design of the turbines proposed for these vessels, both from the point of view of manufacture and also from that of general efficiency on continued service. In considering the report, the directorate of the Cunard Company have also had to bear in mind the effect which the adoption of turbines would have on the design and dimensions of the new ships. It is hoped that now the decision in favour of turbines has been come to, the order for these new vessels—which will inaugurate, we believe, a revolution in marine propulsion on a large scale—will be speedily placed. It is a curious thing that we should receive at the same time as the above facts a reprinted report from the American Society of Naval Engineers on steam-turbine tests. This is issued by the Westinghouse Company, and contains particulars of a series of trials carried out on the turbine manufactured in America by the Westinghouse Company. These trials were made on a 1,000-kw. Westinghouse-Parsons steam turbine-generator, and the following figures were obtained: for loads respectively of 1,510 kw. and 1,019 kw. the steam pressure at the throttle valve was about 149 and 146, and the condenser gave a 27½in. vacuum. The steam per electrical horse-power hour was 13·99lb. for the first load and 15·31lb. for the smaller load. The steam was slightly superheated. The report concludes with the advantages of the steam-turbine for propulsive purposes in naval vessels. It states that, considering its efficiency when used for other purposes, it seems reasonable to conclude that some experiments and actual installations in one or two types of vessels of the navy are fully warranted. The report is signed by Commander A. B. Canaga, United States Navy, and Mr. Ernest N. Janson, of the Bureau of Steam Engineering, Navy Department.

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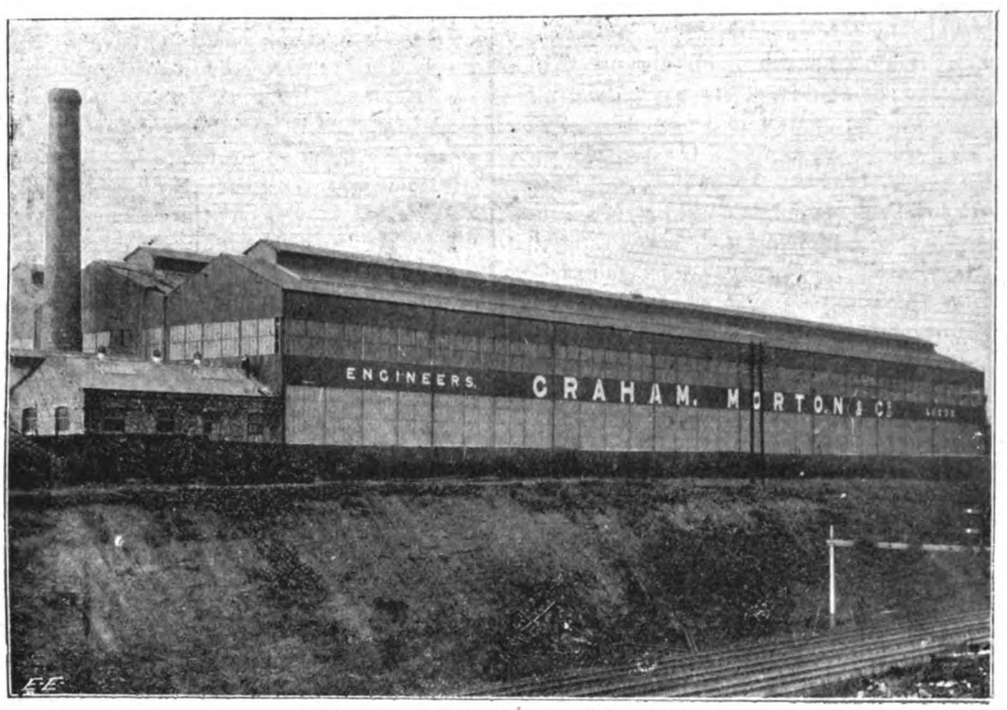
## GRAHAM, MORTON, AND CO.'S NEW ENGINEERING WORKS.

### Introductory.

A large number of engineers and pressmen availed themselves of the opportunity offered them on the 11th ult. of inspecting the new engineering works which have been erected by Messrs. Graham, Morton, and Co., Limited, at Hunslet, Leeds.

In the past we have been accustomed to associate this firm with Black Bull-street, where they established their original works. Several extensions were made to that establishment, but a time came when the ever-increasing volume of work in hand taxed the full limits of the site, and recourse had to be had to first one branch establishment and then another in different parts of the city. The inconvenience of this arrangement led Mr. Maurice Graham, the managing director, to look out for a site commensurate with immediate and prospective needs, and where railway sidings could be carried into the works. Such a site, over seven acres in extent, was found at Pepper-road, Hunslet. Plans were then prepared, and as a preliminary to building work the first sod was eventually cut on May 16, 1903 The first column in connection with the steelwork superstructure was placed in position on July 11, and on Nov. 2 the new workshops were in full operation, the Black Bull-street premises together with the two branch establishments being then closed. Thus in the brief space of about 5½ months from the date of cutting the first sod the works were not only completed but in actual operation. Having regard to the magnitude of the undertaking, this feat constitutes a record which merits unstinted praise. In the the first place, the credit is due to Mr. Graham, without whose great organising ability such an achievement would have been impossible, since the whole of the work was carried out by the firm's own men. So far, at least, as Messrs. Graham, Morton, and Co. are concerned, we have in the above a fitting reply to the vaunted superiority of America in methods appertaining to building work.




Exterior View—Graham, Morton, and Co.'s Works.

### The Offices.

Commencing our tour of inspection at the offices, we found these were located in a separate building, 270ft. long by 41ft. wide. The main entrance hall is at the centre, dividing the building into two parts, that on the right containing the drawing office (117ft. long), with its various departments—estimating and engineering, general, colliery, drawing store, and blue-print room; that on the left the board-room, managing director's office, and miscellaneous apartments for the general clerical staff, etc. The roof is in three spans, an economic point thus being scored, as, owing to the small spans, light scantlings only are required; two rows of cast-iron columns, acting as supports, run the entire length of the building. The centre span is glazed, to ensure the admission of sufficient light in the middle of the building. The outside spans are covered with blue slates, and matchboarded beneath. The whole of the front of the exterior of the building is faced with Accrington plastic bricks, of which 106,000 were used, weighing 284 tons. The windows are arranged to obtain the maximum amount of light, being both numerous and large. The light area of each window is 40 square feet, the total area of windows for the entire building being 6,950 square feet. Without

General View of Shops looking along Centre Bay—Graham, Morton, and Co.'s Works.

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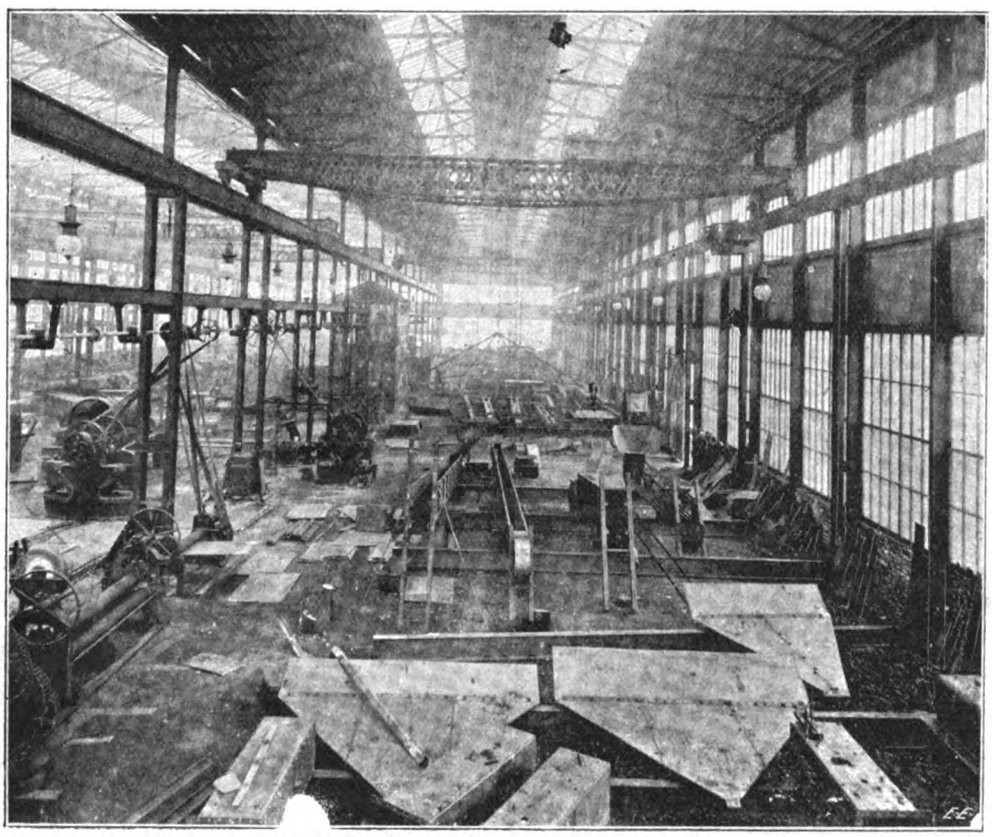
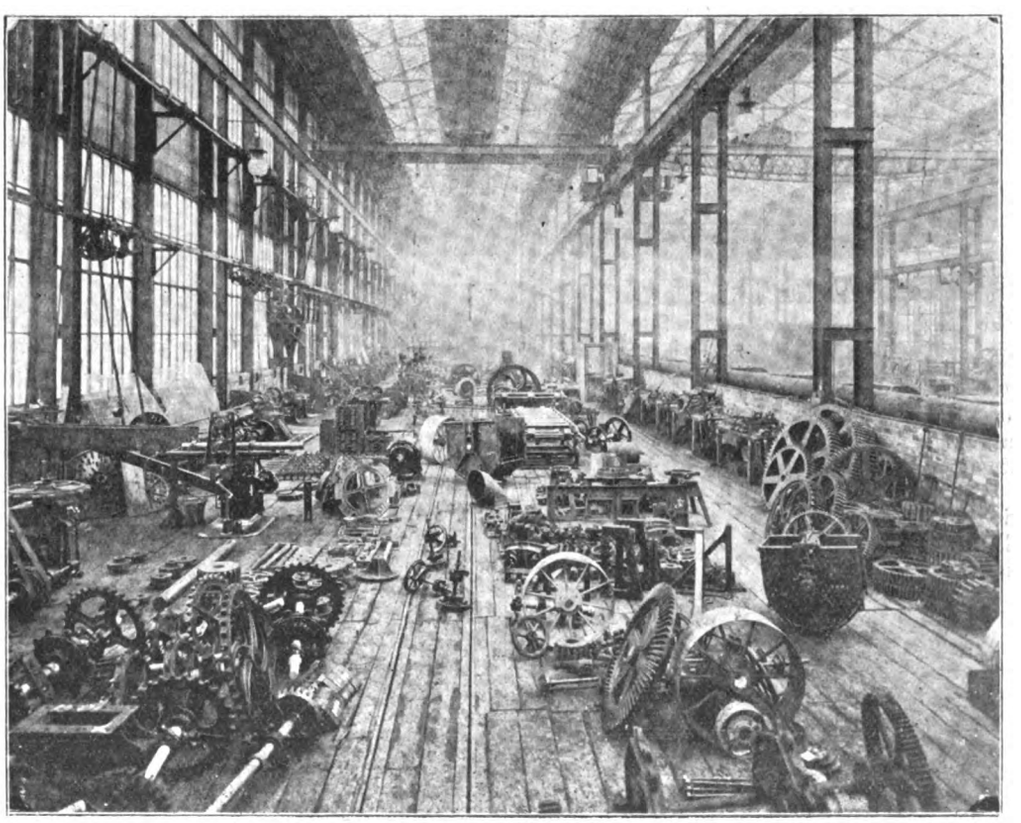
some further explanation it might be thought that the office accommodation provided errs on the side of excess, but when it is taken into account that the drawing office staff alone numbers 50, the necessity for the provision made is at once apparent. For the rest, these offices could hardly be better equipped for their work. Every provision calculated to promote the best results with due dispatch has been made, system and order being observed throughout. A good example of this is seen in the organisation of the drawing office, the first division of which is the estimating department. Here all enquiries coming to the office are conveyed to be promptly dealt with, complete drawings and specifications being prepared where the answer suggests such. Drawings, calculations as a basis for specifications, and the finished specifications are subsequently sent into the blue-print room, where, in the duplex radial photo copying frame, with the assistance of a special arc lamp supplied with current at a high voltage and fitted with a special winding gear to allow of the required light, the prints are made, being afterwards care-



Plating Shop—Graham, Morton, and Co.'s Works.



Fitting Shop—Graham, Morton, and Co.'s Works.

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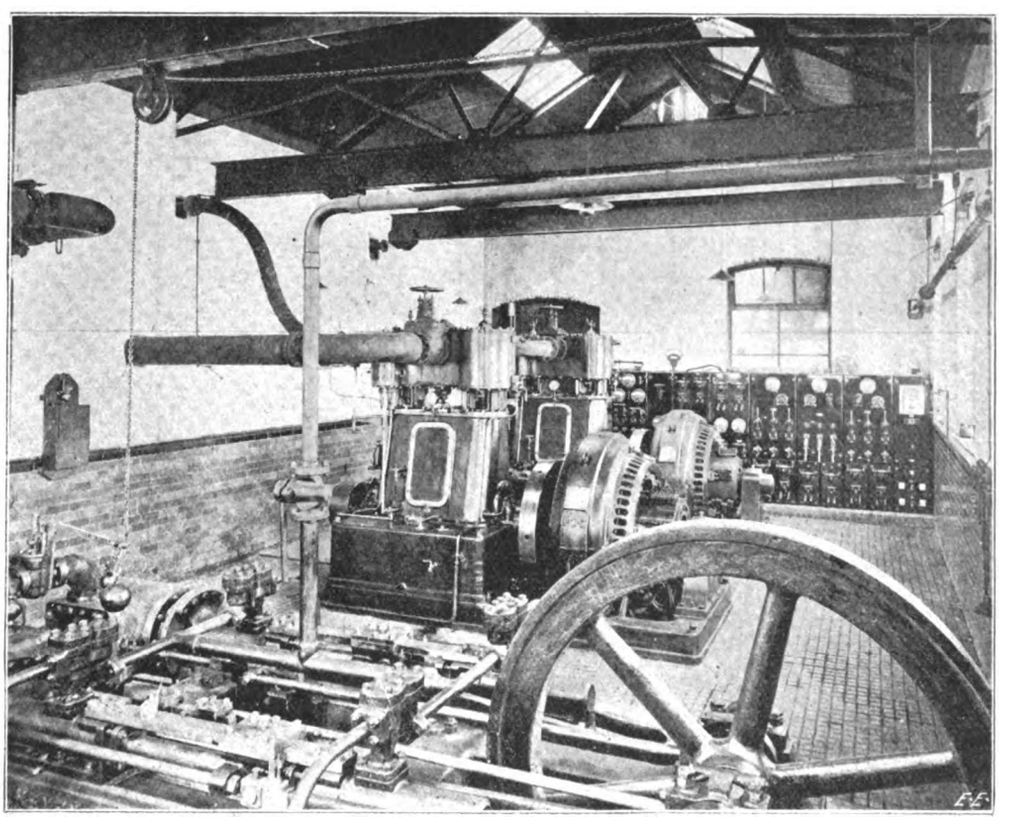
fully washed and squeegeed, and then dried in a hot-air chamber. Many thousands of drawings, tracings (the original drawings are destroyed), and prints are indexed and filed away in the capacious sets of drawers allotted to their reception. But before storing, the finished blue prints are returned to the estimating department, and there checked and numbered.

The whole office is exceptionally well lighted, the light being admitted both through top and side glasses. All partitions, demarcating various sections, are of glass, and all woodwork is painted white. The windows are, moreover, in position to accord the coveted north light. Each desk is provided with movable electric lamps, with light adjustable to any angle. In another department, termed elsewhere "The General," all detail work is drawn out connected with gaswork plant, coal-handling plant for electric power-houses, including conveying and elevating plant, bridge work, roof work, structural work, etc. In addition to the main approach, there are also several entrances from the works situated to the rear of the offices.

### The Works.

Upon entering the works from the separate block are kept all supplies for the engineering shops, and immediately over both are situated the "chain" and "idler" shops, reached by ascending a flight of stairs. The chain shop, with its array of spindled drilling machines driven by electric motors through line shafting, was hastily inspected. Thirty to forty different kinds of chains are required for elevators and conveyors alone; some cast steel, some stamped, but all drilled in jigs to ensure true centres. In the neighbouring shop idler rollers were being made for belt conveyors, angular and flat, the former for carrying the loaded belt, and the latter the unloaded. All sizes of belting, from the humble 12in. to the more pretentious 42in., can be accommodated with suitable "idlers." From the elevated position of the last-mentioned shops we incidentally obtained some good views of the main floor below and its busy workers. Let us recall the pictures. Looking down from the landing at the head of the stairs, we see arranged before us a maze of sections of designs in ironwork in various stages of completion, for our eyes are now inclined towards the headquarters of the constructional ironwork. Almost at our feet a large order is being executed for the Bengal and North-Western Railway of India, and to the left are bridges in course of construc-



Engine Room—Graham, Morton, and Co.'s Works.

constituting the offices described in the foregoing, our appreciation of the building feat which the whole represents was materially increased. Nor is this surprising since the main floor extends to a length of 400ft., and is 140ft. wide. Of substantial, but not heavy, construction, the huge fabric presents special features of interest. Both roof and walls are of glass, supported by steel girders, the interior lighting being, therefore, uniform and excellent. Our first attention was accorded to the tool shop, occupying a corner position. In this shop are wrought the tools required throughout the works. We noticed that its equipment included that ingenious American invention, the Gisholt tool grinder, in which it is possible to use 70 different kinds of turning and planing machine tools. Such, in fact, is its adaptability that it can grind all tools to any and every angle required, the tool-holder being movable to any position in relation to the corundum wheel. A great advantage accruing from the use of this machine is that of time-saving, inasmuch as it is only necessary for the smith to forge the tool roughly, the machine doing the rest. It is tempered by cold blast, and subsequently finally ground.

Adjoining the tool shop are the general stores, where tion to the order of the Great Western Railway Company. Hard by is a bridge destined, when completed, for the Halifax Corporation. Sections of roofing for car-sheds occupy the centre group, while another group we notice is engaged upon elevating and conveying plants for Melbourne and Sydney. Away to the right several large coal-measuring chambers for electric light stations also come into the view which we obtain from this point of vantage.

Leaving the landing, let us now return to a position at the end of the chain shop, whence the fitting and machine shops can be surveyed. Here another field of refreshing activity is revealed, and we observe the progress of the machine work incidental to the manufacture of gearing for elevators and conveyors, and gear-wheels on shafts for gravity bucket conveyors; also the construction of bale elevators, coal and coke elevators, ash elevators, band conveyors, and revolving feeders. In the distance steel grids for hot coke conveyors are being made. Directing our eyes along the centre bay, we notice that the blacksmiths' shop, which occupies a considerable proportion of its length, is practically free from haze. This, we are told, is due to the exhaustion of sulphurous fumes by an 18in. wrought-iron pipe, which is carried under the floor and outside the

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building. The shops are served by five electric overhead travelling cranes of from five to ten tons lifting capacity, and one result of the above-mentioned provision of exhaust pipes is that the drivers of these cranes are thereby enabled to work in a thoroughly wholesome atmosphere. Our attention is in turn diverted to a spot where men are at work lining out templates for roofing and tank work. It goes without saying that, in conformity with their very up-to-date character, everything, as far as practicable, is standardised in these works. Before such order obtained, under the old and almost effete system, fresh templates would have been required for each job. It has been computed that the system whereby standard patterns are worked to, whether in templates or parts of machinery, renders a saving possible in some cases of as much as 33 per cent.

Having descended from the "chain" and "idler roller" shops to the main floor, we at once proceeded to a closer inspection of the works' equipment. Several of the machines included in the latter call for special mention. One is a 52in. boring mill fitted with a revolving table and a vertical bore. It works in any position, and is distinguished by a special aptitude for boring and facing wheels at one operation. To the same category belongs a keyway cutter, for cutting keyways where required—say in couplings, gear-wheels, etc. It cuts any width, from ¼in. to 2in., and, like the first-mentioned machine, is of American origin. Then there is a machine which serves the purpose of milling, superseding the older planing and shaping machines. This is of British make. Nor must we forget a 200-ton hydraulic press, used for pressing the seamless steel corves or colliery tubs, which have helped to make the reputation of Messrs. Graham, Morton, and Co. A second and smaller hydraulic press is employed for pressing the ends of riveted corves, and body plates for elevators, etc. Equally interesting to watch was the action of a machine coiling spirals for spiral conveyors. Time did not permit us to take separate note of the numerous heavy punching machines, drills, and rolling mills, but their collective presence did not escape us any more than did that of the smaller pneumatic drills, riveters, etc., at work.

In the foregoing reference has been made to certain orders going through the shops; no attempt will be made here to complete the list, but mention should certainly be made of 32 Markham's patent machines for carrying the excavating work in connection with the "tube railways" in London, one of which was exhibited. In excavating or boring the "tubes" by means of a Greathead shield there used to be some difficulty in getting the *débris* away from the boring machine, but now this type of conveyor has been introduced considerably more work is got from the machine, and at the same time the whole space in the tube is kept clear of the workmen.

Reverting to the equipment of the shops, it is noteworthy that belt drives from electric motors are the rule, the heavier tools being separately driven, while line shafting is interposed in regard to the groups of small ones. The motors themselves are of the semi-enclosed type, wound for a working pressure of 220 volts, and were supplied by the Phœnix Dynamo Manufacturing Co., Limited, Thornbury Works, Bradford. They aggregate 234 h.p., of which 84 h.p. is fitted to the three-motor cranes serving the shops, while another 25 h.p. is absorbed by the air-compressor used in conjunction with the installation of pneumatic tools. With the exception of the crane motors, which run at 400 revolutions per minute, all the motors are designed for 600 revolutions per minute. The switches used with the shop motors are of the Sturtevant "Cutler-Hammer" type, having renewable segments, fitted with overload and no-voltage release.

Referring to the accompanying general view of the shops, there will be seen to the left of the centre bay a structure resembling a railway signal box. This is the "time" office, where each workman registers his time on a Dey recorder. Here also are fixed the electric bell indicators for the messenger boys, whose duty it is to fetch fresh tools, etc, from the stores, and thus save the workman's time. Two lines of railway running through the works provide facilities for transport. A great stock of the materials used in the manufacture of the firm's specialities is kept in the adjoining yard, fresh consignments being conveyed to their allotted places within the area for storage with the aid of overhead travelling cranes, while steam jib cranes designed to work over the yard lines are further provided to assist in the operations of transport. There are two connections, through turntables, between the yard and works' railways.

It still remains to deal with that important department the "power-house," which adjoins the end of the main building remote from the offices; the chimney shaft shown in the accompanying exterior view marks its exact position. We enter from the works. The plant at present installed includes two Belliss and Morcom high-speed engines, each coupled to a direct-current generator of 150 kw. capacity at 450 revolutions per minute and 220 volts terminal pressure. These sets are capable of dealing with the whole of the power and lighting load. An auxiliary engine driving a Phœnix dynamo of 35 kw. capacity serves for lighting the offices when the works are closed. The switchboard from which the power and lighting circuits are controlled was supplied by Messrs. Crompton and Co., Limited. There is also a double-acting hydraulic pump whose function it is to serve the presses mentioned elsewhere. This pump, which is seen in the foreground of the accompanying view of the engine-room, has cylinders of 14in. diameter and a 20in. stroke. Steam is generated in a Lancashire boiler 30ft. long by 8ft. 6in. diameter at a pressure of 140lb. per square inch. It passes through a superheater on its way to the engines. Incidentally it may be mentioned that the boiler-house is equipped with a small elevating and conveying plant, which gives a good illustration of one branch of the firm's manufactures, the handling of the coal from the truck and its delivery at the boiler being seen in operation.

The "pattern" shop and stores occupy a detached building, 60ft. long by 24ft. wide. Here turning lathes, trimmers, band saws, planes, and other wood-working machines of modern pattern are installed, all electrically driven.

In concluding the above description of these works we may add some interesting data. The quantity of glass used in the works, including engine and boiler houses, amounted to 54,600 square feet, in addition to which 6,950 square feet were used in the offices. The weights of the ironwork were: 343 tons of steel joists, 323 tons of sectional steel, and 50 tons of bolts. The area covered by the works is 7,000 square yards, by the engine and boiler houses 306 square yards, and by the offices 1,230 square yards, which gives a total of 76,824 square feet. These figures are significant when it is remembered that the offices and works were designed and erected by the firm's own staff of employés without the aid of a sub-contractor, being, moreover, completed and in full working operation within the short space of 5½ months from cutting the first sod.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 492.)*

### Different Forms of Oscillators.

*Hertz's Resonator.*—So much for the Hertz oscillator, or starter of electric waves. Hertz called his receiver, or detector of these waves, by the name "resonator," evidently thinking of the analogy of tuning or resonance in the case of sound, because he found that it worked best when "tuned" to the oscillator—in other words, when its circuit's capacity and self-induction were such as to give the same natural period of vibration as that of the oscillator. This question of resonance, or "syntony," has recently become very important. His resonator consisted of a ring of round wire, like an anchor ring, 35cm. (13¾in.) in radius, with a minute spark-gap in it (Fig. 16). Etheric waves from the oscillator falling on this ring set up electric oscillations in it, which, if the tuning or syntonising were good enough, grew larger and larger till they finally burst across the gap, causing a minute spark. The spark is more visible if the ring be held in the horizontal plane with its gap towards the oscillator, the reason probably being that

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the waves from the oscillator are to a certain extent polarised horizontally, and the ring, acting as an analyser, receives best the vibrations when placed in this plane. With his resonator, or "electric eye," Hertz made very important investigations. Interference of the fundamental waves with those reflected from a large sheet of iron (which is opaque to these vibrations) gave rise to stationary waves, and the distance from node to node was measured. Thus the wave-length, and hence the frequency, being obtained, since $v = n\lambda$, where $v$ is the velocity of propagation, $n$ the frequency, and $\lambda$ the wave length, the velocity of propagation was found to be that of light, which has since been calculated (by Michelson) as $2{\cdot}991 \times 10^{10}$ centimetres

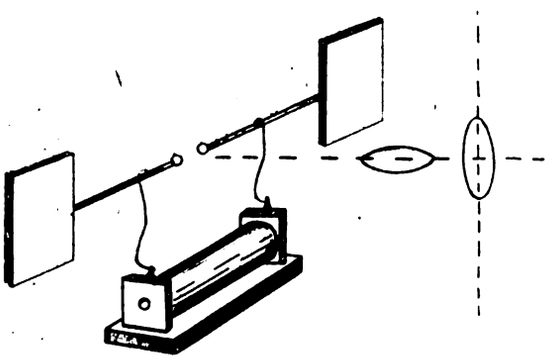

FIG. 16.

per second, or 186,364 miles per second (Newcomb's number, is 186,333). The curve for an oscillator and one for a resonator as used by Hertz are shown in *a* and *b* (Fig. 17).

Dr. Bose found that two minute beads at a short distance apart used as spark-balls formed a satisfactory oscillator, as the accumulation of dust or dirt did not much reduce the intensity of the radiation. The question of the cleanness and polish of the spark-balls in oscillators has been the subject of discussion and experiment. It is found that with low frequency discharge, such as from a Leyden jar, the efficiency is *increased* as the balls get dirty. But, going higher in the scale of frequency, the balls have to be polished frequently, especially when, as in the Hertz apparatus, the frequency goes so high as 50 or 100 millions per second. Dr. Lodge, going as high as 500 or 600 millions per second, found it more necessary still to have high polish; and Dr. Bose, at 30,000 millions per second, found that the slightest deterioration of the surfaces was fatal to the production of ether waves, and he finally made his

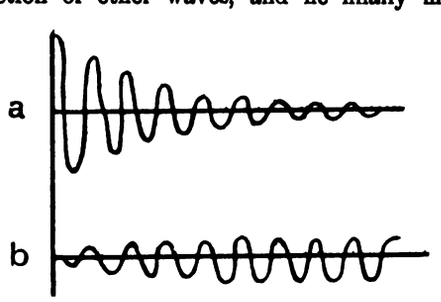


FIG. 17.—Curves for Hertz Oscillator and Resonator.

spark-balls of platinum. At these high frequencies any deterioration or dirt gives rise to a fizzing off or conduction of the charge before sparking occurs. The large capacity of low-frequency apparatus probably accounts for the absence of ill effect due to fizzing off through dirt.

In some very successful oscillators oil is employed. They are usually constructed with three spark-gaps—one in oil and two in air. A typical one, due to Prof. Righi, is shown in Fig. 18, where the oil is enclosed in a small vessel like a jar. A more modern type of Righi oscillator is depicted in Fig. 19, where large solid balls of brass, 5in. or 6in. in diameter, are employed. The function of the oil seems to be to make the discharge more sudden, owing to the comparatively high dielectric properties it possesses. Mr. Marconi used this oscillator in his earlier experiments, but gave it up owing to the fact that a shower of sparks from an induction coil passing through the oil did not allow the oil to collapse together properly, so that the little tunnel made by one spark had not time to fill up before the next spark came, and hence the discharge ceased to be truly oscillatory.

It should be noticed that the magnetic disturbance of an oscillator is one-quarter period in advance of the electrostatic disturbance, or when the rush of current is at its maximum the magnetic whirl is greatest, and the electrostatic difference of potential between the two ends of the oscillator is zero. Returning to our illustration of a spiral spring, when the motion of the weight is greatest—*i.e.*, at the centre of the swing—the strain in the spring is least. A quarter of a period, or a half-swing, later the spring is most extended and the weight is momentarily at rest. For the propagation of ether waves the electric and magnetic effects must be in phase with each other. They start one-quarter period out of phase, but the lag in time of the electric effect is compensated by its lead in space. After the first quarter period the two travel into space together as a true radiation, but during the first quarter period all is confusion, and the energy which does not succeed in getting past this first quarter returns into the circuit and

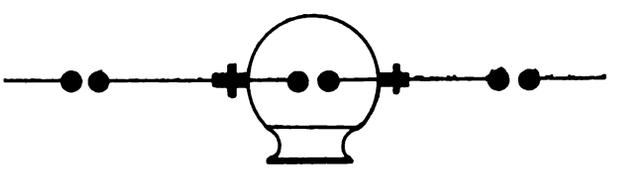

FIG. 18.

partly helps to keep up the oscillations. Thus the more powerful a radiator is the more damped is its oscillations, and if an ordinary alternator of frequency 100 periods per second were used to radiate directly, the wave-length—as Dr. Lodge shows—would be about 2,000 miles, and no true radiation would occur at distances of less than 500 miles, and then the intensity of the radiation would be small. Mr. Marconi in Transatlantic etherography uses an alternator (that at Poldhu being of about 120 h.p.), and the wave-length is probably 600ft. to 1,000ft. But as he does not radiate his alternator current directly, but uses condensers and high-tension spark discharge, the frequency of the alternator is not of importance in calculating the wave-length on account of the other radiating apparatus employed. Following are some of the wave-lengths of most interest to the student: shortest ultra-violet waves, ·0001mm.; violet, ·00043mm. to ·00075mm.; dark heat, ·0008mm. to ·051mm.; shortest Hertz waves, 4mm.; ordinary Hertz waves, 13mm. to 13,312mm.; ether waves used in wireless telegraphy, 500ft. to 1,500ft.

## THE ELECTRIC EAR.

*Detectors or Receivers.*—Having shown how Hertzian vibrations may be set up and propagated, it may not be

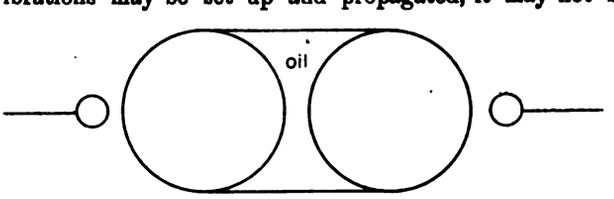


FIG. 19.—Righi Oscillator.

out of place now to refer more fully to various modern methods of *detecting* or receiving these impulses. The various detectors may be classified under different heads, such as electric, thermal, electrostatic, microphonic, and chemical. There are also other effects, many of them peculiar and obscure, of etheric vibrations on the nerve centres which may be called physiological, but it is not necessary to refer further to them here. Some are detectors only, others are receivers such as may be employed in telegraphic work. We need not enter into the delicate question as to what constitutes a detector and how it may become a receiver.

*Electric Detectors.*—A ring with a spark-gap has already been referred to. It is one of the most elementary of electric detectors. Two rods may be used in the same way. Telephones have also been employed, being automatically brought into circuit with a battery when the spark passes. Prof. Boltzmann, by momentarily connecting

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the spark to a dry pile, used it to charge an electroscope, and Dr. Lodge caused the induced spark to make a path by which a charged electroscope discharged itself. A vacuum tube has also been employed, as it can be made to glow by the induced vibrations, or the induced E.M F. may be made to help a high-voltage battery to cause the tube to glow. Prof. Righi used a relay in circuit with such an arrangement as that just described. He found this method almost as good as the coherer, to which reference will be made presently.

*Electromagnetic Detectors.*—Mr. Sydney Evershed's call relay is a remarkable instance of an electromagnetic detector. As used in connection with induction signalling it has already been described.

*Marconi's Magnetic Receiver.*—The action of this receiver is based on the decrease of magnetic hysteresis (inertia) which takes place in iron when exposed to Hertzian oscillations. This matter was experimented on by Mr. E. (now Prof.) Rutherford at Cambridge (*Proceedings* of the Royal Society, 1896, and patent specification No. 10,245 of 1902). A bundle of very fine steel wires was surrounded by a coil. The steel was magnetised, and it was found that when the coil was put in series with a receiving circuit for Hertz waves, the oscillations set up in the circuit demagnetised the steel, this effect being produced even when the transmitter was half a mile distant. Mr. Marconi's magnetic detector or receiver has a band, B (Fig. 20), consisting of iron wires kept moving by the pulleys, $P_1$ and $P_2$, which are

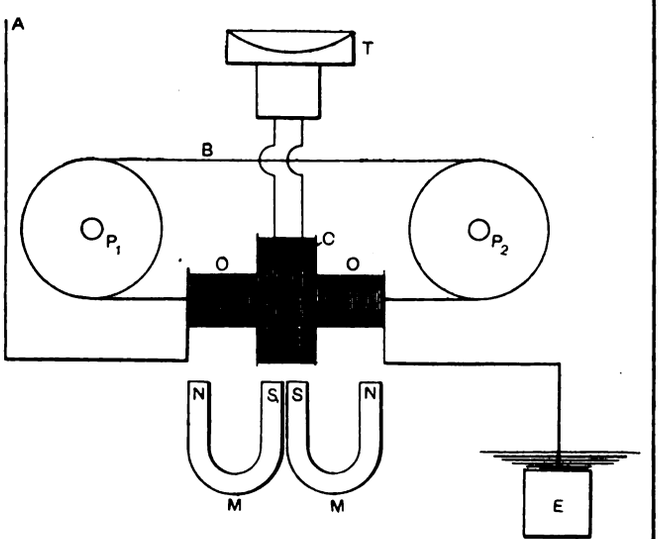


FIG. 20.

revolved by clockwork. The band passes through the coil, O O. This coil is connected at one end to the aerial, A, and at the other end to the earth. The portion of the band in the coil O O, is magnetised by the magnets, M M, and in consequence of the magnetic inertia of the band this magnetised condition is not immediately removed, but a portion of the band beyond the coil, in the direction in which the band is moving, retains its magnetism, but is in a very unstable condition. The incidence of electric oscillations from the aerial through the coil, O O, has the effect of demagnetising the band, especially affecting the magnetism in that part outside the coil, which was there on account of hysteresis, and this magnetism, so to speak, slips back into the coil each time the waves come down the aerial to O O. That part of the band inside the coil is also subjected to the effect of the waves, but is under the influence of the magnets, M M. Around the coil, O O, is a second coil, C, connected to the telephone receiver, T, and the disturbance referred to of the magnetism in a portion of the band causes a sound to be heard in the telephone, which is either short or long, according as the incident waves from the aerial persist for a short or long period. In this way dot-and-dash signals are obtained. This receiver is much more sensitive than a coherer, and is more suitable for use in a syntonic wireless system. This form of receiver was used by Mr. Marconi in recent Transatlantic transmission, and was that by which President Roosevelt's message to the King was read after having traversed more than 2,300 miles.

*Electrostatic Detectors.*—If, in a nearly closed circuit, a tuned receiver like a kind of one-sided electrometer (Fig. 21) be inserted, the needle being at zero and each quadrant connected to one terminal, successful results may be obtained. Bjerknes used such an apparatus, and other inventors have used electrostatic methods.

*Thermal Detectors.*—The oscillatory currents set up inductively by Hertzian waves may be employed to heat junctions of different metals, and thus give rise to thermo-electric currents from which with suitable apparatus readable indications may be obtained. The late Mr. Gregory, of Cooper's Hill, invented a very remarkable detector of this kind, which, on somewhat the same principle as the Cardew voltmeter, was really a sensitive arrangement for showing the minute rise in temperature of a fine platinum wire due to Hertzian vibrations.

*Fessenden's Receiver or Responder.*—A remarkable example of these thermal detectors is that of Prof. Fessenden's, shown in a later illustration. It really consists of an exceedingly fine platinum wire in circuit with two cells of slightly different strengths placed back to back. There is a very slight current—due to the difference in the cells—through the fine platinum wire, but when the electric impulses are received from the distant station the fine wire is heated, and this increases its resistance, which increase of resistance, and consequent stoppage of current, is heard in the attached telephone. This detector, like most thermal detectors, is self-restoring. In all probability the very sensitive "radio-micrometer" of Prof. Boys might be similarly employed to detect, though perhaps not to regularly telegraph by means of, Hertzian waves. This remarkable instrument is really a combination of thermo-electric couple and sensitive-coil galvanometer. A tiny antimony-bismuth couple is connected at one end to a very thin piece of blackened

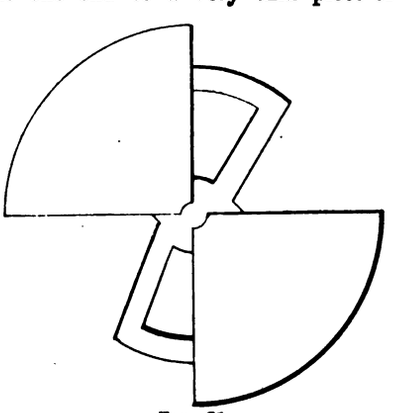

FIG. 21.

copper foil. The other ends of the strips are connected to the one end of a long narrow coil consisting of a single loop of wire suspended at its other end by a quartz fibre. The coils hangs between the poles of a powerful magnet, and the quartz fibre constrains the coil to remain, when no current circulates in it, in the plane of a line joining the poles of the magnet. When any heat radiations fall upon the copper foil, the latter is heated and the current flowing round the loop causes it to turn through an angle, which motion being participated in by the quartz fibre, or rather by a small mirror fastened to a fine capillary glass tube connecting the loop and fibre, deflects a ray of light falling on the mirror, which is reflected and travels along a scale, as in the case of a reflecting galvanometer. Prof. Boys has shown that if the temperature of Jupiter were as high as 100deg. C, its heat would be detected by this apparatus.

*(To be continued.)*

**Admiralty Scheme.**—Messrs. Palmer have completed the alteration of the "Bellerophon" and "Temeraire," which are to be used for the training of engine-room artificers. All the machinery is driven by belts from shafting rotated by electric power. Two dynamos have been fitted, each of 100 kw., supplying electricity for 1,200 lamps and seven motors varying from 7 h.p. to 20 h.p. The dynamos have been supplied by the Thames Ironworks Company, and the engines by Messrs. Peter Brotherhood and Co., Westminster. They are closed 150-h.p. engines, running at 450 revolutions, coupled direct to the dynamos, which generate 450 amperes at 220 volts. In the two ships 14 miles of electric cables are fixed.

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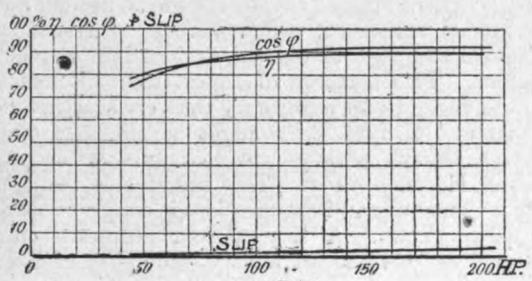
## THE CASCADE CONNECTION OF MOTORS IN ROLLING-MILLS.*

Electrically-driven rolling-mills have been in operation in Sweden for the past eight or nine years. Most of them are supplied with three-phase current, and usually no speed regulation is provided for. Latterly, however, three-phase motors with cascade connection for two and three speeds have also been installed.

Since both the cascade connection of motors and also the electrical driving of rolling-mills are of interest at the present time, a description of one of the three-speed motors will not be out of place. The motor in question is in use at the Sandviken Ironworks, one of the largest ironworks in Sweden, and one which until about a year ago employed steam power almost exclusively. Now, however, power is transmitted electrically from a waterfall at a distance of 54 km. The installation is for 2,700 h.p. at a voltage of 20,000, transformed down at Sandviken, and a periodicity of 50. The three-phase current is conveyed to Sandviken by two different lines. Most of the motors are plain induction motors, and consequently do not permit of any

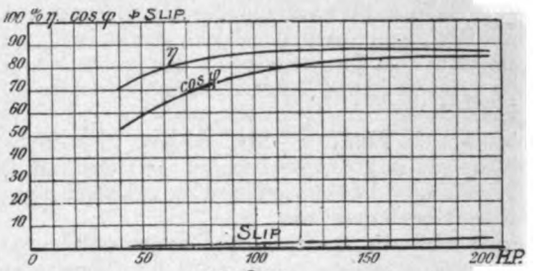


428 REVS.

FIG. 1.

speed regulation without excessive loss. The motor which is the subject of this article, however, works without losses in regulating resistances at the approximately synchronous speeds of 428, 375, and 333 revolutions per minute.

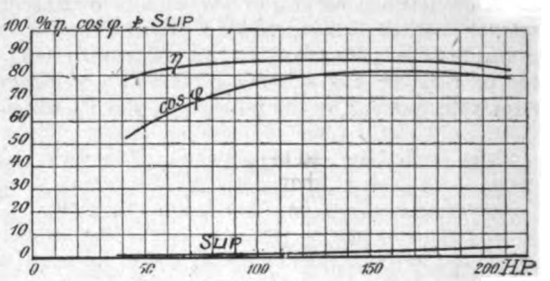
in tandem or cascade with the main motor. The lowest speed is obtained by coupling the auxiliary motor for four poles and connecting it again in cascade with the main motor. The power in each case is 150 h.p. The efficiencies



375 REVS.

FIG 2.

and power factors at different loads and speeds are shown in Figs. 1, 2, and 3. It will be seen that both efficiency and power factor are satisfactory even at the lowest speed. At full load and 333 revolutions the efficiency is 87 per cent. and cos $\phi$ ·81. At 375 revolutions the figures are



333 REVS.

FIG. 3.

88 per cent. and ·83, whilst at 428 revolutions the efficiency is 89 per cent. and the power factor ·92.* The possibility of obtaining so high a power factor with this arrangement is obviously due to the fact that the auxiliary motor, which

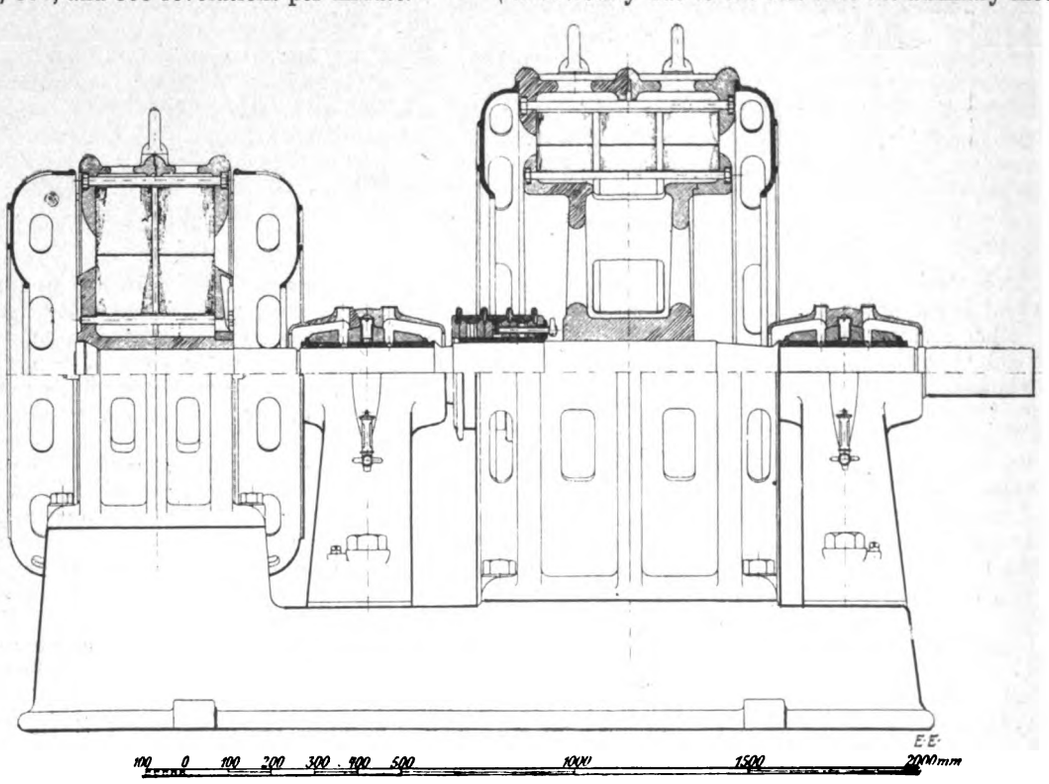



FIG. 4.

The machine consists of a combination of two motors—a main motor, which is an ordinary 14-pole induction motor, and an auxiliary motor, which can work as either a two-polar or a four-polar motor. At the highest speed only the main motor is in use. At the intermediate speed the auxiliary motor is coupled for two poles and is connected never runs at the speed corresponding to its number of poles, can be built with extremely little leakage and a moderate magnetising current. When at rest on short-

* Translation of an article by E. Danielson in the *Elektrotechnische Zeitschrift* for Jan. 21, 1904.

* The curves are calculated by Steinmetz's method on the strength of tests made on the machine. It may be mentioned that two tests were made, one at the manufacturer's and the other at the Sandviken Works. The results differed slightly, and the curves given may show efficiencies rather lower than the truth.

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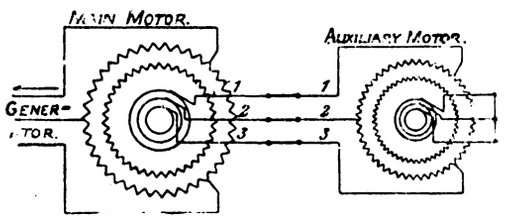
circuit at the correct volts and periodicity, the main motor allows a current of 900 amperes to pass, which corresponds to a leakage of about 17 5 per cent. When coupled in tandem, the currents are 732 and 638 amperes respectively with the two-polar and four-polar arrangements of the auxiliary motor. The insertion of the auxiliary motor, therefore, only increases the leakage by 23 per cent. to 40 per cent. The losses in the iron of the auxiliary motor are very low, as the frequency does not exceed 11 or 12 periods per second. The secondary winding of the auxiliary motor is, for simplicity, of the squirrel-cage type, and starting is effected by inserting resistances in the secondary




IG. 5A.—Direct Cascade Connection.

of the main motor only. The clearance air-gap in the main motor is 1½mm., and in the auxiliary motor 1½mm. The diameter of the rotor of the former is 1,050mm., and that of the latter 540mm. The maximum peripheral speed is consequently 23 5m. per second (4,600ft. per minute).

Fig. 4 shows the general arrangement of the machine, but a longer bed-plate and an outer bearing were actually employed. As stated above, only the ordinary direct cascade connection (Fig. 5A) has been employed. If, in addition, the differential cascade connection were also employed, two more speeds —viz., 500 and 600 revolutions— could be obtained. For this purpose it would only be

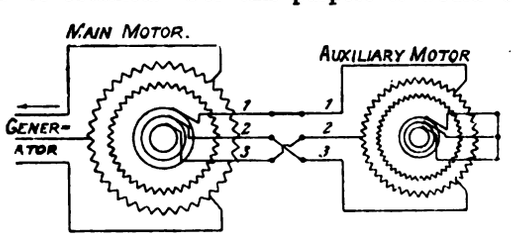



FIG. 5B.—Differential Cascade Connection.

necessary to give the auxiliary motor a properly wound rotor with slip-rings, though at the same time the switching arrangements would, of course, become somewhat more complicated. Efficiency and power factor would remain almost unchanged, though the efficiency might be slightly lower owing to the increase of windage at the higher speeds.

It should be mentioned that with the differential connection two arrangements are possible. If the main motor is made the primary motor—*i.e.*, is connected to the source of supply—the best conditions as regards efficiency are obtained, but at the same time there is the disadvantage that the motor will not attain the required speed by

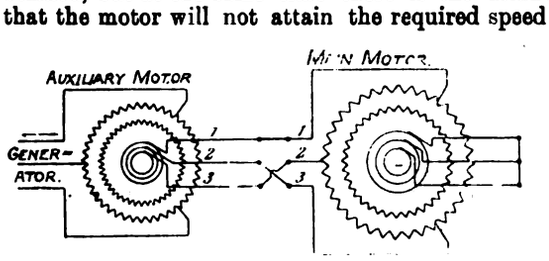



FIG. 5C.—Differential Cascade Connection.

itself (Fig. 5B). It is easily seen that when the primary motor has attained its synchronous speed the rotor has no current in it, so that, if left to itself, the motor could not exceed this speed. If, however, the speed is slightly increased — say, by mechanical means— a positive torque is again exerted, and continues to be exerted until a speed corresponding to the difference between the numbers of poles of the two motors is reached. In this case the motor with the lower number of poles acts as a generator, and supplies the energy to drive the primary motor at a speed above synchronism. The periodicity in the secondary core of the primary motor and in the primary core of the secondary motor will be $\frac{n_1}{n-n_1} \sim$, where $n_1$ is the number of poles of the auxiliary motor, $n$ the number of poles of the main motor, and $\sim$ the frequency of the supply current. With the direct cascade connection the corresponding frequency would be $\frac{n_1}{n+n_1} \sim$. If, on the other hand, the motor with the smaller number of poles is connected to the supply (Fig. 5C) it will reach the required speed without outside aid, the auxiliary motor acting as a frequency changer, taking up mechanical power and transforming the supply periodicity to a higher value. The periodicities in the various cores are, then, as follows: in the primary core of the auxiliary motor = $\sim$; in the secondary core of the auxiliary motor and in the primary core of the main motor = $\frac{n}{n-n_1} \sim$. These frequencies are considerably higher than that of the supply, and the losses in the whole motor are correspondingly increased.

It is, consequently, advantageous to arrange the switching gear so that at starting up the latter connection is employed, but as soon as full speed is attained the connections are changed over to the previous arrangement. Another advantage of this arrangement is the fact that, should the motor become overloaded, it will in many cases, instead of coming to rest, continue to run at a speed corresponding to the number of poles of the main motor.

In conclusion, it should be remembered that much better power factors could have been attained if the machine had been wound for a lower periodicity, as the leakage, especially in the main motor, could then have been made much less. As it is often advantageous for many reasons to employ three-phase current in ironworks, it is quite possible that motors of this kind, having as many as five different speeds without any regulating resistance losses, may come into general use.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

675. Describe in detail, with sketches, how an X-ray apparatus in use in a hospital, and at present worked by accumulators, may be worked from the supply main, which supplies alternate current at 110 volts, 76 periods.—X-RAYS.

676. Give a description of what you consider the best modern synchronising device for three-phase circuits.—E. S. C.

### ANSWERS.

*Question No.* 667.—State clearly the advantages of three-phase working over single phase, both as regards transmission and generation, and also motor use.

*Answer to No.* 667 (*awarded* 10*s.*).—To treat matters in correct sequence we must first deal with

*Generation.*—As far as the alternators are concerned, the advantage is largely on the side of the three-phase plant with all modern types of machines. With the old disc type—Mordey, Ferranti, Siemens, etc.—this is not the case, these being *par excellence* single-phasers; but though this type is not quite extinct, yet it is so out of date nowadays that it may be ignored. Figs. 1 and 2 show diagrammatically a portion of the armature and winding of a modern type (revolving field) alternator as used for single phase and for three-phase working, the carcase being

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identical in the two figures. Owing to the necessity for each loop of the armature winding of the single-phaser to embrace a maximum number of lines of flux simultaneously with every other loop, it is very clear that certain of the slots on the armature are useless In Fig. 1 two slots out of every six are shown empty, the proportion of empty slots varying from one-third to one-half the total number of slots on the armature. In the three-phase machine, as shown in the diagram, all slots are of use, since the maximum voltage of the three phases occurs in succession, while it will also be seen that the end connections of the three-phase winding are shorter than on the single-phase. It, therefore, is the case that the three-phase winding will give an output considerably greater—35 to 50 per cent.—than will the single-phase winding in the same carcase; but this is not all clear gain, since the three-phaser requires

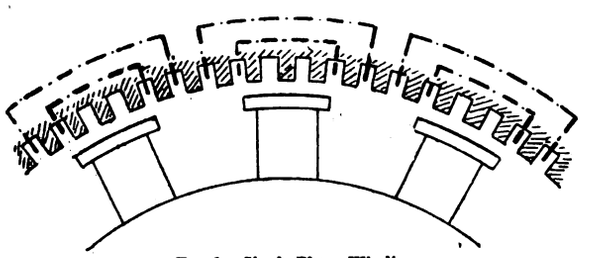

FIG. 1.—Single-Phase Winding.

an additional amount of copper to give the increased output, while the vacant slots on the single-phaser, by acting as ventilating ducts, help to dissipate the heat, and allow the copper to be run at a higher current density. On the other hand, the armature reaction of the single-phaser is considerably worse, since it is intermittent, having a frequency twice that of the alternator, and hence produces a pulsating flux in the field system, necessitating the use of well-laminated pole pieces, and incurring some hysteretic loss in the magnet wheel itself. The armature reaction of the three-phaser being due to the sum of the three phases is much more nearly constant, and hence it is only necessary to laminate the pole-shoes in this case. When all these points are taken into account it will be found that the three-phase machine is about 20 per cent. lighter, and 12½ to 15 per cent. cheaper than the single-phase machine of the same output. But the single-phase system scores heavily in the switchboard, as it will be worked with one terminal earthed permanently and connected directly to the earthed 'bus bar, so that the board proper will have but one live

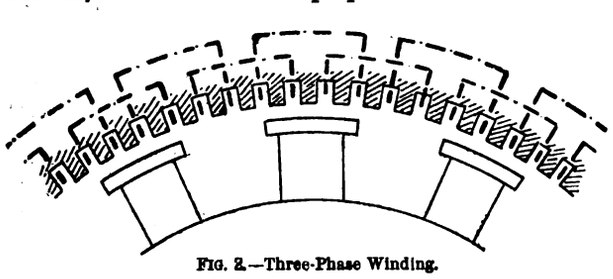

FIG. 2.—Three-Phase Winding.

'bus bar, and all instruments, switches, fuses, etc., will be single-pole. The three-phase board will either be entirely unearthed or else will be earthed at the neutral point, so in either case will have three live 'bus bars with triple-pole switches and fuses, probably three ammeters on each panel, and with a complicated mass of connections which are bound to cross one another considerably, and which must be all carefully insulated from one another. Hence the single-phase switchboard will probably cost but 60 to 70 per cent. of the equally elaborate three-phase board. As regards auxiliary gear in the station, the three-phase plant has the advantage, as economiser and stoker motors, circulating pump motors, etc., may be three-phase machines, and other than the direct-coupled exciters, there will be no need for continuous current in the station. On the single-phase systems in all probability either a continuous-current auxiliary set will be put down, or else the stokers and circulating pumps (if any) will be steam driven, since single-phase motors are not very suitable for work such as this, as is dwelt on below. All things considered, the three-phase station will probably come out slightly the cheaper in all cases except where the station is but small, with an elaborate switchboard, or where there is so little power likely to be picked up that disc type alternators my be used.

*Transmission.*—Here we must consider separately high-pressure overhead transmission, high-pressure underground, and low-pressure underground transmission, as the three cases differ considerably.

*High-Pressure Overhead.*—Here the limiting factor is ultimately the allowable pressure between the wires, this being, of course, dependent on the distance of transmission and the allowable loss in the line. The pressure between line and earth is not so vital a matter, and it is usually found advisable *not* to earth any part of the system, in order that an accidental earth shall not form a short-circuit straight away. At equal voltage between lines—say, 10,000 volts on the single-phase and three-phase systems—we will have the comparison as follows. On the three-phase system three ·05 square inch wires at 1,000 amperes per square inch, or 50 amperes each, will convey $\frac{10{,}000 \times 50 \times 1{\cdot}732}{1{,}000} = 866$ kilovolt-amperes. To convey this amount of power single-phase will need two wires each ·0866 square inch—*i.e.*, the relative weight of wire on the two systems is, three phase, 15; single phase, 17·32; or 15 per cent. more copper wanted on the single phase transmission. But the comparison is not quite fair, since the current density being the same, the power lost will be proportional to the weight of copper, and the single-phase transmission will have a greater drop. To equalise matters we must lower the current density on the single-phase transmission to 866 amperes per square inch, increasing the wires to ·10 square inch each, and we will then have equal $C^2R$ loss in transmission to the three-phase system with three ·05 wires—*i.e.*, our comparison of weight is three phase, 15; single phase, 20; or 33 per cent. more copper wanted. There is a small saving on the poles with single-phase transmission, since only two wires and insulators have to be carried by each; but this is quite a minor matter. More important is the point that three-phase transformers are more expensive than single-phase, and that transforming up and down is therefore more costly on the former. But on long-distance transmission it is copper that is the very costly item, this quite outweighing any other advantages that the single-phase system may possess.

*High Tension Underground.*—In this case it is insulation and manufacture of the cable that makes its cost, the copper, especially in small sectional sizes, being a very small part of the cost; and here single-phase transmission shows up much better than in the last case, for with a single-phase we will certainly earth one pole, and we may therefore use a concentric cable, the inner core being well insulated, but the outer very lightly. With the three-phase system we may earth the neutral point, but in either case all three conductors of our three-core cable are alive and need adequate insulation. As seen above, for equal loss in cables we will need a three-core, ·05 square inch, 10,000-volt cable for three-phase transmission, or a double concentric, ·10 square inch, 10,000-volt cable for single-phase. The latter will have a dielectric thickness of ·38in. round the inner conductor, and of ·09in. round the (earthed) outer. The three-core cable will have a dielectric thickness of ·19in. round each core, and then after the three are assembled, a further thickness of ·19in. if the system is unearthed, or 09 if the neutral point is earthed. Figs. 3 and 4 show (full size) the section of the single-phase and three-phase cables, for comparison the dimensions marked being in each case the diameter. The three-phase cable, be it noted, is for use with the neutral point earthed. It is seen from these that the single-phase cable is the smaller of the two over the outer insulation (1·38in. to 1·56in diameter). Further, the concentric construction makes so much more compact a cable that the lead sheath may be ·125in. thick, while with the three-core cable, owing to the large amount of packing contained, the sheath must be ·15in., so that the dimensions over the lead are respectively 1·65in. and 1·86in. The finishing of the cable is not shown. The single-phase may be laid solid, as it is (save for a jute wrapping) or may be steel-

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tape armoured and buried in the ground direct, since the earthed outer conductor amply protects it from danger of leakage. The three-phase cable, on the other hand, is not considered safe by the Board of Trade with only a lead sheathing, but must either have a sheath of copper wires or strips (usually laid on under the lead) or else must be steel armoured, and great care taken to make the steel armour continuous electrically through all joint-boxes, while it is highly advisable that it should be laid solid, and not merely buried or drawn into pipes unless the latter are of iron. The result is that the single-phase cable, in spite of having more copper in it, is as cheap as the three-phase cable in the larger sizes, and cheaper in smaller sizes of conductor when both are laid on the solid system, while if the single-phase cables are buried direct in the ground, they become the cheaper in all sizes. In this connection it may be noted that the Metropolitan Electric Supply Company in their transmission scheme from Willesden to Central London use two-phase generating plant, but transmit the two phases each by a concentric cable with outer earthed.

*Low-Tension Underground Distribution.*—In this case the voltage of transmission is fixed by that of the lamps or motors, and we may assume it to be 200 volts, as being suitable for lighting. Also, on the three-phase system, our lamps may be either across the corners of the triangle—*i.e.*, between two line wires—or between one line wire and the neutral conductor. These two methods may fairly be contrasted with single-phase lighting on the two-wire and on the three-wire systems. Firstly, with lamps at 200 volts directly on the lines, the case is the same as before, and as here it is *drop* that must be considered, we come back to the old conclusion, that a single-phase ·10 cable is equivalent

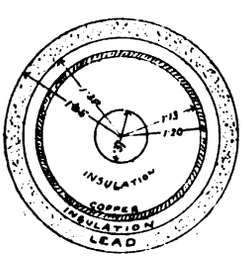


FIG 3.—Single-Phase Cable, ·10 sq. in.

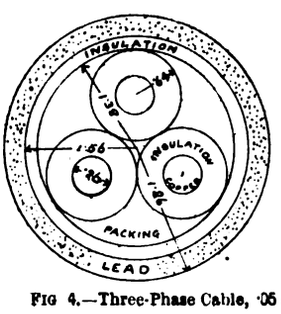


FIG 4.—Three-Phase Cable, ·05 sq. in.

to a three-phase ·05 cable—*i.e.*, we save 33 per cent. of the copper on the three-phase distribution system. But three-phase transformers are more expensive and more bulky than single-phase, so that there is not a great deal of saving to be made by adopting the former system Indeed, it will probably be found advantageous, if a three-phase high-pressure, 2,000-volt station is put down, to instal single-phase transformers and distribute at low pressure by concentric cables, keeping the phases entirely apart, except to power consumers, putting down transformer pillars, each with one single-phase transformer, fairly frequently, so as to keep the distributors small.

If we think of using a four-wire three-phase system with 200 volts between the neutral and each outer, we will have 346 volts on the outers. This may fairly be compared with three-wire single-phase distribution with 400 volts on the outers, the balancing being about equally troublesome on either case. With either system it is clear that the sum of the currents in the outers measures the number of lamps we can instal (six 8-c.p. 200-volt lamps per ampere), while the drop at the lamp terminals is that due to one line only. Hence if the outers are ·10, ·10, and ·10 in the three-phase cable, they may be ·15 and ·15 in the single-phase cable with equally satisfactory results, and it is only in the neutral wire (·05 in the three-phase cable and ·075 in the single-phase) that there is any saving in the former system. But this is more than made up by the easier manufacture of the triple-concentric cable over the four-core, so the single-phase cables will undoubtedly be the cheaper of the two, the difference of pressure—400-volt single-phase and 346 three-phase—being too little to affect appreciably the cost of insulation.

The three-phase system necessitates (unless a neutral high-tension wire is used) at each sub-station a three-phase transformer with the neutral point brought out, or else three single-phase transformers. The single-phase system needs one transformer, with the central point of the winding brought out. Each system is equally self-regulating. Thus, as far as lighting only is concerned, a single-phase distribution system is certainly the more economical.

*Motor Use.*—This is where the three-phase system stands pre-eminent. The three-phase induction motor is a thoroughly satisfactory article, and if with wound rotor and slip-rings can start up against 2½ times against full-load torque, the starting gear being simply a rheostat; or it may have a squirrel-cage rotor, and even then, by means of an auto transformer starter, it can start against full load with not more than 25 per cent. over its full-load current drawn from the power supply. Though better as a constant-speed motor, yet the three-phase motor gives satisfactory results on cranes if given a judicious slip, while makers have no hesitation in putting it forward for hauling gears and similar purposes where it has repeatedly to start up very heavily loaded.

The single-phase motor has now reached a considerable stage of development, and in some towns is used to a very large extent, but, like the gas-engine, it is usually started up on a loose pulley, and the load not put on until full speed is obtained. The trouble is this: that a single-phase current applied to the stator of an induction motor produces an oscillatory flux and not a rotatory one, and hence gives no torque whatever on the rotor. The resulting torque when running is due to the rotor currents and the rotating flux that they, in conjunction with the stator flux, produce; but a single-phase motor having no auxiliary starting winding will run equally well in either direction, if given a start by hand or similar means. To get a starting torque on a single-phase motor the stator is given an auxiliary winding, which is connected at the time of starting to the supply through a choking coil, which creates a great lag of phase in the current in this winding. thus giving to the motor what is virtually a two-phase supply, the phases being 30deg. or 45deg. apart, and this gives sufficient rotating flux to star up the motor if it is but lightly loaded. The motor suffers in its making from the same defect as the single-phase generator—*i.e.*, the full armature surface cannot be used for its main winding. The vacant slots are wound by the starting coils, but these are cut out, and are idle while the machine is running at full speed. It is easy to see, therefore, that the single-phase motor is costly, and with its starting gear it will cost not less than 50 per cent. more than the three-phase induction motor of the same output and speed, the three-phase motor being, as above stated, so much more serviceable, as well as so much cheaper. Single-phase synchronous motors—*i.e.*, generators used as motors—besides being more costly, and less easy to start than three-phase motors of the same type, have much greater liability to fall out of step, and are but little used. Single-phase rotary converters also are very little used, saving only in very small sizes. They are very considerably more expensive than three-phase rotary converters of the same capacity—about 23 per cent.—and are liable to overheat in certain sections of the armature.

For the above reasons, no one dreams nowadays of putting down a single-phase alternating plant for general power distribution, but for railway use a great number of engineers are experimenting with single-phase motors with a view to their use, as the simplicity of the single overhead wire here far outweighs the extra cost of these motors. The single-phase railway motor, when it comes, will be very different from the induction motor, and as it is likely to be useful only on periodicities of not more than 25 ⌒, its use, except for traction and special work, seems likely to be very small.—E. C.

*Answer to No.* 667 (*awarded* 10*s.*).—It is now generally recognised that three-phase working is preferable to single-phase, and one now finds three-phase plant installed in places where a few years ago single-phase plant would have been put down. In these cases the area of supply is large and scattered, and the demand at first is not very great. Among these instances may be mentioned the towns of Erith and Rugby, where the generating plant is three-phase

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in each case, the latter town generating current at 2,300 volts 50 periods, and the transmission being by three-core high-tension cables to transformer sub-stations, where the distribution is at 220 volts. In considering the supply of a town, the future requirements—especially for power—should be given careful consideration, and the matter then becomes a question of three-phase or continuous current. If the supply is at first scattered over a large area, the three-phase plant will meet the requirements, and if continuous-current is required later, this may readily be obtained by rotary converters or motor-generators. We will consider the advantages of three-phase working over single-phase under three heads—viz.: (1) transmission; (2) generation; and (3) motor use.

1. *Transmission.*—It has been claimed that by the adoption of polyphase systems, as compared with single-phase systems, there is effected a saving in the total weight of copper needed for the transmission of power to a given distance. In comparing these systems we have two cases to consider—viz.: (1) the maximum voltage between any point of the transmission line and earth, and (2) the maximum voltage between any two lines. If we take case (1) for the basis of comparison, then there is no saving in copper by the use of three-phase over single-phase current; for each line of *any* system, carrying a certain current at the maximum allowable potential above the earth, may be considered as transmitting a certain amount of power, and, therefore, the total power is simply proportional to the number of line wires, to which the total weight of copper is also proportional. If, however, the system be compared by the maximum voltage between the lines, thereby equating the risks of breakdown of the apparatus, etc., instead of the risks of breakdown of the lines, there is a decided economy of copper by the employment of three-phase currents. Consider an installation with the $\Delta$ connections and the load symmetrically distributed. The current, $c$, in one "leg" of the $\Delta$ will be $\frac{1}{\sqrt{3}}$ of the current, C, in the line. The power absorbed in one leg will be $\frac{1}{\sqrt{3}}$ C V, where V is the voltage between the lines (C and V being the R.M.S. values of the current and voltage respectively). The total power is therefore $\sqrt{3}$ C V, which will be the same if Y connections are employed. If the resistance of one line be $r$, then the total loss of power in the lines is $3\,C^2 r$. Now consider a single-phase system to transmit the same amount of power at the same voltage between the lines. The current will be $\sqrt{3}$ C, and if $r_1$ be the resistance of one line such that there shall the same loss as before, then $6\,C^2 r_1 = 3\,C^2 r$, or $r_1 = \frac{1}{2} r$. Thus the single-phase system requires two wires, each of double cross-section, as against the three wires of the three-phase system. The weight of copper required on a three-phase transmission is thus only 75 per cent. of that required by a single-phase transmission. The above has been worked out for a high-tension transmission. Considering a low-tension distribution for incandescent lamps, if the latter are connected up in $\Delta$, the three-phase system has the advantage of requiring only 75 per cent. of the copper required by a single-phase system. If the lamps are connected in Y fashion, then the three-phase system requires only one-fourth of the copper required by a single-phase system with two wires, but such a system would require a fourth wire from the common junction of the phases for regulating purposes, and thus becomes comparable to a three-wire rather than a two-wire single-phase system. Mr. Görges has given the following data for the weight of copper required in cables for equal power drop and voltage: for single phase, two wires, 100; single phase, three wires (assuming the third wire half the section of the others), 31·2; two phase, four wires, 100; two phase, three wires (reckoning the voltage between lines and common return), 72·8; three phase, three wires ($\Delta$ connection), 75; three phase, four wires (Y connection, neutral wire from common junction of phases), 29·2.

2. *Generation.* — Single-phase generators are far less economical with respect to first cost and operation than three-phase machines of the same output, the former also being much less satisfactory in efficiency and regulation than the latter. The inferiority of the single-phase generator is strikingly illustrated by Mr. M. B. Field in a paper read before the Institution of Electrical Engineers in 1901 (vol. xxxi.), from which Table I. is taken. The table gives the prices quoted by three different firms for three-phase and single-phase generators to comply with the following specification: output, 2,500 kw.; voltage, 6,500 volts; efficiency full load, 96 per cent.; efficiency three-quarter load, 95 per cent.; efficiency half load, 93 per cent.; speed, 75 revolutions per minute; cycles, 25. Fall of pressure between full load and no load, at constant speed and excitation, and unity power factor, to be not more than 7 per cent. It may also be said that it is the practice of experienced manufacturers to rate a generator of given design and weight, when specially arranged for single-phase working, at about 65 to 70 per cent. of its rating as a polyphase generator.

TABLE I.

| — | Three phase | | Single phase | |
|---|---|---|---|---|
| | Weight in tons. | Cost. | Weight in tons. | Cost. |
| 1 | 123 | £6,000 | 184 | £8 900 |
| 2 | 120 | 5,400 | 140 | 6,200 |
| 3 | 110 | 4,600 | 125 | 5,200 |

3. *Motor Use.*—Single-phase motors, unless for locomotive purposes, are invariably undesirable. The apparently hopeless inferiority of the single-phase induction motor is now becoming a matter of practical experience, and these motors cannot compare with a three-phase motor with respect to no-load current, power factor, overload capacity, and starting torque. There is, however, good reason to believe that, with very low frequencies (25 ~ and under) the ordinary series-wound commutator motor, designed with very low reactance voltage per segment and laminated magnetic circuit, will become not only practicable, but in many cases preferable to polyphase motors, where variable speed is required, since this can be obtained by transformer devices. But this cannot come into general use unless very much lower frequencies are adopted. Thus, such a system of transmission would only be of use for a motor load, and lighting would have to be carried out by an independent circuit.

Coming now to three-phase induction motors, we find that these motors can commercially be built with high efficiency, good starting torque and power factor, and will stand a considerable overload. It should be pointed out that the lower the frequency and the higher the speed, the better the motor. The high-speed, low-frequency, induction motor may economically be so designed as to be characterised by high power factor, low current when running light, high overload capacity, and greater economy of material and labour in construction. That the slow-speed induction motor is very inferior is strikingly brought out in the 150-h.p., 36-pole, 68 revolutions per minute, 21-cycle, 350-volt, three-phase motor direct coupled to a mining pump, described in the *Electrical Review* for June 26, 1903. In spite of its great size (the diameter of the rotor being 9ft 7in., and the air-gap 0·071in.) and large output, the maximum efficiency is but 88 per cent, and power factor at full, half, and quarter load respectively is 88, 80, and 60 per cent. Running light the motor input is 32 per cent. of its full load current and the no-load power factor is 15 per cent. The motor is of good design, but cannot, however, compare in cost or economy with a good continuous-current motor of the same rating.

The ideal construction for a three-phase motor is the so-called "squirrel cage" type, thereby dispensing with all rubbing contacts. This form of construction has, however, one great disadvantage in that squirrel-cage motors have very little starting torque, and, nevertheless, consume a large current at starting. The "specific" starting torque—*i.e.*, the torque per ampere—may be increased by making the short-circuiting rings in the rotor of brass instead of copper, but this slightly injures the efficiency of the motor. Wherever possible, the motor should be arranged so that it can be started up without load, thus enabling a squirrel-cage construction to be employed, which is infinitely superior in first cost, maintenance, etc., than one with a wound rotor and slip-rings. The line may be relieved of

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the excessive current at starting by means of a compensator or "auto-transformer," which is an arrangement whereby the motor can be supplied with reduced line voltage at starting. Table II., taken from Oudin's "Standard Polyphase Apparatus and Systems," illustrates this case.

TABLE II.—Values of Starting Torque for Squirrel-Cage Motors.

| Voltage at motor in per cent. of line voltage. | Line starting current in per cent. of full load current. | Motor-starting current in per cent. of full load current. | Starting torque of motor in per cent. of full load running torque. |
|---|---|---|---|
| 40 | 112 | 280 | 32 |
| 80 | 250 | 420 | 72 |
| 60 | 450 | 560 | 128 |
| 100 | 700 | 700 | 200 |

Compensators may be used for medium and large size motors, and are used in conjunction with squirrel-cage motors of over 200 h.p. For smaller sizes a special change-over switch may be used, which changes the connections from Y at starting to Δ for ordinary running. An analogous arrangement for two-phase motors consists in having each phase of the stator wound in two circuits, which, when running, are in parallel, but are connected in series at starting by a special change-over switch. With single-phase motors two windings are required on the stator, one a starting winding and the other a running winding, an arrangement being required at starting for splitting the phase, which consists in general of a switch which, when in the starting position, connects the windings in parallel across the line with a non-inductive resistance in one branch and a reactance in the other. When running the main winding is connected straight on the line.—MONOPHASE.

*Answer to No.* 667 (*awarded 7s. 6d.*).—As special cases would have most likely special features, the writer will deal with the question from the general case of central-station distribution, and, as is the case in most large stations, he will assume a tramway traction load. In dealing with this question let us start at the central station and follow the course of the current on its way to the consumer.

The engines being the same whatever system of current is adopted, the generators are first considered. A single-phase armature is only generally wound on two-thirds of its surface, whilst in three-phase the whole surface is utilised. Consequently for the addition of armature copper for one phase, the output of practically the same machine is increased 50 per cent. Looked at from the point of a given output, it is found the three-phase machine would be both lighter and cheaper. The following is an example: Generators—2,500 kw., 6,500 volts, 75 revolutions, 25 ⁓, three phase, £5,360; weight, 92 tons. Single phase, £6,080; weight, 105 tons. These are both by the same maker and are so comparative. Further, the power factor of three-phase motors is higher than single-phase, and this means a slightly greater output for a three-phase alternator. If the use of three-phase rotaries is considered, this point can be further improved, as they can be made even to cause the current to lead. Regulation of three-phase generators presents no further difficulty than single-phase. Should it be desired, however, to take special care of the lighting load, this can be done by putting it on one phase and regulating for that, leaving the other phases, which would affect only arc lamps and motors, to look after themselves. This would not be detrimental to the arc lamps and motors, as the difference in voltage would only be slight. This would put the regulation on a par with single-phase, but as three-phase motors have been found to not affect the lamps detrimentally, such an arrangement is not warranted.

Turning now to the switchboard, the complication is sometimes complained of to be over-rated. It is certainly more complicated than single-phase, especially if the single-phase is run with an earthed outer, for there are three small switches against one large one. This, of course, means a more costly board for three-phase, but also, what is sometimes of more consequence, it occupies a much greater space. But taking the question as a whole, the difference in expense in the switchboard is found to be very slight, especially the larger the system gets. In a large system the switchboard will only represent one-fifth of the value of the cables, and, as will be seen when the writer comes to cables, the three-phase system has there a great advantage. This includes sub-station switchgear also.

Regarding cables, and the effect of three-phase distributing, a continuous-current analogy may be used. Three-phase distribution may be said to have done for alternating-current work what three-wire distribution did on low-tension continuous-current distribution—viz., raised the pressure of supply, increased the output, and thus save expense. For a given weight of copper three-phase distribution gives us maximum power with minimum strain on the insulation; or for a given power the voltage above any given point is a minimum in three-phase cables. With the same weight of copper and the pressure per leg same as the single-phase pressure, there is obtained 1·73 times the power transmitted. The cost of the three-phase cable would, however, exceed the cost of the single-phase. Coming to laying of the cables, the cost would be found to be very little more for the three-phase, and because of the power transmitted being 1·73 times the other relatively much cheaper. It might be as well to point out here that the sum of the currents flowing is always a constant (if the three phases are balanced), whilst in single-phase it varies from zero to a maximum and back again to zero. This would lead us to infer more efficient use of the copper in three-phase mains than in single-phase.

Coming to the transformers, there is not much to be said. If the three-leg type of transformer be used a slight advantage accrues to three-phase as regards cost, and there is practically no difference in other respects. Should, however, single-phase transformers be used for each phase to reduce spares, then the advantage in cost would lie with the single-phase, in consequence of using larger transformers for a given load.

The low-tension network gives no advantage to either system—in fact, it would be possible to place three-phase at a disadvantage by complication. As both systems would use the three-wire method of distribution, and the voltage would be up to the Board of Trade limit, it will be seen that they are on all fours.

Coming to motors (and with them are included motor-generators and rotaries), the advantage is found to lie wholly with three-phase machines. Single-phase rotaries are out of the question, and no comparison can be made in this respect. It might be mentioned, however, that a three-phase rotary, together with its transformers, costs about the same as a three-phase motor-generator, not using transformers, and these are both cheaper and more efficient than single-phase motor-generators, as per the following example of a 500-kw. motor-generator (single and three phase): one-phase—efficiency at full load, 88½ per cent.; three-quarter load, 87¼ per cent.; half load, 84¼ per cent.; price, £3,000. Three-phase—efficiency at full load, 89½ per cent.; three-quarter load, 88¼ per cent.; half load, 85¼ per cent.; price, £2,350. Smaller motors as used by customers show better power factors and efficiencies for three-phase than single-phase. Polyphase motors have a more uniform torque, are cheaper for a given output, and as regards starting against load the advantage is all on their side. Even the latest single-phase motors that start against load have to use three-phase starting resistances, and then, of course, there is very little between them when we consider the extra wiring for three-phase.

The writer thinks the above will be found to justly sum up the benefits or otherwise of three-phase over single-phase as fully as space will permit.—W. W.

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**"N" Rays.**—Further information on these rays has recently been contributed to the Académie des Sciences in Paris by M. Blondlot, and also by M. Augustin Charpentier. The latter contributor's investigations have been chiefly directed to the physiological action of the rays. It has been proved that when acting on the brain they increase the apparent brightness of objects, and that they also stimulate much in the same way the senses of taste and smell. It is also stated that M. Charpentier has now discovered some newer rays, which he calls "$N_1$" rays, which have the inverse effect, in that they reduce the activity of the organs of sight, smell, and taste.

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THE

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## THE N.E.R. ELECTRIFICATION.

On Tuesday last an electric service of trains was officially inaugurated over a small portion of the suburban lines near Newcastle-on-Tyne of the North-Eastern Railway Company. The section in question is that from Newcastle to Benton, which is only a small portion of the thirty-seven miles of track which the company are electrifying. The first train was started out of Newcastle by Viscount Ridley, who was accompanied by a number of prominent engineers and business men. Immediately after this first train had returned to Newcastle the public service was opened, and was much appreciated. At present three-coach trains will be used for the service to Benton, and these will accommodate one hundred and eighty-six passengers. The service will be at regular intervals of a quarter of an hour. It is not, however, until the electrical trains are run to Whitley and Tynemouth that the full benefit of the conversion will be enjoyed by the public. It is then proposed to reduce the time taken by the stopping trains from thirty-five minutes as at present to twenty-three minutes for the journey of eight miles from Newcastle to Tynemouth. The express trains will do the distance in fifteen minutes. The figures then obtained as to traffic, cost of working, etc., will be the more interesting from the fact that the railway company will be in direct competition with an electric tramway. By a recent decision in Parliament, the Tyneside Tramway Company are to have running powers over the lines of the Corporation of Newcastle, so that the tramway undertaking will have the advantage of picking up and dropping passengers anywhere *en route*. It is this facility which will have to be balanced against the quicker scheduled time on the electrified railway. The conditions are such as to thoroughly justify the step taken by the North-Eastern Railway Company in electrifying their line, and we trust that with the keen competition there will be such an increase in the number of passengers carried as will make both the undertakings profitable.

## STANDARD SCREW THREADS.

The vital importance to engineers of a standard series of screw threads was recognised by the late Sir Joseph Whitworth, and his able efforts to this end were most successful. The Whitworth screws are now used in all large engineering establishments in this country, and many Continental firms have also adopted them. The British Association for the Promotion of Science has for years had a committee dealing with the design and standardisation of smaller screw threads, but in this department uniformity in practice is yet to be obtained. It was in consequence of this, and of the wide variations of pitch in the Whitworth and other threads, that the Engineering Standards Committee appointed a sub-committee on "Screw Threads and Limit Gauges," with Mr. H. F. Donaldson as chairman. A large amount of information on the subject has been collected, and this is to be supplemented at a conference to be held at the Institution of Civil Engineers on the 19th and 20th inst. To this all the leading mechanical engineers of the country are invited, so that evidence may be obtained not only from users of screws and their makers, but also the makers of tools for making and gauging screws. The chief questions to be considered are: (1) whether the present Whitworth and B.A. screws are sufficient for all practical purposes; (2) the interchangeability of screws; (3) the angle, pitch, thread form, etc., of screws; (4) systems of gauging screws. Evidence will also be taken as to whether it would be feasible to lay down a series of standard limits for various classes of work, and if so, what these limits should be. The question as to whether the

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male or female gauge should be taken as a basis for standardisation will also be discussed. The committee are particularly desirous that the conference should be as representative as possible, and include representatives of all classes of mechanical engineering. Those willing to give evidence should communicate with the secretary of the committee, Mr. Leslie S. Robertson, at 28, Victoria-street, S.W., who will send on application a list of questions which will serve as a guide as to the information needed. This conference will, we trust, be well attended, so that it may serve a double purpose. In the first place, it will enable all concerned to express their views, and to state their practical experience on the subject. Secondly, by interesting a large number of engineers, the conclusions of the committee will become more widely known and more quickly adopted. It is only by this latter means that good can result from the labour of the committee in fixing standard screw threads and limit gauges.

## THE "REVIEW" AND OURSELVES ON MUNICIPAL TELEPHONY.

We are glad of this opportunity of saying a few more words on municipal telephony and the *Electrical Review* We are sorry for the *Review*. In its last issue it devotes two separate articles to the consideration of our recent remarks, which proves, if proof were wanting, that we got fairly home. The *Review* in neither of its articles has attempted a real answer to our various points, but has dealt at some length with two remarks given in the concluding portion of our articles. Its leader demurs to the statement :

> "Now, finally, these remarks about Glasgow and other "telephony have been written because those interesting "themselves in municipal telephony complain that they "are not receiving fair play."

We followed with : "We do not hold with that view," and yet the *Review*, in a rather high-falutin' manner, says we allege "that those interesting themselves in municipal telephony are not receiving fair play." Well, we will really allege something, and that is that in its haste to the battle of words the *Review* does not read what is said, and so totally misrepresents the case.

The second point dealt with by the *Review* in both leader and article is our statement:

> "The secondary question, whether the criticisms against "the engineer's estimates and work are correct," etc.

Just previously we said, "it is in the interest of truth that both sides of a question be considered," and qualified it only by intimating that an attack upon an estimate was not an attack upon a principle. It seemed to us then, as it seems to us now, that the *Review* has all along been concerned about a detail, which, however important to discuss, is very far from being vital, even if germane to the real question at issue. The two articles of the *Review* deal (1) with fair play and (2) with Mr. Bennett's estimate, and in neither of which have we hitherto been concerned. With regard to (1), the *Review* can take any side it pleases. If it considers only one side, and arrogates to itself the posing as "truthful James," it must expect to be called unfair, and, in fact, is unfair if it pretends it is seeking the truth. It does not matter a pin to us whether a paper takes up the pro- or anti-municipal position, but it does matter when it pretends to discuss disinterestedly and yet arguing, like a retained advocate, for one side. With regard to (2), we are in a somewhat difficult position. If we have never assented to or upheld an estimate, and only said "Neither his estimates nor his work have been criticised," we can hardly say whether we agree with a real criticism of the estimates or the work or not! As we understand an estimate, it is prepared for certain work on certain lines. Mr. Bennett, we believe, prepared such an estimate for an inquiry. Subsequently Mr. Bennett was engaged to carry out the work, the lines of which differed considerably from those of the estimate. He has been damned through thick and thin by the *Review* for the original estimate, which they apply to the work actually carried out. Did Mr. Bennett originally estimate for the actual work as determined upon? Did he tell his employers that a different scheme would have a different cost, or did he go on with the work without suggesting any variation in the estimate? We cannot answer such questions. All we know is that the original scheme was modified, and our knowledge of engineering work leads us to the conclusion that the estimate would be modified also.

Mr. Bennett alone can explain these matters. If he holds to the original estimate, he it is who must justify it, not we. All we do is to say that a correct or incorrect estimate does not assist or condemn the principles upon which the men who advocate municipalisation depend. Coming to close quarters.

1. What system did Mr. Bennett advocate in 1897?
2. Is his opinion of that system the same now as then?
3. Was the system carried into effect?
4. If not, what modifications were introduced?
5. Did these modifications increase or decrease the cost?
6. Is two years time enough for such a telephone system as that at Glasgow to reach normality?
7. If not, what will be the effect, given further time, upon cost per line or cost per instrument?
8. Is the borrowing of more money the result of success or failure; or, better,
9. Does the result of seeking further borrowing powers point to the conclusion that careful investigation led to belief in success or failure?

It would be interesting to know exactly what the *Review* means when speaking of expenditure. Is a telephone engineer to be limited to an exact sum for expenditure? If the demand for instruments continues, is he to be restricted from getting more money to meet that demand? The *Review's* argument on these points is peculiar. In a flourishing and expanding concern, why should the end of capital expenditure be in sight? Probably these writers will suggest that all extensions should be made out of revenue. They luxuriate now in criticising the Glasgow undertaking, *assuming* without a shadow of reason that normal conditions have been reached in two years. If this assumption is not correct, all their talk is in vain; and if the sixth-year result at Guernsey be taken as a sample of what Mr. Bennett undertakes, he may well say, Wait awhile, time will show who is the more correct. The *Review* knows or ought to know that a large part of the expenditure at Glasgow unproductive at the end of two years will not be so at the end of three years, and that the average cost per line, or per instrument, or per whatever unit you like to calculate by, is a decreasing quantity till the normal be reached; hence its argument that $x$ pounds have been expended bringing in less than the estimated percentage of revenue has no force whatever. The percentage revenue will increase as the capital expended becomes productive. Whether that percentage will reach the figures estimated is another matter; our point is that the normal is not reached, and before usefully discussing figures based upon that condition of affairs we must wait for the time to arrive. We have no wish to labour the tactics of the *Review* further except to say that the reason why municipalities entered into telephonic work was, they thought private enterprise charged too much for a bad service; that private enterprise presumed upon having a practical monopoly, and treated its customers accordingly. As a matter of fact—which cannot be disputed—the action of the municipalities has resulted in a diminution of the charges and a better service. Mr. Bennett's estimates only came in after conviction upon the point mentioned, and those estimates, be they right or wrong, went to show that the opinion had a solid foundation. Mr. Bennett has proved his case at Guernsey, and, if we understand his attitude with regard to other places, merely says, Wait and see. We are absolutely at one with the *Review* as to the value of criticism, only differing upon the point that the opposition case should be fairly put when attempting to prove it wrong.

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## ECONOMY IN ELECTRIC MAINS.

BY B. C. H. J.

The fact that the mains item is about one-half the total cost of an electricity supply scheme of the usual type has led to the design of many devices with the object of decreasing the prime cost of distribution; but as a general thing the saving achieved by the use of cheaper materials, etc., has not been sufficient to compensate for the cost of special supervision and skilled labour, nor to provide for meeting the increased cost of failure incurred. Nevertheless, the designing of such systems is still going on, and the following notes upon the matter may possibly save some people from wasting their time in the search for the (at present market rates) practically unattainable.

The superior economy of the projects that are put forward to solve this problem are generally based upon one or more of the following points:

Conductors of bare copper or aluminium strip or heavy gauge wire, used to save cost of stranding.

Insulation composed of either air, porcelain, bitumen, treated wood, etc., used in conjunction with the conductor when laying or erecting, to save dearer insulating materials and workshop processes.

Protection by wood, stoneware, asphalt, concrete, etc., troughs, or formers, when laid in the ground, for a similar reason to the last.

The various components of these three classes are generally arranged in one or more of the following systems: underground, air insulated; underground, compound insulated; overhead.

With the first-named the underground culvert designs are usually based upon the old-established Crompton culvert system, with various modifications: (1) the substitution of strands, rods, or tubes for the orthodox strip conductor—the tube theory being that the current-carrying capacity may be increased by drawing into it additional copper as required; (2) insulation composed of various forms of stretchers, tubes, or hangers made of porcelain, glass, cement, or other solid insulating material; (3) the protection of earthenware, cast iron, or cement duct, or pipe, or formed of concrete. All these methods fall into line with the original conception itself, which did moderately well with the lower pressures of a few years back, but is now hardly ever laid down for the modern distribution pressures of 400 and 500 volts. The cost of laying such a system, in most cases, is more than that of insulating the same section of conductor by the usual factory methods, as trench levels must be rigidly observed and special draining arrangements made to keep the culvert from being flooded. And this is costly work.

With the second, solid-laid system, a considerable amount of designing has been done, particularly by newly-fledged mains men. The epoch-marking arrangement is generally a wood or stoneware trough with bare copper strip laid on porcelain or other insulators therein; these insulators also act as separators, the whole being filled in with a bituminous compound and covered over by bricks or planking. The great advantage that this class of main possesses is freedom from electrolytic action on the lead, because there is no lead. On paper the designs look very convincing, and in a rainless country, with Paragons for labourers, Admirable Crichtons for superintendents, and Arc-angels for material contractors, the system would make a certain headway. To anyone who knows the conditions of outside work, however, the ultimate fate of such a main laid under normal conditions is a foregone conclusion. One of these patents is worth noting, as it includes for insulating each of the conductors as it is laid in the trough with a strip of bitumen tape before pouring in the compound, which is at present the nearest approach to having a portable cable factory attached to each main-laying job.

Apart from the risk of damage of the insulating material by water in the trench and water from the heavens, and the additional precautions that would have to be taken to provide against this, the cost would be perceptibly increased by the much greater clearances required between conductors in the trough. Where ½in. is the usual clearance with insulated cables, 1in. is the very smallest measurement that could be allowed with bare copper, as the chances of kinking into a dangerous proximity to one another is more likely to be expected when hot compound is poured over the copper, with its high coefficient of expansion. A recent form of this class of main consists of an asphalt trough with asphalt bearers and spacers, and although this suffers from the same chance of accidents when laying as the remainder of the bare copper systems, the high insulating qualities of the bitumen and asphalt, which are the materials used, would give it a better chance of success than where other materials are used.

The overhead air-insulated arrangement, before mentioned, is in use in several parts of England in connection with general electricity supply, particularly where collieries supply contiguous villages for their public lighting, and also where out-of-date installations are in existence; but it is very unusual for this system to be put up in important centres or to carry heavy currents, unless as a means of temporary supply. In fact, as a cheap temporary arrangement it wants a lot of beating, and for series arc lighting on a tramway route there is nothing more suitable, as the heavy steel posts every 40 yards apart are very convenient for clamping the insulators to. Great care, however, should be taken that the wires are placed ridiculously far apart, and with an absurd thickness of insulating material and length of surface leakage between themselves and the earthed post, as there are many evil influences abroad to encompass their downfall which are undreamt of by most designers. As regards temporary supply, should a demand, for instance, spring up in a sparsely-populated suburb, which may or may not pay for a proper system of mains eventually, the extent of the demand can be felt without risking much by running a line on double-petticoat insulators clamped to ordinary scaffold poles. This can be done quickly, as trolley wire of the standard sizes is always stocked by the makers, and suitable scaffold poles are to be picked up at a pound or less apiece. This system is not recommended for more than temporary work, however, and as the demand in question is often only obtained by the promptness with which the line is put up, so it pays to pull it down (for erection as a feeler in another direction) as soon as the demand gets too heavy for its capacity, and to substitute more suitable underground mains for the permanent supply. Probably a great many engineers would have used this overhead arrangement if they were quite sure about that bogey, the Board of Trade, making no trouble, but it is certain that there is more amiable bark than bite about this estimable body, and provided that cataclysms are not caused, there is no reason to expect any interference with this class of distribution. On some country tramway routes may be seen heavy insulated feeders in festoons between the posts, with sags on them of skipping-rope dimensions. This never looks pretty, and may eventually cause trouble, but it is, of course, cheap in cost of installing.

In America a lot of very high-voltage work is carried out by overhead wires, but it is a case of necessity there owing to the distances to be traversed, which would make insulated cables prohibitive in cost. They have their troubles from lightning, tempests, tree branches, insulator failures, etc., and to minimise inconvenience from these causes duplicate circuits are usually run. Aluminium has been used as a conductor for this class of aerial work both in England and America, but it is understood that the joints have caused trouble, and that the metal in its commercial state does not stand atmospheric action as well as copper. There is little or no difference in the cost for equal conductivities, but the larger diameter of the aluminium wire offers greater risk from wind pressure, snow accumulation, etc.

To summarise, the likeliest substitute for light current work is the overhead line, but this is only to be recommended (apart from public arc lighting) for temporary erection, and for cases where no trench-making wayleaves can be obtained. And the initially greater expense of underground cables is balanced by the greater degree of permanency and reliability of the installation.

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**Scotch Private Bills.**—The Lothians Electric Power Bill and the Clyde Valley Electric Power Bill have been placed in a group which will be considered by a Select Committee of the House of Lords on Thursday, April 21.

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## MANCHESTER SECTION'S DOUBLE EVENT.

A unique multiple item of the Manchester Section's programme was carried out on the 23rd ult, when a visit was paid to the Mersey Railway in the afternoon; and in the evening the section foregathered with the Liverpool Engineering Society for the dual purpose of discussing a tea and a paper.

The journey to Liverpool was undertaken by about 100 members, who first inspected the permanent way, rolling-stock, and repair shops at Birkenhead, in the course of which a good many members unduly congratulated themselves upon the superior insulating qualities of their boots by fruitless contact experiments with the "live" rail at the inspection siding, from which rail, however, current had previously been cut off. It was further discovered, on enquiry in the cleaning shed, that the tunnel was being gradually freed from the effects of a generation of steam traffic by the motors attracting to themselves, through the ventilation clearances, all the grime and filth that had ever been deposited in the said tunnel. This process certainly saves the expense of overhauling the tunnel in the old-fashioned way. The power station was critically admired by worshippers at the various shrines (from coal conveyors to feeder cables) that stand so distinctly apart from one another in this specialistic age. The elderly and genial gentleman in the Scotch cap (Bowman), for instance, gazed long and lovingly at the Chloride battery. The tall, keen-eyed pair of brothers (Thomas's) were all over the switchboard, discussing its points with the familiarity born of long years spent in designing and selling boards to a confiding public. That fresh-coloured but sunburnt commercial engineer (Earle), who is also a kind of minor prophet, looked at the machines with an expression that plainly showed his belief in but few articles of bigotry and virtue made outside Salford.

The Liverpool Engineering Society were the hosts at the tea enjoyed at the Royal Institution, and at the meeting afterwards held in the same building, Mr. T. L. Miller, the president, cordially welcomed the visitors, expressing the hope that this first fraternisation of the two societies might not be the last.

Mr. E. COWAN, on behalf of the Manchester Section, thanked the Liverpudlians for their hospitality, and expressed appreciation of the engineering feats performed by that community.

Mr. MILLER then explained that the "Notes on the Design of Electrical Machinery" was originally written and sent by Mr. Louis J. Hunt from London with some advance luggage, but got lost; and the paper consequently had to be entirely re-written by the author within a week, and then during an illness. The president further commented on the pluck displayed therely, and so disarmed criticism on the paper.

Mr. E. THOMAS opened the discussion, Mr. E. COWAN and Mr. FRITH also spoke, but in the absence of the author of the paper (which was read by deputy) the matter lost in interest considerably, and a general exodus took place from the meeting before the proceedings officially terminated, as as it is supposed the Mancunians present were afraid of losing their train. On the whole, however, it was a very pleasant trip, and if the greater number of those present at the meeting were not experts at dynamo designing it was, of course, entirely their own fault.

## SOME NOTES ON THE COST OF GENERATING ELECTRICAL ENERGY.*

BY E J. FOX.

*(Concluded from page 421.)*

Coming to the actual working costs, I set out in Table D results obtained during 1902 by the 12 towns which have achieved the lowest working costs per unit sold, the capital charges being omitted. I also set forth in Table E the working costs in a few private power stations with a large output per unit of plant installed, arranged in the same way as the costs for the public stations in Table D, so that you can compare the one with the other. You will notice that some of the results are so vastly superior in Table E that you may be tempted to enquire whether they are not too good to be true. These costs are made up of four items which constitute the working costs, in addition to which two further items (which are, however, not touched on here)—namely, interest on capital and depreciation—should be added before the total costs can be arrived at.

*Working Costs.*—(1) Cost of fuel; (2) cost of oil, waste, water, and petty stores; (3) wages of workmen; (4) repairs.

*Capital Costs.*—(5) Interest on capital; (6) depreciation.

The type and general arrangement of plant which will give the lowest results when these six items are added together is the one that may be considered the most advantageous, and one hears too often a particular type of plant favoured because it claims great savings in one particular item, whilst other equally important items are omitted. The question which will be of most interest to you is to what extent can a small isolated plant with a good load factor hope to show better results than those obtained in larger stations, such as are enumerated in Table D. It is fairly generally conceded by those that have paid the most attention to this subject that the actual size of the plant has little to do with the cost of production. Other things being equal, a station with a large output has no doubt a better chance than a station with a small one, but a good deal more depends upon the conditions of working and the nature of the load than upon the actual kilowatt of plant installed. As an instance of this, I would ask you to glance at the results obtained at Messrs. Kynoch's works in Birmingham. You will see that the working costs in these works come out at ·343*l.* when they run during the daytime only, generating 18,400 units per week, whereas when they increase their output to 22,400 units per week and maintain a supply during the night-time, their costs come up to ·413*l.* Most public lighting and traction stations, such as are enumerated in Table D, have, as you know, very bad load factors, by which is meant the yearly output of the station in comparison with what this output would be if the maximum demand were maintained continually during the whole year instead of over a few hours per day, and then often during the winter months only, a state of affairs prevailing in many stations. As this load factor is rather a difficult figure to arrive at in the case of private power plants, I have substituted in its place a figure which represents units generated per year per kilowatt of plant installed. This latter figure gives one a better idea of the value obtained out of the whole plant, and is comparatively easy to obtain. If the figure is too low, it is obvious either that a liberal amount of spare plant is being carried or that the number of working hours are small. You will notice in Table D that the maximum yearly output per kilowatt of plant installed in public stations is 1,900, whereas the average is well under 1,000. Corresponding figures in private works are about 5 500, and the average about 4,000. This gives private power plants a considerable advantage in their capital charges per unit sold, as well as advantages in wages, repairs, and maintenance, which involve practically the same cost whether the plant is working fully loaded or not. I think the best plan of dealing with the various items would be to take them seriatim, and to ascertain in what respects private power plants have an advantage over the public supply stations.

*Cost of Fuel.*—You will notice in Table D that the cost of fuel is considerably the highest item making up the works costs in public power stations. This figure, however, is the cost of fuel per unit sold, and includes all distribution losses; consequently, it is necessarily somewhat higher than the figure corresponding with the cost of fuel in private power plants. By keeping the plant at work more hours per day and loaded more fully to its economical capacity, a set of conditions impossible in public stations, this item for fuel can undoubtedly be considerably lowered. I would ask you for a moment to glance at the 12 months' working of the municipal station at Crewe. The chief lesson to be learnt from these figures is that their coal costs have been very constant all through the 12 months, and have not gone up appreciably as one might have expected during the summer months. The reason of this is undoubtedly due to the fact that the plant at Crewe is well proportioned for dealing with the different loads which they have to contend with—in other words that, during the summer months, whatever plant is running is working as economically loaded as the larger plant during the winter months. I might point out in passing that the other items are considerably higher during the summer months than in the winter months, which is only to be expected. You will notice from Table E that several plants are producing a kilowatt on the switchboard for an expenditure of 3lb. to 4½lb. of coal, including the steam used in the auxiliary plant. I see no reason why any plant with a favourable load should exceed 3lb. to 5lb. of coal per kilowatt generated, and the aim should be to obtain this with the cheapest possible coal. Messrs. Watson's, with a load which is certainly almost an ideal one from the point of view of cheap production, have brought their figure down to 3 1/10lb. of coal, costing 5*s.* at the pit mouth, and when one or two further alterations are made in the auxiliary plant, I expect this figure will drop down to 3lb. of

* Paper read before the Cleveland Institution of Engineers at Middlesbrough.

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TABLE D.

| Town. | Kilowatts installed. | Units sold per annum. | Units sold per annum per kilowatt installed. | Load factor. | Cost per unit in pence | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Coal. | Oil, waste, water, and petty stores. | Wages. | Repairs. | Works' costs. |
| | | | | Per cent. | d. | d. | d. | d. | d. |
| 1. Bradford | 6,380 | 9,124,223 | 1,430 | 20·93 | ·26 | ·05 | ·08 | ·13 | ·52 |
| 2. Leeds | 8,740 | 4,448,650 | 508 | 12 31 | ·28 | ·03 | ·17 | ·14 | ·62 |
| 3. St. Helens | 1,340 | 1.237,965 | 920 | 17 84 | ·26 | ·03 | ·17 | ·19 | ·65 |
| 4. Edinburgh | 10,477 | 7,760 307 | 742 | 14·75 | ·34 | ·04 | ·09 | ·18 | ·65 |
| 5. Bolton | 3,700 | 3,802,598 | 1,028 | 18 87 | ·35 | ·06 | ·15 | ·10 | ·66 |
| 6. Bootle | 850 | 1,619.129 | 1,906 | 28 44 | ·41 | ·03 | ·15 | ·11 | ·70 |
| 7. Liverpool | 21,190 | 23,186 083 | 1,094 | 25·11 | ·37 | ·06 | ·15 | ·13 | ·71 |
| 8. South Shields | 1,600 | 1,148,965 | 716 | 15·82 | ·37 | ·04 | ·20 | ·15 | ·76 |
| 9. Nottingham | 5,642 | 4,094.897 | 727 | 12 97 | ·46 | ·10 | ·16 | ·09 | ·81 |
| 10. Preston | 1,920 | 1,058,709 | 550 | 13·31 | ·36 | ·06 | ·18 | ·23 | ·83 |
| 11. Farnworth | 610 | 445,912 | 730 | 14·54 | ·46 | ·10 | ·18 | ·11 | ·85 |
| 12. Leith | 990 | 946,650 | 925 | 19·79 | ·55 | ·04 | ·21 | ·09 | ·89 |

TABLE E.

| — | Units per year per kilowatt installed. | Units per week. | Lbs. coal per unit. | Cost of fuel per ton. | Costs per unit in pence. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Coal. | Oil, waste, stores, etc. | Wages. | Repairs. | Works' cost. |
| | | | | s. d. | d. | d. | d. | d. | d. |
| Watson, Linwood | 5 400 | 64,000 | 3¼ | 8 0 | ·138 | ·011 | ·021 | ·018 | ·185 |
| Ditto | 5 400 | 57,000 | 3 | 8 0 | ·133 | ·012 | ·021 | ·021 | ·207 |
| Ditto | 5,400 | 44.190 | 4 | 7 9 | ·171 | ·016 | ·027 | ·027 | ·242 |
| Ditto | 5,400 | 50 880 | 3 1/10 | 7 9 | ·131 | ·014 | ·023 | ·023 | ·191 |
| Dorman, Long, and Co., 1903. | 5,037 | 151,122 | 2 8 | 10 0 | ·15 | — | — | — | — |
| Dorman, Long, and Co, 1902. | 5,050 | 60,400 | 3·04 | 11 6 | ·179 | ·019 | ·085 | ·03 | ·313 |
| Kynoch.—Day load | 1,240 | 18,400 | 5 5 | 6 6 | ·190 | ·045 | ·065 | ·043 | ·343 |
| Ditto Day and night | 1,490 | 22,400 | 7 0 | 6 6 | ·243 | ·050 | ·075 | ·045 | ·413 |
| C. and S. L. Railway | 2,817 | 132,195 | 4·16 | 13 9 | ·307 | ·037 | ·064 | ·038 | ·446 |
| Crompton and Co., Chelmsford | 2,820 | 22,800 | 4½ | 15s. to 19s. | (water ·01) ·43 | ·018 | ·109 | ·022 | ·579 |
| Vickers, Sheffield—South | 2,000 | 50,000 | — | 7 3 | ·255 | ·032 | ·101 | 081 | ·469 |
| Vickers, Sheffield—North | 3,280 | 40,300 | — | 9 9 | ·313 | ·063 | ·102 | ·101 | ·579 |

TABLE H.—WATSON BROS., LINWOOD, 500-KW. PLANT READINGS FOUR CONSECUTIVE WEEKS IN JUNE, 1903.

| Units generated per kilowatt installed, taking 50 weeks a year. | Units generated per week. | Total coal per week. | Cost of coal. | | Lbs. coal per unit. | Coal in pence per unit. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Per ton. | Per unit. | | Oil, waste, stores. | Wages. | 2½ per cent. on £10,000 repairs. | Works' costs. |
| | | t. c. | s. d. | d | | d. | d. | d. | d. |
| 6,400 | 64,000 | 93 3 | 8 0 | ·138 | 3¼ | ·011 | ·018 | ·018 | ·185 |
| 5,700 | 57,090 | 93 8 | 8 0 | ·152 | 3⅜ | ·012 | ·021 | ·021 | ·207 |
| 4,419 | 44,190 | 81 12 | 7 9 | ·171 | 4 | ·016 | ·027 | ·027 | ·242 |
| 5,088 | 50,880 | 71 15 | 7 9 | ·131 | 3 1/10 | ·014 | ·023 | 023 | ·191 |

TABLE I.—CREWE ELECTRICITY WORKS.

| Date. | Units generated per month. | Lbs. of coal used per unit generated. | Cost of coal per ton on rails at Crewe. | Cost per unit generated. | | | | | Maximum load during month. | Units used by condensers. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coal. | Oil and stores. | Wages, generation. | Wages and materials, maintenance. | Works' cost. | | |
| 1902. | | | s. | d. | d. | d. | d. | d. | Kw. | |
| December | 52,050 | 7·1 | 7 | ·262 | ·019 | ·113 | ·023 | ·417 | 275 | 3,700 |
| 1903. | | | | | | | | | | |
| January | 50,033 | 6·76 | ,, | ·258 | ·020 | ·148 | ·053 | ·479 | 282 | 3,626 |
| February | 40.584 | 7·1 | ,, | ·270 | ·025 | ·138 | ·050 | ·483 | 270 | 3.690 |
| March | 37,908 | 6·5 | ,, | ·242 | ·026 | ·150 | ·072 | ·410 | 268 | 2,350 |
| April | 28,880 | 6·25 | ,, | ·246 | ·034 | ·153 | 095 | ·528 | 220 | 1 522 |
| May | 23,569 | 6·9 | ,, | ·267 | ·042 | ·180 | ·095 | ·594 | 210 | 1,376 |
| June | 17,813 | 6 8 | ,, | ·264 | ·057 | ·230 | ·176 | ·727 | 198 | 1,138 |
| July | 19 877 | 7·2 | ,, | ·285 | ·051 | ·238 | ·185 | ·759 | 205 | 1,194 |
| August | 25.463 | 6 8 | ,, | ·259 | ·040 | ·170 | ·120 | ·589 | 214 | 1,454 |
| September | 33,764 | 6 5 | ,, | ·246 | ·030 | 141 | ·065 | ·482 | 278 | 1,866 |
| October | 46,405 | 6·3 | ,, | 230 | ·022 | ·149 | ·056 | ·468 | 290 | 2,648 |
| November | 53,000 | 6·3 | ,, | ·262 | ·018 | ·115 | ·020 | ·383 | 295 | 3,094 |
| | 429,345 | | | | | | | | | 27,128 |
| Averages | | 6·7 | — | ·255 | 032 | 160 | 089 | ·525 | — | — |

cheap coal. It should be possible on test with a good compound condensing engine using superheated steam (150 deg. F.) to obtain a kilowatt on the switchboard for 21lb. or 22lb. of water including the auxiliary plant, or 18½lb. to 19½lb. for a triple-expansion engine. Allowing for radiation losses and the plant being worked commercially below its most economical load during periods of the day, these figures might be increased to 25lb. to 30lb. for the compound engines, and 20lb. to 25lb. for the triple-expansion engines. Taking 9lb. of water evaporated per pound of coal at a working pressure which is equivalent to about 10lb. of water from and at 212 deg. F., you will see there should be sufficient margin in my figure of 3lb. to 5lb. of coal per kilowatt generated. To get down to the lowest figure—viz., 3lb. of coal—considerable care will have to be taken to maintain the plant at an economical load, and to keep all the auxiliary plant in a high state of efficiency when dealing with large outputs. However, these precautions are well worth taking, as the savings involved per annum are considerable. No particular claims are made in favour of the high-speed engine over the results obtainable with the best types of slow-speed Corliss

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engines in this particular item of coal consumption, although it should be borne in mind that high-speed engines take more kindly towards a fairly high degree of superheat than do slow-speed engines, and consequently with a temperature of 550deg. F. at the engine stop valve lower steam consumptions are to be obtained with high-speed engines than is possible with slow-speed engines at a more moderate degree of superheat. This item may be expected to vary between ·125d. and ·4d. per unit generated, depending upon the cost of coal in the locality.

*Oil, Waste, Water, and Petty Stores.*—This item in a private power-house need not exceed ·02d. per unit, or if water is obtainable cheaply, or for nothing, it may be still further reduced. Enclosed high-speed engines undoubtedly give an advantage in this respect.

*Wages of Workmen.*—This item may vary between ·025d. and 1d. per unit, depending almost entirely upon the output obtainable. In addition to the above, the public stations in Table D are handicapped in two ways so far as this item is concerned. In the first place, their costs include labour outside the engine-house—such as looking after mains, etc. In the second place, a public power station being isolated must have labour sufficient for dealing with an emergency, whereas a private works need only have sufficient labour for keeping the plant in good condition, and, in the event of a breakdown or one of the staff being indisposed, there is usually little difficulty in drawing from another department. As an instance of what is being done in everyday practice in the way of running high-speed engines with the minimum of attention, I would refer you to two of the older stations of the Liverpool Corporation. At their Paradise-street station they have installed 14 350-h.p. Willans-Siemens steam dynamos, and 12 of these sets are continually running. The engine-room staff for dealing with this consists of one driver and a greaser per shift, and during the day an extra hand is employed in cleaning up, polishing, etc. At their Oldham-place works nine Willans-Siemens sets are installed, all of which are continually running. One driver and one greaser per shift are able to manage this, in addition to doing all their necessary cleaning, polishing, etc. I mention these two cases because they are both old stations, the plant having been at work between 10 and 14 years, and those that think that high-speed engines are troublesome after some years' running will certainly find a ready answer here. The great saving in labour with high-speed engines is, of course, not so pronounced in a small station where only one or two small sets are installed, but when the plant grows the saving in labour is considerable. The actual cost of the item varies considerably with the yearly output per kilowatt installed, and will be considerably enhanced if a night shift or a week-end is run with only a light load on the feeders.

*Repairs.*—I think high-speed engines have built up a sufficiently good reputation during the past 20 years in this respect not to require any comments from me. I am prepared to state that the cost of this item taken in conjunction with item 3 is no heavier, and in all probability considerably less than in stations using slow-speed engines, provided the high-speed engines are the best of their type. This item can be considerably reduced below the figures given in Table D on account of a permanent staff not being necessary for reasons already touched on. This item can, I think, safely be put at 0·5d. per unit generated for private works. Summarising these four items we have the works costs, made up as follows:

| | Possible minimum per unit. d. | Probable maximum per unit. d. |
|---|---|---|
| Cost of fuel | ·125 | ·40 |
| Oil, waste, water, and stores | ·02 | ·02 |
| Wages | ·025 | ·10 |
| Repairs | ·05 | ·05 |
| | ·22 | ·57 |

Or, roughly, ¼d. per unit as the minimum, and ⅝d. per unit as the maximum. Large stations with a good load factor, such as electrolytic works, or the loads which we hope some of the power distribution companies will in time obtain, should be able to beat the minimum stated above.

Below I give a table which may be of interest, giving an approximate estimate of the capital cost of a central power station such as are being installed for dealing with the requirements of private works. These costs can be taken to come out between £20 and £25 per kilowatt installed, and I think the division as given below is about in the right proportion.

*Approximate First Cost of Power Plant per Kilowatt.*

| | | | |
|---|---|---|---|
| Steam dynamos (high-speed engines) | £8 | 0 | 0 |
| Foundations for ditto | 0 | 10 | 0 |
| Boilers with settings | 5 | 0 | 0 |
| Piping, valves, and feed pumps | 2 | 0 | 0 |
| Economiser | 0 | 10 | 0 |
| Condenser with air-pump | 1 | 10 | 0 |
| Switchboard | 1 | 0 | 0 |
| Buildings | 5 | 0 | 0 |
| | £23 | 10 | 0 |

WATSON BROS., LINWOOD.

*Description of Plant.*—The engine-house consists at present of two 250-kw. steam dynamos (Bruce Peebles dynamos and Willans high-speed engines), the latter being triple expansion and working with a boiler pressure of 250lb. per square inch at the stop valve, the steam being superheated to give a temperature of 500deg. F. at the engine. By means of jet condensers a vacuum of 25in. to 25½in. is obtained on the engines. Each steam dynamo runs about 128 hours per week, the output at night being only slightly less than that during the daytime; the load is, therefore, extremely favourable for economical working. The staff is divided into two shifts, which work 12 hours each, each shift consisting of one engine-driver and one stoker. The boilers, two in number, are of the Babcock type, and have 3 580 square feet of heating surface each; each boiler consists of 18 sections of nine tubes, the latter being 18ft. long by 4in. diameter. The furnaces are fitted with this firm's chain grate stokers, and the boilers are arranged with their own superheaters. Each superheater is made up of 64 tubes, having a heating surface of 460 square feet, and the steam in the superheater main has a temperature of 500deg. to 550deg. F. The exhaust steam feed-water heater contains 316 square feet of heating surface, and is capable of dealing with 22,000lb. of water per hour, and is used for the exhaust steam from the air and feed pump engines, the resulting temperature in the feed water being 160deg. F. This feed water is then passed through an economiser, after leaving which the resulting temperature is about 300deg. F. The whole installation has been designed by Mr. R. D. Munro, of the Scottish Boiler Insurance Company, who is acting as consulting engineer to Messrs. Watsons. The average cost per unit taken over a month is therefore made up as follows (see Table H):

| | |
|---|---|
| Coal | ·148d. |
| Oil, waste | ·013d. |
| Wages | ·022d. |
| Repairs 2½ per cent. on £10,000 | ·022d. |
| Works' cost | ·205d. |
| 5 per cent. interest on £10,000 | ·044d. |
| 10 per cent. depreciation on above | ·088d. |
| Total cost per unit | ·337d. |

DORMAN, LONG, AND CO., MIDDLESBROUGH.

The plant installed at Messrs. Dorman, Long, and Co.'s Britannia Works amounts to 1,500 kw., the dynamos, which are all direct coupled to their engines, being of the low-voltage type—viz., 120 volts. The smaller engines are of Messrs. Bellias and Morcom's make, whilst the three larger ones were built by Messrs. Richardson, Westgarth, and Co. More recently a Willans 700-i.h.p. high-speed engine has been installed in the way of extensions. A test carried out for a fortnight during November last showed that the total coal burnt was 374 tons 17cwt. 1qr., whilst the total amperes, taking the average of 10-minute readings from the log book, amounted to 8,857 amperes per hour, the total time the plant was running being 273 hours, gives a total of 302,211 Board of Trade units for the period. This brings the coal consumption per electrical unit to 2·8lb. During the fortnight that this test was carried out a very light load was maintained on the station during the week-ends, whereas in the ordinary course the plant would be totally shut down at the end of the week, consequently better results would be obtained under ordinary working conditions. It should, however, be pointed out that the condensers are run from a separate battery of boilers, consequently this coal consumption does not include the power taken to drive the condenser. It is rather interesting to know that the previous test carried out on this plant—viz., during November, 1902—gave a coal consumption of 3·041b. per electrical unit, whilst the kilowatt installed was rather less than half that installed at present.

139½ *Hours' Test—Nov. 17 to 23, 1902.*

Plant installed, 600 kw.—viz., three 100-kw. and one 300-kw.

| | |
|---|---|
| Units generated per kilowatt installed | 5 050 |
| Units generated per week | 60,400 |
| Cost of coal per ton | 11s. 6d. |
| Cost of coal per unit | ·179d. |
| Pounds coal per unit | *3·04d. |
| Oil, waste, stores | ·019d. |
| Wages | ·085d. |
| 2½ per cent. on £15,000 repairs | ·03d. |
| Works' cost | ·313d. |
| | Per unit. |
| Works' cost | ·313d. |
| 5 per cent. interest on £15,000 | ·059d. |
| 10 per cent. depreciation on £15,000 | ·119d. |
| Total cost per unit | ·491d. |

* Several other weeks show between 3lb. and 3½lb. coal.

The figures as actually prepared by Messrs. Dorman, Long, and Co. are as follows:

| | | |
|---|---|---|
| Units generated during week | = | 60,403 |
| Steam used per electrical unit | = | 27·521b |
| Coal per electrical unit | = | 3·041b |

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| | Per unit. |
|---|---|
| Coal, 3·04lb. at 11s. 6d. per ton | ·179d. |
| Water, 27·52lb. at 3½d. per 1,000 gallons | ·009d. |
| Stores used | ·010d. |
| Wages (including keeping 150 arc lamps in repair) | ·066d. |
| Repairs | ·019d. |
| Superintendence | ·019d. |
| | ·302d. |
| Interest and depreciation 10 per cent. on £15,000 | ·099d. |
| | ·401d. |

Coal per indicated horse-power = 1·81lb. ; water per indicated horse-power = 16·43lb.

KYNOCH, LIMITED, BIRMINGHAM.

The plant installed at these works amount to 740 kw. direct driven by Willans high-speed engines. One portion of the plant, amounting to 500 kw., is usually run during the daytime, the other portion, amounting to 200 kw., being used at night. The day shift lasts from 8 a.m. to 8 p.m., and power is available and required for various purposes during the whole of the 24 hours. A separate set of boilers is used for feeding the engines which are used at night, and are of the Lancashire type, whilst during the daytime boilers of the Economic type are in use working at 160lb. steam pressure. The steam used is not superheated, and at present economisers are not installed. The plant is run condensing during the daytime and non-condensing at night. The pumps for the condensers are electrically driven.

CITY AND SOUTH LONDON RAILWAY.

*Description of Plant.*—The kilowatts installed in this station amount to 2 440, which is divided between Willans high-speed central-valve engines and slow-speed vertical type of engines by Messrs. Cole, Marchent, and Morley. The boiler feed pumps are steam driven, and the air-pumps working the surface condenser are both steam and electrically driven, the steam-pump being usually used, and the electrically-driven pump kept as a stand-by. The average units generated per week amount to 132 195 ; pounds of coal per unit generated, 4·16 ; cost of coal per ton, 13s. 9d.

The following table of generating costs per unit gives an average of the year's working :

| | |
|---|---|
| Coal | ·307d. |
| Water | ·010d. |
| Oil, waste, and other stores | ·027d. |
| Wages | ·064d. |
| Repairs | ·038d. |
| Works cost per unit | ·446d. |

CROMPTON AND CO., LIMITED, CHELMSFORD.

*Description of Plant.*—Three steam dynamos are installed—viz., two 150-kw. Marshall-Crompton sets and one 120-kw. Willans high-speed set. The boilers, three in number, are of Messrs. Babcock and Wilcox's make, one of which is fitted with chain-grate stokers, and has proved so successful that a second one is being likewise adopted. The steam pressure available is 150lb., and is superheated in Messrs. Babcock's superheaters to the extent of 470deg. to 550deg. F. at the engine. The condenser is of the Ledward's evaporative type, capable of giving 24in. as a maximum at full load. Each of the Marshall-Crompton sets is run about 110 hours per week on an average. The high-speed set is not at present running regularly, due to its being rather too small to take the full load ; it is kept as a stand-by. The staff employed in this station consists in one stoker and one driver ; and on the day shift one charge hand, one general hand, and one switchboard attendant are employed in addition. The proportion of units used in the auxiliary plant (motor-driven feed pumps and motor-driven air and circulating pump) to the total units generated is 3½ per cent.; the feed pumps are motor-driven and not steam-driven. The oil separator used is a "Holden and Brooke," with a feed-water filter of Messrs. Crompton's own design.

*Details of Cost of Power for Half-Year ending April* 2, 1903.

| | |
|---|---|
| Units generated in the period | 592,275 |
| Cost of coal per ton (hard) | 18s. 9d. |
| ,, ,, (small) | 15s. 1d. |
| ,, per unit | ·431d. |
| Pounds coal per unit (about) | 4·5d. |
| Oil, waste, stores, etc., per unit | ·018d. |
| Wages per unit | ·109d. |
| Repairs and maintenance per unit | ·022d. |
| Works' cost per unit | ·579d. |

CREWE ELECTRICITY WORKS.

*Description of Plant.*—At present there are installed two 200-kw. Willans-Mather and Platt steam dynamos, the total output being 510 kw.; three 30ft. by 7ft. Lancashire boilers by Yates and Thom supply steam to these engines, the steam pressure being 150lb. per square inch and not superheated ; three Ledward ejector condensers and two motor-driven centrifugal pumps are installed ; one Weir and one Green's flywheel type of feed pump is used for feeding the boilers. The load factor for the 12 months under review came out at 16·6 per cent. Table I gives details of 12 months' working at these works.

In conclusion, the writer would like to express his indebtedness to those that have been good enough to furnish him with particulars as to their working costs, notably Mr. Hausman, chief engineer of Messrs. Kynoch's ; Mr. P. V. MacMahon, engineer to the City and South London Railway ; and to Mr. Sayon, of Messrs. Easton and Co., who has kindly given the author particulars relating to superheaters.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on March 24 the following candidates were balloted for :

*Members.*—S. Clegg, Electricity Works, Lincoln ; A. R. Dayson, Tramways Office, Fawcett-street, Sunderland ; F. J. Evans, 15 Windsor-road, Barry, Glamorgan.

*Associate Members.*—J. C. Beeley, Eastern Telegraph Company, Aden ; A. Davis, Hollins-lane, Warrington ; C. H. Douglas, The Vicarage, Hargrave, Chester ; C. F. Dyer, 19, Hessle-view, Brudenell-road, Leeds ; W. W. Gailey, Sao Paulo Railway, Sao Paulo, Brazil ; E. E. Garrard, 56, Apsley-road, Great Yarmouth ; C. Laszló, Bhowanipur Electric Supply Station, Calcutta ; W. J. Lloyd, care of Stanley Electric Manufacturing Company, Pittsfield, Mass., U.S.A. ; G. S. Maben, City of Wellington Electric Light and Power Company, Limited New Zealand ; C. F. Mackness, care of Allgemeine Company, 125, Charing Cross-road, W.C. ; C. Rodgers, Stafford-view, Stafford ; G. Trenbath, 13, Guildford-road, Cholmondeley-road, Pendleton ; C. E. Vormeister, Electricity Works, James-street, Carlisle ; H. Waring, Electrical Engineer's Office, Todmorden ; H. Watson, 9, Holland-place, Glasgow.

*Associates.*—H. E. Davis, 81, Finchley-road, N.W ; H. Geen, Culver Lodge, Newton Abbott, Devon ; A. E. Larkman, 78, High-street, Southampton ; J. Meek, jun., 5, Harrowden-villas, Fauconberg-road, Chiswick, W.; S. Pilkington, 1, Upper Tichbourne-street, Leicester ; W. Walker, Cedar Villa, Highfield, Gorton, Manchester.

*Students.*—A. Bathwell, 112, Clifton-road, Canning Town ; W. G. Guns, 39, Jesmond road, Newcastle-on-Tyne ; A. E. Hill, 79, Earl's Court-road, W. ; G. C. Kennard, Thatched Cottage, Bushey Park, Hampton Wick ; F. J. Pescher, 14, Wellington-road, Old Charlton, S.E.; S. Piercy, 33, Achilles-road, Hampstead, N.W.; W. Pintner, 7, North Park-terrace, Edinburgh ; W. E. Poole, 17, Guildford-place, Heaton, Newcastle ; S. P. St. C. Raymond, Faraday House, Charing Cross-road, W.C.; G. A. Tomlinson, 103, Radford-road, Nottingham ; P. Weir, 7, Shepherd's Bush-road, W.

## PERSONAL.

Mr. Wyld, the manager of the Doncaster Corporation tramways, who is on the eve of his departure from the town to a larger and more important post under the Corporation of Birkenhead, was on Sunday presented by the tramways staff with a handsome testimonial and a marble and onyx clock, while the electricity department presented Mr. Wyld with a silver cigar case, shaped to fit the pocket, with scrolled signature and gilt inside, incribed, "Presented to W. Wyld, Esq., by the staff of the electrical works, as a token of their esteem, on his leaving Doncaster."

The Bedford Town Council have granted various increases of salaries, including £50 and £26 to the electrical engineer and the deputy electrical engineer respectively.

The Wimbledon District Council have increased the salary of Mr. H. T. Lee, electrical engineer, from £300 to £400. Mr. T. R. Stancombe, mains and test-room assistant, having resigned, Mr. E. M. Howe, engineer-in-charge, has been appointed to the position at a salary of £104 per annum.

## FORTHCOMING EVENTS.

SATURDAY, APRIL 2.

**Birmingham Mechanical Engineers.**—"Gas Measurement," by Mr. A. Cooke.

THURSDAY, APRIL 7.

**Rontgen Society.**—At 8 30 p.m., exhibition evening.

**Liverpool Engineering Society.**—At 8 p.m., discussion on "Marine Engineering."

FRIDAY, APRIL 8.

**Junior Institution.**—At 8 p.m., "The Heating and Ventilation of Factories," by Mr. Kenneth Gray.

**Manchester Students, Institution of Electrical Engineers.**—At 7.30 p.m., "Direct-Current Controllers," by Mr. H. N. Dutton.

SATURDAY, APRIL 9.

**West Hartlepool Scientific Society.**—At 7.30 p.m., annual meeting.

**Manchester Students, Institution of Electrical Engineers.**—At 2.30 p.m., visit to Messrs. W. T. Glover's cable works.

**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed : Grimsby, April 23, Newcastle, May 6 and 7 ; Buxton, May 20 and 21.

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## LIVERPOOL ELECTRICITY ACCOUNTS.

From the accounts of the Liverpool Corporation electric supply department for the year ended Dec. 31, 1903, it appears that the total expenditure on capital account now amounts to £1,553,808. Abstracts of the revenue account and general balance-sheet are given herewith.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 69,216 | 15 | 9 |
| Distribution of electricity | 4 319 | 19 | 10 |
| Rents, rates, and taxes | 12 743 | 4 | 5 |
| Management expenses, salaries, etc. | 10,855 | 9 | 6 |
| Special charges, insurances, etc. | 1,640 | 1 | 1 |
| Amount written off for bad debts | 62 | 15 | 1 |
| Balance carried to net revenue account | 107,473 | 7 | 4 |
| | £206,311 | 13 | 0 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current for lighting and power | 118.684 | 9 | 3 |
| Sale of current for street lighting | 2.290 | 6 | 2 |
| Sale of current to electric tramways | 77 930 | 10 | 0 |
| Rental of meters | 2,362 | 13 | 6 |
| Allerton installation rents and privilege rents | 40 | 11 | 3 |
| Rents of property, less rates, repairs, etc. | 740 | 12 | 11 |
| Manufacturing account | 4,262 | 9 | 11 |
| | £206,311 | 13 | 0 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Loans as per capital account | 1,386 845 | 9 | 0 |
| Sundry creditors | 73.691 | 1 | 3 |
| Surplus and sinking fund | 253,855 | 14 | 3 |
| Bank of Liverpool | 16,635 | 11 | 10 |
| | £1,731,027 | 16 | 4 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended as per capital account | 1,553 808 | 10 | 9 |
| Stocks on hand, and value of work in progress | 4,542 | 0 | 4 |
| Sundry creditors for current supplied, etc. | 73 569 | 4 | 3 |
| Investment of sinking fund | 77 005 | 5 | 10 |
| Investment of reserve fund | 22,102 | 15 | 2 |
| | £1,731,027 | 16 | 4 |

## APPOINTMENTS VACANT.

**Assistant Electrical Engineer,** York. Salary, £200 per annum. Applications to City Electrical Engineer by April 6. See advertisement.

**Gas Engineer and Manager and Electrical Engineer,** Malvern. Salary, £400 per annum. Applications to Mr. H. L. Whatley, Council Offices, Malvern, by April 23. See advertisement.

**Electrical Engineer,** Singapore. Salary £360 to commence. Applications to Mr. O. C. Lindsay, M.I.C.E., 217, West George street, Glasgow, by April 19.

**Electrical Engineer,** Chester. Salary, £300. Applications by April 6.

**Tramways Manager,** Rochdale. Commencing salary, £300 per annum. Applications to Town Clerk, Town Hall, Rochdale, by noon on April 5.

**Engineering Clerk of Works,** Napsbury Asylum, St. Albans. Salary, £3. 3s. per week. Applications to Mr. Walter Geo. Austin, Guildhall, Westminster, S.W., by April 6.

# LEGAL INTELLIGENCE.

## ROBERTSON v. CITY AND SOUTH LONDON RAILWAY COMPANY.

In this case the plaintiff claimed £271. 10s., being the sum awarded to her by a sheriff's jury as compensation for damage done by the company in execution of their works. The plaintiff had served a notice in writing under Section 68 of the Lands Clauses Consolidation Act, 1845, claiming the sum of £270, together with an account showing the particulars of her claim, and amongst the items so shown was a claim for £25 for damage by depreciation in value of part of the property affected. The company made a formal offer of £150, but as this was not accepted the matter in due course went before a sheriff's jury for assessment of the amount. During the proceedings before the jury it was stated on behalf of the plaintiff that an error had been made in claiming only £25 in respect of this depreciation, and a claim was put forward for £50 in respect of that item of damages. The jury assessed the damages in relation to that item at £50, and for the whole claim at £271. 10s., being £1. 10s. in excess of the total sum claimed. The sheriff duly gave the plaintiff judgment for that amount, and the present action was brought to enforce that judgment. The defendants contended, *inter alia*, that the plaintiff, having claimed by her notice a specific sum in respect of the depreciation, was not entitled to put forward a claim for a larger sum in respect of that item of damage when before the jury, and that the jury had no jurisdiction to award a sum in excess of the total sum claimed. Counsel cited several precedents in support of this contention.

Mr. R. F. Colam appeared for the plaintiff; Mr. Courthorpe-Munroe and Mr. Langston for the defendant.

**Mr. Justice Channell,** in delivering judgment, said that with regard to this point there were two questions: one was whether a jury had jurisdiction to give as compensation an amount exceeding the total amount claimed; the other was, supposing the jury had jurisdiction to do that, could they when items of claim were given by the claimant give more than was claimed in respect of any one item? His view was that a claimant must, in making his demand for compensation, give sufficient information to the company to allow them to make an offer of a sum for compensation. The claimant must make the subject matter of his claim clear. In his opinion, it was quite clear that when a claimant had stated the subject matter of his claim, he could not put before the jury a claim in respect of a new subject matter. He could not, however, find anything in the statute which said that when a jury thought that a claimant was entitled to more than he had claimed in respect of a subject matter brought to the notice of the company, they might not award him more than he had claimed. If a jury did so to an extravagant amount their verdict could be set aside, but if they acted reasonably he could see no reason why they should not be able to award a sum in excess of the sum claimed. The object of making a money claim in addition to stating the subject matter of the claim was that there might be an assessment of the sum to which the claimant would be entitled should the company not contest the amount of the claimed. His Lordship was quite satisfied that there was no principle which prevented a jury, when a claimant had split up his lump sums into items, from giving more in respect of any one item than was actually claimed for that item, provided they did not exceed the whole sum claimed. He had rather more doubt as to whether the jury could give more than the total amount claimed, and, although he was inclined to think that they could, it would perhaps be safer for the plaintiff if she would accept a judgment for £270.

The plaintiff having agreed to give up her claim for the extra £1. 10s., judgment was entered for her for £270 and costs.

# COMPANIES' MEETINGS AND REPORTS

## GREENOCK AND PORT GLASGOW TRAMWAYS.

The directors' report for the year ended Dec. 31 last states that there has been an increase in the traffic receipts of £2,455. 1s. 3d. They consider this a satisfactory result, having regard to the unfavourable weather and the depressed state of the shipbuilding industry during the past year. The total revenue for the year amounted to £29,025 and the expenses to £18,219, which sum includes rentals payable to corporations, interest on loans, cost of repairs and maintenance, and all other expenditure properly chargeable against the year's revenue, leaving a net profit of £10,805, which, added to the amount of £3,986 brought forward from the previous account, makes a balance available for distribution of £14,792. The directors propose to place to depreciation and renewals account £1,500, and to the reserve (sinking) fund £1,780, and to pay dividends at the rate of 5 per cent. per annum on the preference shares and at the rate of 6 per cent. per annum on the ordinary shares, leaving a balance to be carried forward of £2,093.

The ordinary general meeting was held in London, Viscount Emlyn presiding.

The **Chairman,** in moving the adoption of the report, stated that they had carried during the year 6,200,778 passengers. Their share capital was now issued and fully paid up. There had been spent on capital account during the year £5,818, principally on the construction of the extension in Port Glasgow, and on the provision of a Diesel engine, which was used for supplying electricity in the depôt after midnight. With reference to the arbitration expenses (£529), the directors had decided to write this amount off over the period covered by the arbitrators' award. The amount allocated to 1903 was £176. Difficulties still existed between the Corporation of Greenock and the Company as to the proportion of profits to be paid to the Corporation. Power and running expenses had decreased by £1,688. This was due, to a large extent, to the fact that for the year 1902 the Corporation claim as to the price of current was allowed in full, and they were, consequently, credited with 1·5d. for all units taken. Therefore, this year, in addition to having the current brought into the accounts at the revised rates—namely, 1·5 for the first 500,000 units, and 0·7d. for all units paid over and above the first 500,000—they also received the benefit which would in the ordinary way have been received during 1902.

**Mr. Hilton** seconded the adoption of the report, and the dividends of 5 per cent. per annum on the preference shares and 6 per cent. per annum on the ordinary shares were declared.

Mr. C. S. Hilton and Mr. F. B. Lea were reappointed directors.

## WINCHESTER ELECTRIC LIGHT AND POWER.

The sixth annual general meeting of the Winchester Electric Light and Power Company, Limited, was held at Winchester on the 22nd ult., Mr. T. F. Kirby, chairman, presiding.

The directors, in their report, stated that the equivalent of 7,301 8-c.p. lamps had been added, making the total connection at the end of the year 35,557 lamps. Including the balance brought forward from last year's accounts, £128. 16s. 11d., the accounts showed a net profit of £4,784. 14s., which, after payment of debenture interest, left a balance of £3,079. 13s. 11d. available for dividend. The directors

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recommended that a dividend for the half-year at the rate of 7 per cent. per annum making 5½ per cent. for the year, be paid, which would absorb £1,650, and that £1,200 (in addition to £73. 9s. 3d. recommended as premiums on debentures issued during the year) be placed to the reserve for the renewal of plant, leaving a balance of £156. 4s. 8 t. to be carried forward. The works had been maintained in good order, further additions had been made to the plant, and the accumulators had been replaced by a larger set. During the year 1 312 ordinary shares had been issued at par and fully paid up, and £1,900 of debentures had been issued at a premium.

The **Chairman**, after waiting half an hour for a quorum, said the only business that could be done would be to declare a dividend and adjourn the meeting for a week. He mentioned that an interim dividend for the half-year at the rate of 4 per cent. per annum was paid in October last for the first time, and the directors now proposed to declare a dividend at the rate of 7 per cent. per annum, making a total of 5½ per cent. for the year, and allowing £1,200 to be placed to the reserve, leaving a balance of £156 to be carried to the next account. He proposed that a dividend at the rate of 7 per cent. per annum to be declared. He added that the reason the meeting was held a week later was because the Government auditor was unable to audit the accounts before March 15.

**Mr Stopher** seconded the proposed dividend, which was agreed to.

## BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The report for 1903, to be presented at the meeting on the 7th inst., states that total receipts have amounted to £164,714 during the year, and expenditure to £92,369, leaving £72,345. This balance, with the amount brought forward from last year, £3,270, has been carried to net revenue account. There has been placed to renewals fund (raising same to £16,000) £5,000, and written off capital expenditure £4,500. To meet a loss on sales of surplus stores there has been written off £1,301. To create a sinking fund for the redemption of debenture capital £2,500 has been applied, and £500 to the creation of an accidents insurance fund. The 6 per cent. dividend on the "A" and "B" preference shares absorbs £20,250, and the directors now recommend a dividend of 3 per cent., or 3s. each, on the ordinary shares, leaving £2,479 to be carried forward; 3,210,194 miles were run, an increase of 88,635 miles. The number of passengers increased by 949,781. The average premium on gold was 127·27 per cent., as compared with 133·50 per cent. in 1902.

## BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

Under the presidency of Mr. Aymor H. Sanderson, the seventh annual meeting was held last Friday at the Company's offices, Moorgate-court, London.

The **Chairman**, in moving the adoption of the report and accounts (which have been published), said there had been a substantial increase during the past year in the revenue receipts, in the lamps applied for, and in the units sold. The total amount of the capital expenditure had been £286,889, of which £55,432 had been expended during the past year. The amount invested in the Richmond (Surrey) Electric Light and Power Company had increased from £105,436 to £110,186, the additional sum representing advances made to the Company. The revenue account showed a marked improvement in every department. The gross receipts were nearly £4,000 in excess of those of the previous year. The Richmond Company continued to make steady and satisfactory progress.

**Dr. J. A. Hosker** seconded the resolution, which was unanimously agreed to, and dividends on the ordinary shares at the rate of 8 per cent. adopted.

## NORTHERN COUNTIES ELECTRIC SUPPLY.

The annual meeting of the Northern Counties Electricity Supply Company was held at Newcastle on the 16th ult., Mr. J. D. Millburn presiding.

In moving the adoption of the report (which appeared in our last issue), the **Chairman** said they had spent a great deal of capital during the last year, but it had been necessary, as they held a number of provisional orders which had to be carried out by certain dates, and it had been a question which they should carry out first. The Company had two distinctive features in that it was able to sell for several years in advance current at full retail price, while the cost of production was cheapening yearly, and it also had immunity from purchase by local authorities except at market value as a going concern. They now had plant estimated to produce an output of four or five million units, and if they obtained 1d. per unit profit it meant £17,000.

**Admiral Cleveland** seconded the adoption of the report, which was agreed to.

Captain Pulleine and Mr. F. J. Tennant were re-elected directors, and Messrs. Strachan and Co. were re-elected auditors.

## FOLKESTONE ELECTRICITY SUPPLY.

The report of the Company for the year 1903 states that up to Dec. 31, 1902, the equivalent of 40.699 8-c.p. lamps was being supplied, whilst up to Dec. 31, 1903, the equivalent of 54,805 8-c.p. lamps was being provided. There is a profit on revenue account of £6,026, which, with the profits of installation work, etc., and the sum of £203 brought forward, and after allowing for interest on debenture stock, bank charges, etc., and carrying £1,000 to a depreciation fund, shows a net balance for distribution, after allowing for the interim dividend at the rate of 4 per cent. per annum, of £2,452. The directors recommend a dividend at the rate of 7 per cent. for the half-year (making 5½ per cent. for the year), the placing £400 to reserve fund, thus leaving a balance of £302, which it is proposed to carry forward. The agreements with the Corporation of Hythe and the Urban District Council of Sandgate for working their provisional orders have been carried into effect. The capital expenditure for Hythe and Sandgate is included, for the first time, in the accounts, and the items appear in the balance-sheet under separate headings. A suspense account is also included in connection with the Hythe temporary lighting, which it is proposed to write off in the course of two or three years. A further issue of £25,000 preference shares has been made since the close of the year to cover extensions in Folkestone, Hythe, and Sandgate, and pay off the bank overdraft. These shares were only offered to shareholders and debenture holders of the Company, and were well subscribed. There is £3,865 still unallotted, which can be taken up by shareholders or debenture holders in terms of the circular letter issued in February.

## GATESHEAD TRAMWAYS.

The twenty-second annual meeting of the Gateshed and District Tramways Company was held on the 24th ult. at the London offices of the Company, Norfolk-street, Strand. The chairman of directors (Mr. C. R Greene) presided.

The **Chairman**, in moving that the report and balance-sheet be received and adopted and the recommendations approved, said that they had got an increase of traffic of £6,051, that sum including receipts from advertisements, etc. There had been an increase in expenses owing to the extra mileage run, but they were effecting a satisfactory weekly diminution. This would tell favourably in their next year's balance-sheet. One heavy item in the balance-sheet against them was the increase in rates and taxes. This matter would have the serious attention of the directors. It was possible they might be over-rated at Gateshead, and that on an appeal they might be able to get relief. There had been a capital expenditure of £10,368 in connection with the Wrekenton extension. That extension was doing fairly well, but as it was only opened in October last it had not yet had a fair chance. Another matter to which he wished to refer was that of the fares. For 1d. they were carrying people in some instances a distance of three miles, and taking into consideration the gradients, the fare was not enough. The matter required the serious consideration of the Board, and there was the possibility of an increase on some of the longer lines. If they got this increase and took into consideration the increase of traffic which was going on, he thought he could fairly say that next year's balance-sheet would be a more favourable one.

**Mr. L. A. Atherley Jones, K.C., M.P.**, seconded the motion, and the report and balance sheet, which provided for payment of the dividends on the 6 and 5 per cent. preference shares and of a 3 per cent. dividend on the ordinary shares, were adopted.

A vote of thanks to the chairman terminated the proceedings.

## CLONTARF AND HILL OF HOWTH TRAMROAD.

The general meeting of this Company was held last week. The chairman, Sir Francis Wm. Brady, Bart., presided.

The **Chairman** moved the adoption of the report and statement of accounts. These showed that the profits on the working of the line during 1903 were £1,175. 14s. 6d.

**Mr. Martin F. Mahony** seconded, and the motion was carried.

**Mr. Arthur Hanlyn** said that in view of the fact that in the original prospectus the gross turnover from traffic was put at £12,000 as a moderate estimate, and that it did not reach £5,000, there seemed to be considerable room for its further development, for which purpose he made various suggestions.

The **Chairman** replied that these would be sympathetically considered, but that there were no funds available in respect of some of them.

Mr. J. E. Martin and Mr. Wm. L. Murphy were elected directors, and the auditors. Messrs. Craig Gardner and Co., having been re-elected, the meeting ended.

## GUILDFORD ELECTRICITY SUPPLY.

The report of this Company for 1903 states that the Company's business continues to increase steadily, the gross receipts for the past year being £3,897. 7s. 7½d., as against £3,312. 15s. for the year 1902. The balance of the net revenue account, after providing for payment of the dividends on the preference shares issued in lieu of the founders' shares, for depreciation, and also for payment of a further instalment of the heavy law costs incurred in 1902, is £475. 4s. 10d. Out of this balance it is proposed to pay a dividend of 3 per cent. on the ordinary shares, and to carry forward the balance of £71. 8s. 10d. The retiring directors are Mr. A. F. Asher and Mr. C. J. Scott, both of whom offer themselves for re-election.

## ANGLO-ARGENTINE TRAMWAYS.

The report for the year 1903 shows an available balance of £106,071, against £22,002 for 1902. The receipts amounted to £328,994, against £254,582 for the previous year, an increase of £74,412; while the working expenses—£174,426, against £191.136—showed a reduction of £16,710. The total net receipts for 1903 total, therefore, £154,568, against £63 446 for 1902, an increase of £91,122. The directors recommend that a final dividend of 2s. 6d. per share be paid on the preference shares; that the sum of £1,350 be employed to write down £10,000 consols to 85; that a sum of £15,000 be placed to the credit of reserve and renewal account; that a dividend of 6 per cent. be paid on the £850,000 of ordinary shares, absorbing

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£51,000; and that £6,220 be carried forward. The results are all the more satisfactory as horse traction was not finally abandoned until last September. The directors, having made arrangements to purchase current at a smaller cost than that at which the Company could generate it, notified the contractors that they would not require the power-houses and necessary machinery. To cover this, and sundry other matters, the contract price was reduced by mutual agreement from £1,000,000 to £850,000 in ordinary shares. This arrangement, besides being advantageous in itself, relieves the undertaking of the necessity of maintaining a costly electrical staff in Buenos Ayres, and materially lessens the Company's responsibilities. The average gold premium for the year 1903 was 127·27 per cent., as compared with 133·50 per cent. for 1902. Negotiations are still proceeding for the transfer to this Company of the City of Buenos Ayres Tramways Company's system, and the result will be communicated at the earliest possible moment.

## ELECTRIC LIGHTING AND TRACTION COMPANY OF AUSTRALIA.

The directors' report for the year ended Aug. 31, 1903, states that during the year capital expenditure in Australia on buildings, plant, and mains has been incurred as follows: Melbourne undertaking, £10,217. 8s. 6d.; Adelaide undertaking, £15,572. 19s. 3d.; Geelong undertaking, £1,832. 9s. 11d.—total, £27,622. 17s. 8d. The second moiety of £75,000 5 per cent. first mortgage debenture stock was sold in March, 1903, and of the proceeds a portion was utilised for pressing capital requirements in Australia and the remainder applied in reduction of the loan from the Company's bankers, which on Aug. 31, 1903, stood at £78 670. The profits derived during the year from the Company's undertakings in Australia amount to £6,248. 17s. 5d. Management and general expenses at the London head office amount to £2,317. 16s. 11d., and debenture and bank interest to £9,277. 18s. 10d. After payment of these charges and writing off repairs and renewals incurred during the year, and also a deficit of £71. 10s. on the Port Adelaide undertaking, there is a balance to the debit of profit and loss account of £7,442. 2s. The Company's business during the year has been seriously prejudiced by the general depression in Australia, consequent upon the prolonged drought. The present outlook is, however, more hopeful, due to better harvest prospects and other causes, and this improvement is reacting favourably upon the Company's business, the connections for light and power during the first four months of the current year showing a satisfactory increase over the corresponding period of last year. Substantial economies have been effected during the year in working expenses, the average cost per unit sold showing a reduction of 25 per cent. as compared with the previous year. The total connections to the Company's mains in Australia on Aug. 31 last amounted to the equivalent of 89,600 8-c.p. lamps, showing an increase of 23 000 8-c.p. lamps over the connections existing at Aug. 31, 1902. During the first four months of the current year the equivalent of 12,500 8-c.p. lamps has been applied for and connected. The Company's engineer and manager in Australia, Mr. F. W. Clements, reports that there is a growing demand for the use of electric power in connection with the Company's undertakings, over 400 h.p. having been added to the mains during the year under review. All possible efforts are being made to encourage this source of revenue by means of a revision of the Company's tariff of charges and in other ways. The directors have been approached by influential Australian interests desirous of participating by means of local capital and representation in the Company's undertakings. The negotiations are receiving the careful attention of the directors. The profit and loss account of the Melbourne undertaking shows a gross profit for the past year of £2 093. 16s. 3d. The effect of the administrative and working economies which have been carried out during the 12 months will no doubt be felt more fully during the current year. The directors believe that the Melbourne undertaking will eventually become the Company's most profitable asset, but its development must necessarily be a matter of time, owing to the large suburban areas over which electric supply has to be provided, involving heavy capital outlay in advance of revenue returns. The Adelaide station continues to make good progress, the financial result for the past—its second—year of working being a gross profit of £3,449. 13s. 7d., as compared with £500. 7s. 2d. for the previous year. The additional connections secured amount to the equivalent of 16,200 8-c.p. lamps, and further applications for light and power continue to be received at a satisfactory rate. The Geelong station has earned a gross profit of £705. 7s. 7d. during the year, and has added the equivalent of 4,850 8-c.p. lamps to its mains. Several important contracts for the supply of power are being negotiated, and the prospects generally of the Geelong undertaking are favourable. The small station at Port Adelaide has continued to work at a loss, but the latter has been reduced by careful management to £71. 10s., as compared with £435. 7s. 11d. for the previous year. It is anticipated that expenses will be covered during the current year, and in these circumstances the directors do not propose to press forward with the preparations for closing the station and supplying the district from Adelaide.

The fourth annual meeting was held on Monday at Winchester House, Mr. J. B. Braithwaite presiding.

In moving the adoption of the report, the **Chairman** remarked that at Melbourne for the first time they had had no assistance whatever from the city load. The City Corporation had purchased the Company's mains inside the city, and erected a power station, with the view of supplying themselves. For some time, however, it was necessary for them to take current from the Company, and for that reason it had been rather difficult to know what their position would be when that demand ceased. The final portion of the city load was transferred to the Corporation's station at the end of the previous financial year, with the result that the earnings for the period covered by the accounts were obtained entirely from their own lights in the suburbs, for which the Company had orders for 25 years. The gross lighting revenue from Melbourne was £7,981, against £21,223 in the previous year, so that the loss of the city load had meant a decrease of £14,000. Owing to a saving in working expenses, however, the actual profit on the station was only £5 400 less. If the proposal to connect Port Adelaide with Adelaide should be carried out, he had no doubt that the former would prove a source of profit in the future, instead of a loss. So far as the Board could judge, the profit for the present year should be sufficient to pay the whole of the debenture interest, the standing charges, and the bank loan, but there was no prospect, he thought, of any dividend on the preference shares.

**Mr. M. F. Armstrong** seconded the motion.

A short discussion followed, in the course of which **Mr. G. Brookman** (chairman of the Adelaide local board) said that he believed the revenue of the Adelaide undertaking would be largely augmented, within a few years, from suburban lighting. When the gas company's contract expired, he hoped that this Company would secure a portion of the city lighting.

The report was adopted unanimously.

## WINDSOR ELECTRICAL INSTALLATION.

The report of the directors for the year 1903 shows a steady increase in the Company's business. The number of lamps and motors installed on Dec. 31, 1902, was equivalent to 25,239 of 8 c.p. During the year 2,648 were added, bringing the total to 27,886 at the end of the year 1903, of which 2,362 represent the motor power. The capital expenditure amounted to £2,622. 11s. 2d. After crediting the account with £680, being the cost of machinery sold to the Slough and Datchet Company, the total expenditure was £64,844. 2s. 3d.; the principal increase being £1,997. 14s. 3d. on new mains, including additional feeder cable laid in Thames-street and distributing cables at Eton College and Windsor. The net profit, after providing £719 for interest on borrowed capital, was £5,051. 5s. 7d. The amount of profit available for distribution was £5,090. 6s. 3d., and out of this the directors recommend that the sum of £1,000 be added to the depreciation, renewal, and reserve fund, bringing this fund up to a total of £8,070. An interim dividend of 2½ per cent. was paid by the directors during the year, and they now recommend that £100 be transferred to the net revenue account from the dividend equalisation account and that a further dividend at the rate of 5½ per cent. less income tax be declared, making a total dividend for the year of 8 per cent. The Company commenced to take a supply of current from the Slough and Datchet Company's generating station on Oct. 16, and from that date to the end of the year they supplied this Company with 11,524 units. The modern machinery at the Slough generating station leads the directors to believe that it will be conducive to low working costs in the production of current. Since the close of last year the directors have accepted a further allotment of 4,000 £1 shares in the Slough and Datchet Company, bringing the total investment in that undertaking up to £14,000.

| Dr. ABSTRACT OF REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 3,479 | 9 | 3 |
| Distribution of electricity | 553 | 5 | 3 |
| Rents, rates, and taxes | 457 | 6 | 4 |
| Management expenses | 723 | 13 | 7 |
| Law and parliamentary charges | 43 | 7 | 7 |
| Special charges, insurance, etc. | 132 | 10 | 3 |
| Total expenditure | 5,389 | 12 | 3 |
| Balance carried to net revenue account | 5,726 | 12 | 6 |
| | £11,116 | 4 | 9 |
| Cr. | £ | s. | d. |
| Sale of current per meter, less discount | 8,799 | 4 | 10 |
| Sale of current under contract | 8 | 0 | 0 |
| Sale of current for public lighting | 1,773 | 10 | 2 |
| Rental of meters and other apparatus | 417 | 10 | 6 |
| Rents receivable | 102 | 10 | 1 |
| Transfer fees | 2 | 2 | 6 |
| Pupils' premium | 13 | 6 | 8 |
| | £11,116 | 4 | 9 |

| Dr. ABSTRACT OF BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 70,000 | 0 | 0 |
| Sundry creditors | 2,747 | 0 | 5 |
| Depreciation, renewal, and reserve fund account | 7,070 | 0 | 0 |
| Dividend equalisation account | 2,000 | 0 | 0 |
| Bad debts reserve account | 50 | 0 | 0 |
| Balance at credit of net revenue account | 3,907 | 17 | 8 |
| Overdraft at bankers | 2,158 | 17 | 7 |
| | £87,933 | 15 | 8 |
| Cr. | £ | s. | d. |
| Capital account—amount expended for works | 64,844 | 2 | 3 |
| Stores on hand | 1,185 | 6 | 3 |
| Free wiring and motors, cells, and apparatus on loan | 3,624 | 3 | 7 |
| Unfinished contracts | 635 | 10 | 3 |
| Sundry debtors for current supplied | 4,367 | 3 | 10 |
| Other debtors | 3,180 | 19 | 7 |
| Rates paid in advance | 94 | 14 | 3 |
| Cash in hand | 1 | 15 | 8 |
| Investment | 10,000 | 0 | 0 |
| | £87,933 | 15 | 8 |

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## NEW COMPANIES REGISTERED.

**Sir Hiram S. Maxim Captive Flying Machine Company, Limited.**—Capital, £30,000. Object: to acquire any interest or rights to use any invention relating to captive flying machines, or rotating cars for public recreation, or experimental purposes, and for apparatus for actuating the same; in particular to acquire from the Sir Hiram Maxim Electrical and Engineering Company, Limited, the benefit of certain existing inventions in relation to rotating cars and apparatus. Registered office: 44, Gillingham-street, Westminster.

**United Electric Tramways, Monte Video, Limited.**—Capital, £500,000. Object: to enter into any agreements for the acquisition of shares or debentures of La Sociedad Comercial de Monte Video (incorporated under the laws of Uruguay); to acquire or construct, maintain, and work any tramways, light railways, etc. Registered office: Basildon House, Moorgate-street, E.C.

**Doherty Motor Accessories Company, Limited.** — Capital, £5,000. Object: to acquire the business now carried on by W. H. Doherty, F. J. Page, J. Welch, and J. Bayley at Trafalgar Works, Upper Well-street, Coventry, as the Doherty Motor Accessories Company, and to carry on the business of manufacturers of motor parts and accessories, motor fitters, motorcar, boat, and launch builders, engineers, electricians, &c. Registered office: Trafalgar Works, 8½, Upper Well-street, Coventry.

### Lien Registered.

**Cowper Coles Galvanising Syndicate, Limited, Westminster.**—Lien registered March 16, for £100 debenture, part of £1 200; amount previously issued, £1,000; no trustees; charged on all the property, except the uncalled capital.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Gillingham.**—The Corporation invite tenders for the supply of engine and dynamo oil and for electrical meters. Tenders by April 11.

**Liege.**—The Provincial Government require tenders for the construction of electric tramways and for taking over two lines already existing by April 2.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Edinburgh.**—The City Council invite tenders for 12 months' supply of electricity meters. Specifications from the Resident Electrical Engineer, 5, Dewar-place. Tenders by April 4.

**Lichfield.**—The Council invite tenders for a lease of the Council's powers for supply of electricity. Particulars from Mr. George Ashmall, 20, Bore-street, Lichfield. Tenders by April 16. See advertisement.

**Edinburgh.**—The Council invite tenders for extension switchboard panel and steam and exhaust pipework. Specifications, etc., may be obtained from the Resident Electrical Engineer. Tenders by April 23.

**London, E.**—The Stepney Borough Council invite tenders for the erection of the second half of the electricity generating station at the electricity works, Osborn-street, Whitechapel, E. Tenders by April 14.

**Woolwich.**—The Council invite tenders for the supply and erection of an electric crane. Particulars can be obtained from the Borough Engineer, Maxey-road, Plumstead. Tenders by 12 noon on April 14. See advertisement.

**Madrid.**—The Post and Telegraph Department require tenders for a central telephone station at San Lorenzo de El Escorial, and substations at Cercedilla and San Rafael, and the installation of the telephone system by April 2.

**Todmorden.**—The Corporation invite tenders for the erection of the buildings, etc., required for electricity supply and refuse destructor purposes—viz.: (Section 1) buildings; (2) chimney; (3) steel roof trusses, etc. Tenders by April 18.

**London, N.W.**—The St. Pancras Borough Council invite tenders for supplying two 1,000-kw. steam-turbines connected to two continuous-current dynamos, switchboards, condenser, etc., complete at the King's-road power station. Tenders by April 12.

**Leeds.**—The Tramways Committee invite tenders for the supply of various tramway materials during period ending March 25, 1905. Particulars may be obtained from Mr. J. B. Hamilton, Tramways Office, City-square, Leeds. Tenders by 12 noon on April 6.

**Withington (Lancs.).**—The Guardians of Chorlton Union invite tenders for one electric bed lift, to be erected in the new pavilions. Specifications, etc., may be obtained from Mr. James B. Broadbent, A.R.I.B.A., 15, Cooper-street, Manchester. Tenders by April 5.

**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Manchester.**—The Corporation invite tenders for two 750 kw. turbo-generators, and for alterations and additions to high-pressure steam piping and valves. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department. Tenders by April 13.

**Swansea.**—The Corporation invite tenders for (Contract No. 16) open-type street arc lamps including accessories, and (17) converting the existing gas lamps to Nernst lamps, including accessories. Specifications, etc., from the Borough Electrical Engineer. Tenders by noon on April 2.

**Acton.**—The District Council invite tenders for (a) two 200-kw. motor-generators, balancer, and booster, (b) switchboard, (c) cables and arc lamps, (d) accumulators, (e) 10-ton crane. Specifications, etc., can be obtained from Mr. W. H. Trentham, 39, Victoria-steet, S.W. Tenders by April 12.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Walthamstow.**—The Urban District Council invite tenders for the extension of their electric generating station. Specifications, etc., may be obtained on application to the Council's engineer, Mr. G. W. Holmes, A.M.I.C.E., Town Hall, Walthamstow. Tenders before 5 p.m. on Friday, April 8.

**Partick.**—The Town Council invite tenders for one 500-kw. steam dynamo, 76-kw. steam balancer (dynamos only), and extensions to main switchboard. Specifications, etc., can be obtained from the Town Clerk's Office. Tenders before noon on April 12. See advertisement in last issue.

**Manchester.**—The Corporation invite tenders for supply, delivery, and erection of synchronous motor-generators at sub-stations and flue-fired superheaters at Dickinson-street station. Specifications may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall. Tenders by noon on April 7.

**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Gillingham.**—The Corporation, having discontinued the use of their single-phase plant, invite tenders for the purchase and immediate removal of the following machinery: engines, boilers, alternators, switchgear, transformers, meters, pumps, piping, and sundry other materials. Tenders by April 11.

**London, E.C.**—Tenders are required for the supply and delivery of electric plant for locomotive workshops, for the East Indian Railway Company, as per specification to be seen at the Company's Offices. Tenders are to be sent to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by 12 noon on April 13.

**Reading.**—The Corporation invite tenders for the supply and delivery of six double-decked bogie electric tramcars and one electrically-driven water-cart. Specification, etc., may be obtained from Mr. Walter Binns, engineer and manager, Tramways Office, Mill-lane, Reading. Tenders by 12 noon on April 2.

**London County Council.**—The Council invite tenders for erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Specifications, etc., may be obtained at the Architect's Department (Highways Section), Trafalgar House, 13, Charing-cross, S.W. Tenders by 10 a.m. on April 26.

**Manchester.**—The Lancashire and Yorkshire Railway Company invite tenders for the supply of various articles during 12 months ending April 30, 1905, including signal, telegraph, and electric light wires and fittings. Particulars may be obtained from Mr. Duffin, Stores Department, Osborne-street, Manchester. Tenders by 10 a.m. on April 4.

**London, S.W.**—The Westminster Electric Supply Corporation invite tenders for the supply, delivery and erection at their Duke-street sub-station of high-tension switchboard and low-tension switchboard. Specifications, etc., may be obtained from Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders before 10 a.m. on April 18.

**Grimsby.**—Tenders are required for wiring and supply of fittings for the electrical installation at the Alderman Dobson Schools in Harold-street, Grimsby, for the Education Committee. Specification may be obtained from Mr. W. A. Vignoles, M.I.E.E., borough electrical engineer, Corporation Electricity Works, Grimsby. Tenders not later than first post on April 18.

**Middlesex.**—The Visiting Committee of Napsbury Asylum, near St. Albans, Herts, invite tenders for the wiring and plain fittings required for about 2,500 points. Particulars from Mr. Wm. H. Massey, M.I.C.E., of 25, Queen Anne's-gate, Westminster, S.W. Names of contractors desiring to tender to be sent to the Clerk of the Committee by April 6. See advertisement in last issue.

**Park Royal.**—The Directors of the Great Western Railway invite tenders for motor-generators, natural-draught cooling towers, electrically-driven and hand-driven overhead travelling cranes and runways, conveyors, etc. Specifications, etc., can be obtained at the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, London, S.W. Tenders by April 26. See advertisement.

**Glasgow.**—The Corporation require tenders for supplying and erecting electric lighting installation, embracing engines, dynamos, lamps, wires, fittings, etc., required at Crawford-street destructor works and stables, Crawford-street, S.S. Specifications and forms of tender may be had on application to Mr. D. M'Coll, superintendent of cleansing, City Chambers, 64, Cochrane-street, Glasgow. Tenders by 4 p.m. on April 7.

**Maidenhead.**—Tenders are required by the Corporation for the supply of stores to the electric power station for 12 months ending March 31, 1905, as follows: (A) engine-room and general stores; (B) tools and engineers' ironmongery; (C) lamps, burners, resistances, globes, and distribution stores. Particulars may be obtained at the office of Mr. C. O. Milton, A.I.E.E., resident electrical engineer, Power Station, Braywick-road. Tenders by April 7.

**Christiania.**—The Board of Trade have received from H.M. Consul-General at Christiania a dispatch reporting that tenders are invited for the supply to the Norwegian State Railways of 464,450 sole-plates and 123,000 spiral washers. A copy of specification, etc., may be seen on

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application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders by 3 p.m. on April 8. Apart from the usual customs duties a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

**Yorkshire.**—The holders of an order for the construction of a light railway in an agricultural district in Yorkshire are prepared to consider the question of transferring the same on terms. The district proposed to be served by the railway is a very wide one, and at present without railway facilities. The prospective amount of passengers and merchandise traffic will, it is expected, be amply remunerative. The capital required will, it is estimated, be about £100,000. For further information apply Railway, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, London, E.C.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Hammersmith Vestry.**—The tender of Cowans, Limited Salford, has been accepted for Andrews's duplicate mains system, at £124. 10s.

**Exeter.**—The Corporation have placed an order with Cowans Limited, Springfield-lane, Salford, for Andrews's duplicate mains system, at £258.

**Aberdeen.**—The Council have accepted the tender of the Westinghouse Company, at £5,676, for the supply of 720-kw. sets for the electric lighting station.

**Dundee.**—The Tramways Committee have recommended the acceptance of the tender of Messrs. Thomas Parker's, Limited, Wolverhampton, for three new generators.

**Gravesend.**—The Town Council have accepted the tender of Graham, Morton, and Co., at £99. 10s., for elevator at the coal store, and Messrs. Zimmers, at £178. 10s., for a coal-conveying plant.

**Poplar.**—The Borough Council have accepted the tender of Messrs. Bruce Peebles and Co., of Edinburgh, for the supply of two turbo-generators and condensing plant with Parsons turbines, at £13,351.

**Islington.**—The Borough Council have accepted the tender of the British Insulated and Helsby Cables, Limited, for the supply and laying of solid mains and paper-insulated cables for one year from April 1.

**Hackney.**—The Guardians have received the following tenders for electrically lighting buildings in course of erection at Gainsborough-road: G. E. Taylor and Co., 8, Bush-lane, Cannon-street, E.C., £661. 19s. 10d.; Electrical and General Engineering Corporation Company, 17, Gracechurch-street, E.C., £579.

**Londonderry.**—The Corporation have accepted the tender of Willcox and Co., 23, Southwark-street, London, and Vacuum Oil Company, Norfolk-street, London, for oils; the Reason Manufacturing Company, Lewes-road, Brighton, for meters and demand indicators; General Electric Company, for carbons, for the Foylehill Hospital.

**Llangollen.**—The Llangollen and District Electric Light and Power Company have placed contracts as follows: Messrs. Crompton and Co., steam dynamos and booster; Messrs. Horusby and Co., boilers and water-heater; General Electric Company, switchboard; Messrs. Blake and Knowles, pumps; Messrs. D. Davies and Son, buildings.

**Hornsey.**—The Borough Council have accepted the tenders of Babcock and Wilcox, Limited, for water-tube boilers, at £3,025; the Wilskemp Smoke Consumer and Fuel Economiser Syndicate, Limited, for smoke-consuming apparatus, at £266. 16s. 6d.; and of the General Electric Company, Limited, for engine-house plant, at £6,298. 10s.

**Loughborough.**—The Town Council have accepted the following tenders for plant required in connection with the electricity undertaking: Messrs. H. and T. Danks Limited, of Netherton, Dudley, for the two dryback boilers, at £1,050; Brush Electrical Engineering Company, Limited, for the steam turbines and dynamos, at £2,850, and condensing plant, at £895.

**Erith.**—The Urban District Council have accepted the following tenders: Sir Hiram Maxim Company, Limited, for superheater and economiser connections and pipework, £932. 10s.; the Electric Construction Company, Limited, for the supply of the motors required for one year; the British Westinghouse Electric Manufacturing Company, Limited, for supply of two 10 h.p. motors at £116. 16s.

**Battersea.**—The Borough Council have accepted the tender of Mather and Platt, at £825, for electric pumps and pipes required in connection with the extension plant at the central electric generation station, and Babcock and Wilcox, at £2 060, for two water-tube boilers similar to those previously supplied one, however, being fitted with hand fired furnace. C. A Parsons and Co. are to supply a spare armature for the steam turbine-dynamo, at £700.

**Various.**—The British Westinghouse Electric and Manufacturing Company, Limited, report the following contracts: South London Electric Supply Corporation, 12 50-kw. and six 18-kw. transformers; Coventry Corporation, 12 50-kw. transformers; Islington Borough Council, contract for the supply of meters for 12 months; Sydney Corporation, the supply of single and polyphase meters for 12 months; South Medomsley Colliery, a complete electric power and lighting installation.

**Poplar.**—The Borough Council have received the following tender for two 1,000-kw. turbo-driven three-phase alternating-current generators and condensing plant:

| | |
|---|---|
| Bruce Peebles and Co., Edinburgh (accepted) | £13.351 |
| Mather and Platt, Limited | 14 890 |
| Parsons and Co. | 14 310 |
| Richardson, Westgarth, and Co. | 13 150 |
| Willans and Robinson | 12,074 |

**London County Council.**—The Council have received the following tenders for the supply and erection of the 30-ton electric jib crane for use at the river wharf, in connection with the Greenwich electricity generating station:

| | |
|---|---|
| Ransomes and Rapier, Limited, London (accepted) | £3,105 0 0 |
| Jessop and Appleby Bros., Limited, Leicester and London | 3,111 10 0 |
| J. Booth and Bros., Limited, Rodley, Leeds | 3 334 0 0 |
| Cowan, Sheldon, and Co., Limited, Carlisle | 3,402 0 0 |
| G. Russell and Co., Limited, Motherwell | 4,548 17 0 |

**London.**—The Metropolitan Asylums Board have received the following tenders for fire-alarms and telephones installation at Caterham Asylum:

| | |
|---|---|
| F. Hodgson and Co., 24, Queen Victoria-street, E.C. | £298 0 0 |
| Gent and Hurley, 44, Belvoir-street, Leicester (accepted) | 322 15 0 |
| Cox-Walkers, Darlington | 326 0 0 |
| Baxter and Impey, Dudley-street, Birmingham | 328 10 0 |
| E. Newbald and Co., 18, High-street, Sutton, Surrey | 346 10 4 |
| E. T. Mackrill and Sons, Kingsbury-square, Aylesbury | 375 15 1 |
| A. V. Gifkins and Co., 68, Victoria street, S.W. | 378 0 0 |
| J. Sax and Co., Limited 51, Rupert-street, W. | 384 10 0 |
| P. Dewhirst, 24, Birley-street Blackpool | 389 0 0 |
| J. T. Mayfield and Co., 63 and 63A Cannon-street, E.C. | 395 0 0 |
| Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, S.W. | 401 8 6 |
| W. J. Furse, Traffic-street, Nottingham | 480 0 0 |
| Tamplin and Makovski, Limited, James street, Haymarket | 455 0 0 |
| Wright, Metnuen, and Co., 27, Chancery-lane, W.C. | 462 0 0 |
| J. Bakewell and Co., Limited, 46, King William-street, E.C. | 493 10 0 |
| Willey and Co., Limited, Exeter | 520 0 0 |
| Jackson Bros., The Broadway, Plaistow | 533 0 0 |
| Sherman, Redfern, and Muston, 16 and 17, Devonshire-square, E.C. | 547 9 0 |
| National Telephone Company, Limited, Salisbury House, London-wall, E.C. | 580 0 0 |

Engineer's estimate, £520.

**Greenock.**—The following tenders have been received for extension of generating plant:

| | |
|---|---|
| International Electrical Engineering Company, London (with Brush engines) | £2,749 |
| Ditto (with Howden engines) | 2 897 |
| J. Fowler and Co., Leeds (with Howden engines) | 2,867 |
| Ditto (with Allen engines) | 2,985 |
| Dick, Kerr, and Co., London (with Belliss engines) | 3,648 |
| Ditto (with Willans engines) | 3,320 |
| Ditto (with Allen engines) | 3,235 |
| Ditto (with Howden engines) | 3,042 |
| Ditto (with Browett-Lindley engines) | 3 461 |
| Ditto (with Gourley Bros.' engines) | 2,746 |
| Brush Electrical Engineering Company, Loughborough (with Brush engines) | 2,910 |
| Ditto (with Brush-Parsons turbines) | 3,060 |
| I. R G. P. and Telegraph Works Company, London (with Belliss engines) | 3 636 |
| Ditto (with Allen engines) | 3,283 |
| Ditto (with Howden engines) | 3 203 |
| Siemens Bros., London (with Gourley Bros' engines) | 2 771 |
| Ditto (Davey, Paxman, and Co.'s engines) | 3,088 |
| Ditto (with Howden engines) | 3,196 |
| Ditto (with Browett-Lindley engines) | 3 499 |
| Ditto (with Willans engines) | 3 353 |
| Ditto (with Allen engines) | 3 296 |
| Ditto (with Belliss engines) | 3,566 |
| Industrial Electrical Engineering Company, Hyde (with Allen engines) | 3,151 |
| Ditto (with Belliss engines) | 3,434 |

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| | |
|---|---|
| Ferranti Limited, Hollinwood (Siemens dynamos) | 2,980 |
| Ditto (Silvertown dynamos) | 3,360 |
| Ditto (E.C.C. dynamos) | 2,567 |
| Davey, Paxman, and Co., Colchester (with Johnson and Phillips dynamos) | 2,989 |
| Ditto (with E.C.C. dynamos) | 3,112 |
| Ditto (with Lancashire Dynamo Company's dynamo) | 3,016 |
| Ditto (with Thos. Parker dynamos) | 2,990 |
| T. Parker, Limited, Wolverhampton (with Alley-M'Lellan engines) | 2,915 |
| Ditto (Davey, Paxman, and Co.'s engines) | 2,998 |
| Ditto (with Belliss engines) | 3,524 |
| Lancashire Dynamo and Motor Company (with Alley-M'Lellan engines) | 2,924 |
| Ditto (with Belliss engines) | 3,620 |
| Ditto (with Browett-Lindley engines) | 3 431 |
| Ditto (with Howden engines) | 3,133 |
| Ditto (with M. Paul and Co.'s engines) | 2,454 |
| Ditto (with Willans engines) | 3 420 |
| Bruce Peebles, Edinburgh (with Belliss engines) | 3 464 |
| Ditto (with Willans engines) | 3,266 |
| Ditto (with Howden engines) | 3,063 |
| Ditto (with Gourley engines) | 3,667 |
| Electric Construction Company, Wolverhampton (with Gourley engines) | 2,815 |
| Ditto (with Howden engines) | 3.139 |
| Ditto (with Willans engines) | 3,424 |
| Ditto (with Belliss engines) | 3,585 |
| Ditto (with Allen engines) | 3,317 |
| J. P. Hall and Co., Oldham (with Belliss engines) | 3,780 |
| C. A. Parsons, Newcastle (with Parsons turbine) | 3.000 |
| Crompton and Co., Chelmsford (with Gourley engines) | 2 511 |
| Ditto (with Belliss engines) | 3,461 |
| Johnson and Phillips, London (with Davey, Paxman, and Co.'s engines) | 2,945 |
| Ditto (with M. Paul and Co.'s engines) | 2,361 |
| Ditto (with Sisson engines) | 3 531 |
| Ditto (with Belliss engines) | 3,487 |
| Ditto (with Browett-Lindley engines) | 3,406 |
| Ditto (with Allen engines) | 3,197 |
| Ditto (with Howden engines) | 3.027 |
| Browett-Lindley, Patricroft (with Siemens Bros.' dynamos) | 3,446 |
| Ditto (with Lancs. Dynamo Company's dynamos) | 3,413 |
| Ditto (with Fowler dynamos) | 3,206 |
| Ditto (with I.E.E. dynamos) | 3,257 |
| Ditto (with Johnson and Phillips dynamos) | 3,476 |
| Ditto (with Mather and Platt dynamos) | 3,455 |
| Lahmeyer Electrical Company, London (with Browett-Lindley engines) | 3,258 |
| Ditto (with Belliss engines) | 3,555 |
| Ditto (with Howden engines) | 2,964 |
| General Electric Company, Birmingham (with Davey, Paxman, and Co.'s engines) | 2,880 |
| Ditto (with Howden engines) | 3,020 |
| Ditto (with Belliss engines) | 3 457 |
| Electrical Company, London (with Howden engines) | 2,943 |
| Ditto (with Allen engines) | 3,053 |
| Ditto (with Willans engines) | 3,152 |
| Ditto (with Belliss engines) | 3 350 |
| Mather and Platt, Salford (with Allen engines) | 3 306 |
| Ditto (with Howden engines) | 3,113 |
| Ditto (with Browett-Lindley engines) | 3 490 |
| Ditto (with Willans engines) | 3 510 |
| Ditto (with Belliss engines) | 3,737 |
| Mavor and Coulson, Glasgow (with Gourley engines) | 2,691 |
| Ditto (with Belliss engines) | 3 576 |
| Royce, Limited, Manchester (with Belliss engines) | 3 950 |
| Ditto (with Belliss engines) | 3,690 |
| British Westinghouse, Manchester (with Belliss engines) | 3,473 |
| Ditto (with Howden engines) | 3.150 |
| Ditto (with Paul engines) | 2,453 |
| J. and H. M'Laren, Leeds (with Siemens dynamos) | 4,940 |
| British Electric Plant Company, Alloa (with Willans engines) | 3,559 |
| Ditto (with Belliss engines) | 3,951 |

**Hammersmith.**—The Council have received the following tenders for supplies for the next 12 months: Smokeless coal (accepted tenders only)—large best Welsh smokeless coal, delivered at wharf, per ton, (free burning), M. Cory and Son, Powell Duffryn Navigation 17s 5d., Nixon's Navigation 18s 5d., (hard dry) Crynant or equal 15s. 8d., Fforchwen 17s 9d.; Toro' and Thro' best Welsh smokeless, free burning, C. J. Huxtable, small Tredegar, 12s. 4½d. Rubber goods—G. Angus and Co. £20. 7s. 10d. (accepted); E. Murray and Co., £20. 17s. 1d.; J. T. Wilks and Co., £21. 16s 7d; F Bird and Co., £21. 18s. 11d.; Wilcox and Co., £23 18s. 8d.; Crosger Bros., £27. 17s; St Helens Cable Company, £28. 1s. 10d.; J. Gibb and Co., £28. 19s.; Macfarlane and Co., £31. 1s 4d.; Dixone Company, £36 9s Tools—J. Gibb and Co., £81. 1s. 4d.; F. Bird and Co., £85. 11s. 5d.; J. House. £100. 9s. 1½d. (accepted); Buck and Hickman, £103 14s. 9½d.; Pfeil and Sons, £104. 7s. 4½d.; W. H. Willcox and Co., £105. 17s. 7d.; B. Hunt, £116. 4s. Gauges—J. Gibb and Co., £6. 5s. 9d.; J. W. Pimblett and Co., £6. 10s. 2d. (accepted, local firm); G. Angus and Co., £6. 13s. 5d.; W. H. Willcox, £6. 17s. 6d.; North Eastern Rubber Company, £7. 3s.; Buck and Hickman, £7. 13s. 3d.; Macfarlane and Co., £10. 6s. 2d.; Crosger Bros., £11. 1s. Screws—J. Gibb and Co., £28. 18s. 10d. (accepted); Buck and Hickman, £37. 19s. 4d.; Pfeil and Sons, £41. 11s. 2½d; J. House, £155. 6s. 7d. Carbons—De Grelle, Houdret, and Co., £138. 10s. 7d.; Sloan Electrical Company, £139. 18s. 11d.; F. Henrion, £141. 6s. 10d.; Johnson and Phillips, £153. 12s. 2d.; Brush Electrical Engineering Company, £156. 14s. 6d.; General Electric Company, £160. 18s. 2d. (accepted); International Electrical Engineering Company, £175. 6s. 9d.; A. N. Bell and Co. £192 8s. 1d.; G. Braulik, £201. 16s.; International Electric Company £204; Reed's Electrical Engineering Supplies Company, £266. 15s 7d.; Berry, Skinner, and Co., £296. 2s.; Siemens Bros. and Co., £346. 17s. 3d. House service boxes—Cowans Limited, small size 15s., large size £1. 1s. 6d.; Callender's Cable Company, small size £1. 1s. 6d., large size £1. 6s. 6d.; Presburd and Burt, small size 16s. 1d., medium size 18s. 4d., large size £1. 1s. 7d.; Sunbeam Lamp Company, large size. £1. 17s. 6d.; S. Dixon and Co., large size, 19s. 6d.; Spark and Co., large size, £1. 5s. 6d.; Electric and Ordnance Accessories, small size 18s., large size £1. 13s. 6d.; Keighley Electric Light Company, small size 13s. and 14s., medium size 14s. 6d. and 16s., large size 15s. 6d. and 17s.; Johnson and Phillips, large size, 19s. 10d.; Reason Manufacturing Company, large size, 15s. 6d.; St. Helens Cable Company, large size, £1. 3s.; Henley's Telegraph Works Company, small size 11s. 6d., large size 17s. 6d. (accepted). Meter boxes (25 amperes)—Simplified Underground Conduit Company, £1. 2s.; Cowans Limited, £1. 15s. 6d.; Webster and Co., £3; S. Dixon and Co., £1. 1s. 6d.; Dorman and Smith, £2. 2s. 6d.; Berry, Skinner, and Co., £1. 3s. 6d.; Johnson and Phillips, £1. 19s. 6d.; Reason Manufacturing Company, £1. 6s. 6d.; St. Helens Cable Company, £1. 1s. 6d.; Henley's Telegraph Works Company, 19s. 6d. (accepted). Also tendered: Cowans Limited, 50 amperes £1. 17s. 6d., 80 amperes £1. 19s. 6d., 150 amperes £2 6s.; and Henley's, 50 amperes £1. 4s. Meters—Very varied figures were quoted under this heading. The tender of the British Thomson-Houston Company for 100-type induction meters was accepted. Their quotations were as follows: 5 amperes £2. 5s., 10 amperes £2. 7s. 6d., 15 amperes £2. 10s., 20 to 40 amperes £2. 12s., 50 amperes £3. 15s. In order to show how the other quotations were we give the prices for 10 and 50 amperes respectively: International Electric Company, 10 amperes £2. 2s., 50 amperes £2. 10s.; British Thomson-Houston Company, 10 amperes £2. 7s. 6d., 50 amperes £3. 15s. (accepted); G. Braulik, 10 amperes £2. 3s., 50 amperes £3. 12s.; Brush Electric Engineering Company, 10 amperes £2. 8s., 50 amperes £3. 7s. 6d.; Electrical Company 10 amperes £2. 10s. 8d., 50 amperes £3. 17s. 6d.; Chamberlain and Hookham, 10 amperes £2. 10s., 50 amperes £4; Ferranti Limited, 10 amperes £2. 8s., 50 amperes £2. 16s.; Bastian Meter Company, 10 amperes £2. 16s., 50 amperes £4. 9s. 3d.; Witting, Eborall, and Co., 10 amperes £3. 2s. 3d., 50 amperes £5. 5s.; Key Engineering Company, 10 amperes £3. 2s. 9d., 50 amperes £5. 5s. 6d.; British Westinghouse Company 10 amperes £3. 16s. 10d., 50 amperes £4. 5s. 6d.; General Electric Company, 10 amperes £4. 6s., 50 amperes £5. 8s. 6d. Electrical goods (accessories)—G. Braulik, £20. 3s. 4d.; Edison Swan United Company, £20. 3s. 9d.; Berry, Skinner, and Co., £20. 9s. 1d.; General Electric Company, £20. 11s. 3d. (accepted, local firm); Emanuel and Sons, £21. 0s. 3d.; Johnson and Phillips, £23. 5s. 11d.; Hiram Maxim Electric and Engineering Company, £25. 11s. 0½d. Insulating—General Electric Company, £22. 12s. 8d. (accepted); R. Woods and Co., £22. 17s 4d.; Siemens Bros. and Co., £24. 10s.; G. Braulik £25. 4s.; British Insulated and Helsby Cables, £25. 11s.; W. T Henley's Company £26. 2s. 8d.; E. Roberts, £28; Emanuel and Sons, £28; St. Helens Cable Company, £39. 4s.; E. Murray and Co., £49. Also Connolly Bros., Berry, Skinner, and Co., and J. T. Wicks and Co. for a few items only. Insulated wires—Anchor Cable Company, £2?9. 7s. 10d. (accepted); Johnson and Phillips, £280. 10s. 9d; Liverpool Electric Cable Company, £283. 19s. 6d.; W. T. Glover and Co., £287. 1s. 5d.; British Insulated and Helsby Cables, £298 7s. 1d; Siemens Bros. and Co., £323. 9s. 10d.; General Electric Company, £323. 14s. 8d.; Western Electric Company, £325. 0s. 10d.; Connolly Bros., £335. 4s. 9d. Also St. Helens Cable Company, W. T. Henley's Telegraph Works Company, Berry, Skinner, and Co., W. T. Dennis and Co., Craigpark Electric Cable Company, Sir Hiram Maxim Electric Company, and G. Braulik for a few items only. Arc lamp accessories—Johnson and Phillips, £10. 5s. 9d. (accepted). Arc lamp globes and shades—Johnson and Phillips. £42. 2s. 1d. (accepted); General Electric Company, £52. 15s. 6d.; Siemens Bros. and Co., £79. 1s. 4d. Also Emanuel and Sons, for opal shades only. Brushes and brooms—F. Bird and Co., £40. 12s 6d. (accepted); Buck and Hickman, £48. 13s. 4d. Packing and jointing materials—W. H. Willcox and Co., £92. 11s. 10d. (accepted); J. Gibb and Co., £94. 18s. 11d; J. W. Pimblett and Co., £96. 17s. 8d.; F. Bird and Co., £97. 13s. 6d.; Wallach Bros., £102. 3s. 0½d.; G. Angus and Co., £106. 9s. 1d.; E. Murray and Co., £109. 17s. 5d; Crosger Bros., £112. 18s.; Macfarlane and Co., £113. 10s. 3d. Also British Asbestos Company, St. Helens Cable Company, J. T. Wicks and Co., Cape Asbestos Company, Dixone Company, Bagshawe and Co., and Klinger and Co. for a few items only. Commutator brushes—R. Woods and Co., £8. 12s. 3d.; C. R. Heap. £8. 15s 9d.; A. A. James, £8. 17s. 3d. (accepted); Brush Electrical Company, £9. 3s.; General Electric Company. £9. 9s 1d.; Buck and Hickman, £13. 7s. Incandescent electric lamps (for whole of items)—Reid's Electric and Engineering Supplies Company, £107 1s.; Hiram Maxim Electric Engineering Company, £125. 11s.; General Electric Company, £179. 12s.; Cryselco Company, £185. 0s. 6d.; Sunbeam Lamp Company, £196. 4s. 6d; W. H. Davey and Co., £194. 17s.; (for incandescent lamps only)—Reid's Electric and Engineering Supplies Company, £31. 5s. 6d.; Premier Electric Lamp Company, £33. 15s.; Cryselco Company, £35. 6s 6d.; Brush Electrical Company, £36. 6s.; Hiram Maxim Electric Engineering Company, £39; British Thomson-Houston Company, £44. 12s. 2d.; General Electric Company, £45. 9s. (accepted); Zurich Incandescent Lamp Company, £47. 2s.; W. H. Davey and Co., £49. 7s.; Sunbeam Lamp Company, £49. 16s.; Edison and Swan United Electric Lamp Company, £54. 18s.; also G. Braulik for one item only.

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# BUSINESS NOTES.

## TRACTION.

**Leith.**—The preamble to the Corporation's Bill has been proved.

**Swindon.**—The construction of the tramway system is proceeding apace.

**Hull.**—The Corporation trams have been running four years, and £62,000 have been paid over to the rates.

**Stockport.**—The Board of Trade have inspected the Cheadle-Gatley extension, and the service has commenced.

**Pemberton.**—The District Council have received sanction to borrow £16,155 for the construction of tramways.

**Bristol.**—The prosecution of the tramways company for overcrowding continues, nine conductors being fined last week.

**Preston-Horwich Tramway.**—The Preston, Chorley, and Horwich Tramway Bill has been read a third time in the House of Lords.

**Luton.**—The Town Council will inspect the proposed tramway route on the 14th inst., preparatory to an application for a provisional order.

**Metropolitan Electric Tramways, Limited.**—Particulars of the offer of £350,000 4½ per cent. debenture stock at par appear in another column.

**Walthamstow.**—The construction of the tramway, which is estimated to cost £180,000, has been commenced, and it is expected that the line will be completed in six months.

**Bristol.**—The Warmley Rural District Council have now assented to the proposed extension, and the Bill as drawn, except for the exclusion of tramways 7 and 9, will go before a Select Committee.

**Southport-Lytham Tramway.**—The Southport-Lytham Tramway Bill, which authorises an extension of time to acquire land, etc., has been reported for third reading by a committee of the House of Lords.

**Lifeguards.**—Within the last few days two children have been saved from serious injury by lifeguards. In two other cases the children became entangled with the lifeguards, and were dragged along with fatal results.

**Douglas.**—The Corporation has this year devoted £2,350 to the relief of rates. The Chairman of the Finance Committee stated that there was every reason to believe that the prosperity of the tramway undertaking will continue.

**Weston-super-Mare.**—The first section of the Weston Grand Pier is being rapidly pushed forward, and, with the pavilion, will be opened in June. Access to the pavilion from the far end of the pier will be facilitated by electric trams.

**Dumbarton-Balloch.**—The local authorities have not yet come to a decision with respect to the proposed electric tramway. If they are not disposed to adopt the scheme, the Electric Supply Corporation are ready to step into the breach.

**Southampton.**—A section of the track laid down for the Corporation in 1889 1900 is to be relaid at a cost of £8,300, beyond which it is estimated another two miles will have to be similarly treated during next year at an equal or greater outlay.

**Paisley.**—The eastern section of the electric tramways system, from Hawkhead to the Cross, has been completed, and one of the Glasgow Corporation cars has traversed this portion of the system. Everything seemed to work satisfactorily.

**Greenwich.**—At the last meeting of the Borough Council it was reported that the accounts with respect to the contract for paving the tramway margins in the borough had now been made up, showing the sum of £7,998. 14s. 9d. due to Messrs. Fry Bros. under their contract.

**Ossett.**—The Corporation's application for a provisional order to construct tramways which would link up the neighbouring districts was before the Board of Trade last week, when the evidence was taken and arguments heard. The Wakefield Light Railway Company are opposing.

**Exeter.**—The City Council have instructed the Tramways Committee to enquire and report as to the desirability or otherwise of entering into arrangements with a company or other body of undertakers for the purpose of renting and working the tramways when constructed.

**Broughty Ferry.**—The Commissioners have found the preamble of this Bill proved, clauses being subsequently adjusted. The moral is pointed from this in some quarters that if the railway companies are to compete with the tramways in the matter of suburban traffic, they too must adopt electrification.

**Berlin-Hamburg Scheme.**—It has been definitely decided to postpone *sine die* all idea of constructing the much-talked-of "high-speed electric railway" between Berlin and Hamburg, which was to have reduced the time of the journey by one half. The authorities have come to the conclusion that the project is unfeasible.

**Platform Invention.**—It is reported that an American engineer has devised a moving platform for railway stations, which will glide at the same speed as a passing train, and permit passengers to enter or leave the cars with ease and safety, as well as the charge and discharge of luggage, without the train stopping for the purpose.

**Brixton.**—In order that the electrification of the line between Brixton-road and Streatham shall be carried out as expeditiously as possible, the London County Council have determined that the service between these points shall be suspended for the two months in which the contractors are under obligation to complete the work.

**Mansfield.**—The Mansfield and District Light Railway Company have given notice of their intention to apply to the Board of Trade to extend for one year from May 13 next the time limited by the Mansfield and District Light Railway Order, 1901, for the construction and completion of the light railway and works authorised by the order.

**Tyneside.**—A trial trip has been made over a new section of electric railway from Newcastle to Benton. This is about six miles long, and runs through the populous residential districts of Jesmond and Benton. This line is expected to be running before Easter week is out, but there may be a little delay in regard to the main portion of the system due to backwardness of the sub-power stations.

**Canvey Island.**—A new light railway is being constructed from the ferry at Benfleet Station to the eastern extremity of Canvey Island, a distance of about four miles, which will be opened in July. The contract price is about £48,000. A handsome bridge over the creek to connect the island with the mainland at South Benfleet, on the London, Tilbury, and Southend Railway, is also to be erected.

**Twickenham.**—At the last meeting of the District Council it was stated that the London United Tramways Company would, in order to cope with the crowded traffic, run a service of cars from the Fulwell depôt in the summer. It was remarked that a service from Shepherd's Bush and Hammersmith to Richmond would be very useful. The Council decided to ask the company to adopt 1d. fares from the Orphanage to Cole's Bridge.

**Anglo-Argentine Tramways Co.**—The progress made by this company, whose report appears in another column, is illustrated by the following figures, which represent the returns for 1833, 1902, and 1903 respectively: number of passengers, 27,575 011, 27,419,188, and 35,470,461; number of miles run, 4,374,277, 5 988,671, and 6,273,767; receipts per mile run, 8 78d., 10·20d., and 12·59d.; expenses per mile run, 6·63d., 7·66d., and 6·67d.; number of cars in stock, 374, 388, and 280.

**Preston.**—The residents of Deepdale and Ribbleton Wards desire an extension of the new tramway system along Ribbleton-lane, from Deepdale-road to the borough boundary. On the 24th ult. the Tramways Committee considered petitions from property owners, ratepayers, and residents and received a deputation in support of the petitions. Finally the committee decided to defer the matter until they have had a year's experience of the working of the routes at present under construction.

**Automatic Signals.**—The North-Eastern Railway Company will in a few days commence the use of the Hall automatic signals between Alne and Thirsk. Although in extensive operation in America, the Hall signalling has not previously been adopted by any British railway. Air at 50lb. pressure is stored in a cylinder at the base of each signal post, whilst valves admitting air into the cylinders are operated by an electromagnet energised by relays from the track circuit with automatic signals.

**Bradford.**—The gross receipts of the Corporation's electric tramways for 1903-4 amounted to £193,000, as against £173,000 in 1902-3. The expenditure amounted to £120 000. As a trading concern there would have been £73,000 left for dividend and depreciation, though the maintenance of the cars, permanent way, and the overhead equipment comes out of revenue; £37,900 will be applied to the sinking fund and interest, and the balance will be allotted to depreciation and such other purpose as the Council thinks fit.

**Newcastle.**—The Select Committee of the House of Lords have allowed only one of the tramways comprised in the Corporation's Bill—that from the borough boundary to Scots Wood Bridge—and they declined to allow the purchase of Scots Wood Bridge by the Corporation. With regard to the extension of the quays and the works in the Ouse Burn Valley, an arrangement was come to between the parties. The committee also directed that the Chillingham-road should be widened as demanded by the Walker Council.

**Scarborough.**—Notwithstanding the inclement weather experienced during the past few weeks the construction of the tramways has proceeded rapidly, and during the last four weeks Messrs. Edmundson, the contractors, have completed 3,000 lineal yards of work on the streets. The principal section on which progress has been made is from the end of Aberdeen-walk down to St. Nicholas-street, where the section up Newborough has been almost joined on. The work in Eastborough and on the foreshore has also been continued at a rapid rate.

**Erith.**—The District Council have decided that the plans and specification for the bridge at the Lower-road level crossing be altered so as to comply with the railway company's requirements at the approximate cost of £500. A site for the car-sheds has been approved. With regard to the Bexley-road bridge, the Board of Trade would not allow a double line of tramways over this bridge with the kerbs of the footpaths as they are at present, but required about 6in. taken off each footpath, or the lines interlaced. The Council have decided on the former course.

**Underground Fusion.**—Mr. R. W. Perks, M.P., chairmain of the Metropolitan District Railway Company, remarked the other day that there could be no doubt of substantial economies being effected by the amalgamation of the Metropolitan and the Metropolitan District Railways. This would particularly be the case with respect to the cheapening of the electric supply required for operating the two railways. The shareholders of the Metropolitan Railway were in favour of amalgamation. The opposition to the overtures of the Metropolitan District came from the directors, and at the present time the negotiations were entirely dropped.

**Aberdeen.**—The draft agreement between the Aberdeen Suburban Tramways Company and the Corporation has been submitted and approved. At the last meeting of the Town Council it was reported that the experiment on the Mannofield route of using covered-top cars had proved highly successful. The receipts for the past week amounted for the new covered car to £43, as against £28, £30, and £31 for those without covers, and this increase was not at the expense of the ordinary takings. Further experiments in the same direction are con-

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templated. In order to obviate draughts which are experienced in certain directions of the wind in the roofed car, it is proposed in future to erect sliding doors.

**Poplar Obstruction.**—Alderman Ivey, chairman of the Tramway Committee of the West Ham Corporation, complained before the London Traffic Commission of the anomalous condition of things that exist through divided local jurisdiction with regard to tramways. Speaking of the electrification of the tramway from Aldgate to Stratford-broadway, he said that, owing to the veto of the Poplar Borough Council his Corporation were in the awkward position of having to work the tramway from Stratford-broadway to Bow Bridge by horse traction as a disjointed section separate from their new electrical section. If the Poplar Council did not withdraw their veto of the overhead system, it was possible that in future passengers would have to change cars at Bow Bridge.

**Watford.**—The Committee of the House of Commons presided over by Mr. A de Tatton Egerton had before them on Friday the Watford and District Tramway (Extension of Time) Bill, under which the promoters sought a further period of years in which to construct and equip a line of electric tramways authorised in previous sessions. The committee, having heard evidence and arguments, found that the preamble was not proved. The Bill was, therefore, rejected. The engineers, Messrs. Pritchard and Green, of Birmingham, are presenting the plans for the approval of the Urban District Council and the Board of Trade, and they intend to proceed with the making of the line forthwith. It is hoped that the Urban District Council will be ready with their current by August, which is the date mentioned in the Bill for construction.

**King's Norton.**—A further conference between a sub-committee of the Tramways Committee of Birmingham City Council and representatives of King's Norton District Council took place the other day. The King's Norton District Council is constructing a new line of tramways on the electric trolley system to Pebblemill-road, where it will join the Bristol-road route, and it is anticipated that the work will be finished in a few weeks. The District Council has thought it advisable to lease the new line to the British Electric Traction Company until 1911, when the Bristol-road lease will fall in. The exchange of views was very thorough, and a friendly spirit again prevailed, but it is understood that no definite agreement has yet been arrived at, as both sides desire to take time to further consider the proposals.

**Torquay.**—At the last meeting of the Town Council it was reported that, after the Tramways Bill had passed the House of Commons, the Lord Chairman's counsel had struck out the electrolysis clause on the ground that last year a similar clause was struck out in the Beckenham case, although it was obtained last season in the cases of Exeter and Brighton. He had also struck out the third schedule of the Bill, which contained the agreement come to with the tramway company with reference to the promotion of tramways. The Town Council had until April 20 for lodging a petition. Representation would have to be made to the Lord Chairman so that his counsel's views should not obtain, and if that did not result in the reinstatement of the electrolysis clause and the reintroduction of the agreement as the schedule to the Bill it would be necessary to take steps to petition the House of Lords.

**London County Council Tramways.**—At Tuesday's meeting of the London County Council the Highways Committee recommended that, in connection with sections of the Council's system in Southwark and Bermondsey, tenders be invited for the erection, under the Council's supervision, of a temporary generating station at Bankside, Southwark, and for the plant and equipment for same; and that the committee be authorised to enter into an agreement with the City of London Electric Lighting Company for the supply of current at 2d. per unit for the working of this plant. Replying to questions, Lord Welby stated that the estimated amount of receipts from the tramways for the year just about to end was £578,500. The actual receipts were £498,363, which, with an estimated further receipt of £17,000, made a total of £515 363, showing a deficiency of £63,137. We understand that the expenditure is also £20,000 above the estimate.

**Pennsylvania.**—Sir Weetman D. Pearson has returned from New York with the signed contracts for the East River tunnels, which are to be constructed by his firm for the Pennsylvania Railway Company at a cost of £4,000,000. There are to be four tunnels under the East River to connect New York with Long Island, and the work is to be completed within four years. Altogether the railway company will spend the vast sum of £20,000,000 on their improvements. Sir Weetman remarked that theirs was not the lowest tender, but the contracts were given to his firm because they had a good knowledge of the work, and the Americans have had very little experience in it up to the present. Unskilled men will be employed above ground at from 6s. to 7s. per day, and those who work below ground will receive from 8s. to 14s. per day. The fact that the contracts have been given to a British firm evoked considerable comment in the New York Press.

**Derby.**—Considerable progress is being made with the work of laying down the electric tramways on the London and Osmaston roads. The posts carrying the trolley wires have nearly all been erected, and a good portion of the lines on both routes laid. The car-shed is a splendidly-appointed place, with glass roof and interior walls of glazed bricks. The new tramcars, which are all built and ready for delivery, are of the most up-to-date type. A rumour has been going about the town to the effect that electric tramcars cannot be run up Ashbourn-road on account of the Great Northern Railway bridge, which is very low, but it is understood that this difficulty can be overcome, and that no doubt in the course of time Friar-gate and Ashbourn-road will also have the use of the electric cars. There is no difficulty now in obtaining rails. The Middlesbrough firm who are supplying them are in a position to turn out several thousand tons per week. It is expected that the electric trams on the London and Osmaston roads will be running by the end of May.

## LIGHTING AND GENERAL.

**Errol.**—The Town Council have decided to borrow £20,000 for electricity purposes.

**Salford.**—The Town Council have resolved to borrow £25,000 for electric lighting works and fittings.

**Mansfield.** The Electricity Committee are considering a report by the engineer as to the adoption of time switches.

**Harrow.**—The General Post Office are about to open an exchange in connection with the Post Office telephone system.

**Whickham.**—The Electric Lighting Orders (Confirmation) Bill has passed the first reading in the House of Commons.

**Walthamstow.**—The Urban District Council propose a further expenditure of £40,000 for electric lighting purposes.

**Maryport.**—A report from Mr. Nicholson on electric lighting will come before the next meeting of the Urban District Council.

**Brighouse.**—A report of Messrs. Lacey and Sillar on the proposed electrical installation at the Mill-lane gasworks is under consideration.

**Strathmore.**—The report noted in our last issue referring to the Blairgowrie scheme has been referred to a committee of the Water Trust.

**St. Pancras.**—The Borough Council are replacing four of the old engines and dynamos with two steam-turbines of 1,000 kw. capacity each.

**Stoke-on-Trent.**—The Corporation have decided to apply for sanction to borrow the cost of wiring all the Corporation buildings for electric lighting.

**Bethnal Green.**—The Borough Council have resolved to supply electric light, to erect a dust destructor, and carry out other works, the total expenditure involved being £200,000.

**Catalogues.**—A. W. Gamage, Limited, have issued an extensive and well-arranged illustrated catalogue containing particulars of motors and everything that the "motist" may require.

**Roller Bearings.**—We are informed that ground has just been broken and contracts let for a 75ft. addition to the new machine shop of the Hyatt Roller Bearing Company at Harrison, N.J.

**Greenock.**—The staff of the Greenock electricity works held their first annual supper and dance last Friday. Between 70 and 80 couples were present. Mr. J. A. Robertson, electrical engineer, presided.

**Bexhill.**—The Electric Light Committee have decided to include £474 in the next year's estimate, and to apply for an additional £200 to cover the amount in excess of previous loans already sanctioned.

**Dover.**—From the electricity supply company's report it appears that if the undertaking had during the past year been a municipal concern, the profits made would have left a surplus of £1,203, after paying all capital charges.

**Hull.**—The Electric Lighting Committee have decided to meet a deputation from the Hull and District Chamber of Trades and the Albert and Myton Wards Ratepayers' Association with regard to the present charges for electric light, etc.

**Wisbech.**—The Town Council have decided to accept the terms of the National Electric Construction Company, Limited, for electric lighting in the borough. At a subsequent meeting of ratepayers a resolution was passed in opposition to the scheme.

**Bristol.**—Extensions of the mains have been sanctioned in Elgin-park, Park-row, Wells-road, Unity-street, St. Nicholas-road, and Redcliff-parade West, and an experiment will be made in Chantry-road with Nernst lamps instead of the incandescent lamps at present in use.

**Heckmondwike.**—The minutes of a special meeting of the Electricity Committee, recommending the expenditure of a further sum of £5,000 on plant for the production of current, came before the Urban District Council on Monday, and were referred back to the committee.

**Llangollen.**—Recent contracts placed by the Llangollen and District Electric Light and Power Company appear in another column. The consulting engineers are Messrs. E. Bremner Smith and Bremner, of Oswestry. It is anticipated that the supply will commence in August next.

**Simplex Steel Conduits.**—The Simplex Steel Conduit Company, of Birmingham, Manchester, and Norfolk-street, Strand, W.C., have issued an embossed trade-mark show card, and we are asked to say that any of our readers who desire copies of the same will be supplied by the company free of charge.

**Fulham.**—It is proposed that the rate collectors be relieved of the duty of collecting the consumers' electric lighting accounts, and that a collector of electric lighting accounts be appointed in the finance department under the control of the borough treasurer at a commencing salary of £150 per annum, rising by annual increments of £10 to a maximum of £200.

**London Gazette.**—A general meeting of the members of the Trafford Power and Light Supply, Limited, will be held at Prudential-buildings, 78, King street, Manchester, on April 29, at 3 p.m., to have an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of, and to determine the manner in which the documents shall be disposed of. A general meeting of the Manchester Electrical Works, Limited, will be held at 147, Leadenhall-street, London, on April 29, at 5 p.m., to have an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of, and to determine the manner in which the documents shall be disposed of. A second and final dividend of 5¼d. per share has been declared in the estate of the Electric Lamp Regenerating Company, Limited, 3, Crown-court, 62, Old Broad-street, London. Payable any day, except Saturday, between 11 and 2 at the Official Receiver's Office, 33, Carey-street, Lincoln's-inn, London, W.C.

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**Hammersmith.**—The Guardians have decided that a committee be appointed to visit the Islington parish infirmary at Highgate, for the purpose of inspecting the electrical installation there. The Building Committee have now under consideration the question of the electric installation for the new workhouse and infirmary buildings.

**Dundee.**—The revenue of the electricity department, it is expected, will amount in May to nearly £7,000. Thus a surplus of £500 would accrue, which it is proposed to devote towards the reduction of the price to the smaller consumers. The present rates are: to consumers of under 20,000, 4½d.; and to consumers of over 20,000, 2½d. per unit.

**Ashington.**—The electric lighting scheme in the district is now almost completed. Nearly all the lamps have been connected with the mains. The number of lights for public lighting purposes has been doubled as compared with the old method of illumination. Many of the churches and public halls in the district have adopted electric lighting.

**Private Bills.**—The Metropolitan Railway Bill, the Cambrian Railways Bill, the West Metropolitan Railway (Abandonment) Bill, and the Tyneside Tramways and Tramroads Bill have been read a third time in the House of Lords. In the House of Commons the Torquay Tramways and the Govan Burgh (Electricity) Bills have been read a third time.

**Falkirk.**—The North British Railway Company have asked the Town Council for terms of a supply of electricity for their Grahamston Station and goods yard, and probably the High Station. They would require at least 35,000 units per annum, and the matter has been remitted with powers to the convener, the town clerk, and resident electrical engineer.

**Lincolnshire and Yorkshire Electric Power Bill.**—The Committee of Selection in the House of Commons have appointed the following members to consider the above, among other private Bills: Mr. Cawley (chairman), Colonel Denny, Dr. Hutchinson, and Mr. Remnant. The committee will meet for the first time to hear counsel and take evidence on April 13.

**Tylorstown.**—Messrs. D. Davis and Sons contemplate installing electric plant at Tylorstown for the working of the machinery at their four pits at Ferndale and Tylorstown. The pumping engines at Tylorstown are at present worked by electrical powers. Engineers from Germany have been consulted on the matter, and have visited the place with the object of reporting on the scheme.

**St. Austell.**—The National Provincial Electric Corporation, Limited, have forwarded to the District Council particulars of the proposals *re* the installation of electric light at St. Austell to be carried out before May. The Council in consequence decided to withdraw its request to the Board of Trade to revoke the order on condition that a guarantee be given that the company would supply electricity within six months of that date.

**Wireless Telegraphy.**—We are informed that recently wireless messages were sent and received in perfect order from the naval station at Heligoland to a boat laying in Hamburg Harbour, and also to a Dutch station erected in a wharf building at Amsterdam. Although the distance, 180 miles, is not large, the fact is interesting as the matter has been accomplished by means of the ordinary appliances supplied to small naval installations.

**Finchley.**—The Urban District Council have approved the following estimate: generation, £476; distribution, £50; public lighting, £64; management, £310; instalment on loans and repayment, £193. 9s. 11d.—total, £1,084. 9s. 11d. Less estimated receipts, £770; estimated deficit, £314. 9s. 11d. The estimated receipts from private houses during the next year are £395. The workmen's dwellings are to be wired at an estimated capital cost of £245.

**Retford (Notts).**—The Town Clerk, reporting at the last Town Council meeting as to the provisional order for supplying electricity, said the time had expired, and the Board of Trade had intimated that they would not permit it to be extended much longer. The Council had made arrangements with the Derbyshire and Notts Electric Power Company to bring the electric supply to the boundary of the borough, where the Council would take control and distribute.

**North Wales Electric Power Bill.**—When the North Wales Electric Power Bill came before the Standing Orders Committee of the House of Lords last week, the examiner reported that the promoters had not complied with the Standing Orders in describing the various works. The committee suspended the Standing Orders and allowed the Bill to proceed, the agent stating that the parties had come to an agreement, and that the representative of Sir Richard Bulkeley, the petitioner, was present in the room.

**Wimbledon.**—The Electric Lighting Committee approved the estimate of capital expenditure for the 12 months ending March 31, 1905, amounting to £6,600. The District Council will apply for sanction to the borrowing of the amount required as follows: mains, £4,000; transformers, £500; sub-stations, £800; meters, £1,200; law costs, etc., £100—total, £6,600. The electrical engineer has been instructed to proceed forthwith with the construction of the underground sub-stations in Somerset-road and Lower Downs-road.

**Thornbury.**—The clerk (Mr. H. P. Thurston) reported at the last District Council meeting the result of an interview which Mr. T. King and himself had had with the Hon. F. L. Pelham at the Board of Trade Office in London last week, with reference to the proposed Electric Powers Bill. The difficulty of the scattered area was discussed, and also the question of the several parishes in the district contributing to the cost without receiving the benefits of the Bill. He (the clerk) was of opinion that the District Council would be granted the powers asked for.

**Stirling.**—The engineer is preparing an estimate of capital required in excess of that already borrowed, the estimate to include any prospective works. The last monthly report by Mr. Hanson, the engineer at the power station, shows that for the four weeks ending Feb 20 last 24,869 units were generated at the station, as compared with 21,789 for the corresponding period of 1903. Estimated by equivalent 8 c.p. lamps, the number was 12,337 The total number connected for all purposes was 13,491, as compared with 10,364 for the same period last year.

**Hornsey.**—The recent electrical exhibition promoted and held by the Council at Crouch End was very successful, and produced a number of new customers, including an order for the wiring of 60 houses in Muswell Hill, and others at Woodland-rise and Woodland-gardens, Highgate. The entire cost of the exhibition, including the supply of electric current for the many lamps and motors, was defrayed by the payment for stall space by the firms exhibiting fittings and appliances. Hornsey has now 411 private consumers connected up, the total number of lamps connected being 24,419.

**Clewer.**—At a recent public meeting the following resolutions were passed: "(1) That the Lighting and Watching Act of 1833, for the whole of the parish, be adopted; and that the Parish Council draw up a scheme to be submitted to another meeting of parishioners." The subject was introduced by Mr. G. Carter. "(2) That this meeting of ratepayers is of opinion that it is of absolute necessity that a scheme be adopted for the collection of refuse, especially with regard to those parts thickly populated, where not sufficient space exists for the proper and safe disposal of such refuse."

**Malvern.**—The electric lighting works were opened on Thursday week by Sir H. Lambert, chairman of the District Council. Powers were obtained in 1890, and in 1899 the Board of Trade threatened to revoke the order if steps were not taken to carry it into effect. Eventually a scheme was approved, providing electric lighting works and refuse destructor, to be erected at the old gasworks, in Pickersleigh-road, at a cost of £17,000, and this has now been satisfactorily completed. Mr. W. H P. Maybury is the surveyor and gas and electrical manager, and Mr. J. H. Crowther the consulting engineer.

**Newport.**—The Newport Chamber of Commerce have adopted a resolution asking for the provision of telephone call boxes at the principal railway stations throughout the country. To the request of the Newport Chamber that such call offices should be opened at the chief stations in South Wales and Monmouthshire, favourable replies had been received from the Post Office, the National Telephone Company, and the Great Western Railway Company. The Post Office asked for the names of stations at which such facilities were asked for, and the chamber resolved to suggest the chief stations from Hereford and Gloucester to Swansea, including the Rhondda and Monmouthshire valleys.

**Erith.**—The resident electrical engineer in his last report states that the cost of renewals and attendance upon the Nernst lamps fitted in the public lamps during the past year had been £847, that of this sum £450 was made up of wages and £397 was for renewals, which worked out at an average of £1. 2s. per lamp per annum for attendance, and 19s. 9d. per lamp for renewals alone, or a total charge of £2. 1s. 9d. per lamp per annum. It is proposed that the Nernst lamps in the public lamps be replaced, as they burn out, by incandescent lamps, two 8-c.p. incandescent lamps to be fitted in the place of one ½-ampere Nernst lamp, and three 8-c.p. incandescent lamps in the place of one ½ ampere Nernst lamp.

**Birmingham.**—The Electric Supply Committee will this week consider their report to the City Council. They will probably recommend the Council to proceed with the erection and equipment of a generating station on the site of the old general hospital, Summer-lane. The committee have had the matter under consideration for some time, and it is estimated that the scheme will cost about £250,000. The scheme, which has been prepared by Mr. Chattock, embodies also the equipment of sub-stations and the laying of an extensive system of underground cables, which bring up the total sum required to over £400,000, nearly half of which will be rendered necessary by the future requirements of the tramways department.

**Glasgow.**—Recently the Caledonian Railway Company objected to the electricity department of the Corporation continuing to take their water supply for condensing purposes at Pinkston electric power station, Port Dundas, from the Forth and Clyde Canal unless a satisfactory arrangement was come to with the Corporation regarding the height of the roof of the Central Station above the bridge which crosses Argyle-street. An amicable settlement has been arrived at regarding the matters in dispute between the parties. The company now agree to give the electricity department all the water they require from the canal so long as it is in their power to do so, while the Corporation on their part have withdrawn their objection to the height of the roof above the Argyle-street railway bridge.

**Glasgow.**—The National Telephone Company have made arrangements for the exclusive right of transmitting by means of the electrophone the performances at the undermentioned theatres and music halls in Glasgow—namely, the Royal, Royalty, King's, Pavilion, Palace, and Zoo Hippodrome. The first church in the district to be fitted with the "electrophone" connection is Rutherglen East United Free Church. Other churches will be similarly connected. Occupants of private residences connected with the National Telephone system in the Glasgow district may become subscribers to the "electrophone" at £3. 3s. per annum, with electrophone receivers for the use of two persons, extra receivers being supplied at £1. 1s. each a year. No charge is made for installation or maintenance.

**Torquay.**—In regard to the proposed new electric light and power station, originally estimated, with machinery, to cost £42,500, it was reported at the Council meeting last week that at a meeting of the committee appointed to reconsider the estimate with a view to reducing the cost, they had put before them another scheme, in which the estimated cost of the buildings was set down at £8,471, as compared with £11,105 in the original scheme. The cost of the chimney, 8ft. 6in. in diameter and 170ft. high, was estimated at £2,300, as

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compared with £3,147 for the original combined shaft 260ft. high and 10ft. 3in. in diameter. It was eventually decided to recommend the Council to revert to the original site and scheme. After discussion the whole question was referred back to the committee.

**Dorking.**—The Dorking Electricity Supply Company (Messrs. Edmundsons, Limited) have commenced operations this week, and the light has been greatly appreciated. The installation starts with a total of 1,500 lamps, representing between 60 and 70 consumers being already connected. The charge is made upon the maximum demand system, the current being supplied at the rate of 7d. per unit for the first hour and 4d. per hour after. An alternative of 6d. per unit is offered for those who desire a flat rate. For power and heating purposes the charge is 4d. per unit for the first hour per day and 1½d. after, or a flat rate of 2½d. The slot-meter system and free wiring are also offered. The resident engineer is Mr. C. Lakin-Smith. The provisional order has been leased to Messrs. Edmundsons by the Urban District Council on very favourable terms.

**Bo'ness.**—Plans for the erection of the electric lighting power station at the east end of Main-street have been passed. The building to be erected is partly two storeys in height. The ground floor is to be utilised as the battery-room. The first floor will comprise offices, etc., for the engineer and office staff. To the rear of the office block, the engine-house is situated. The large and spacious building immediately behind the engine-house and facing north will accommodate the boilers, coal stores, and other accessories for the maintenance of the plant. A chimney stalk, which is to be of a slightly ornamental nature, is to be erected at the back of the buildings at the west side, and will be 120ft. in height. The main building will be entirely of freestone. Owing to the engine-house and boiler-house being to some extent enclosed with the other buildings, light and ventilation will be obtained from the roof. Mr. H. Dighton Pearson, A.R.I.B.A., 17, Chancery-lane, W.C., is the architect.

**Caerphilly.**—The Urban District Council are promoting a provisional order enabling them to supply electric light to Caerphilly town, Llanbradach, Aber, and Senghenydd. At the recent Board of Trade enquiry, Mr. A. H. Preece, for the promoters, said that since last year there had been a great increase in the number of houses in the district, that the proposal to provide a generating station had been abandoned, and an agreement entered into between the Council and the South Wales Electrical Power Company to supply electricity in bulk at three stated points within the district, at a price of 1½d. per unit for a minimum supply of 50,000 units per annum. The order was supported by the unanimous resolution of the Council, of public meetings held throughout the district, of chambers of trade, and of ratepayers' associations. The chief witness for the opposition was Mr. Hammond, and it was urged that the scheme could not be commercially successful; that outside the railway and colliery companies, who would make their own arrangements for power and light, the great bulk of possible consumers would be colliers, and that to avoid showing a loss on the estimates the promoters had inflated the value of current supplied to public lamps and had lowered the outlay on sinking fund.

**London County Council.**—On Tuesday an application from the St. Pancras Borough Council for sanction to the borrowing of a sum of £28,580, repayable within 42 years, for the extension of mains in connection with its electric light installation, was agreed to. The Highways Committee were authorised to expend sums, not exceeding £7,000 in all, for the provision of a temporary electricity generating station at Bankside and the purchase of the requisite plant and electrical equipment for such station in connection with the electrical working of further portions of the Council's tramways situated in the boroughs of Southwark, Bermondsey, etc. The committee were further authorised to obtain tenders for the supply of such plant and equipment, and to arrange for the erection, under the supervision of the chief officer of tramways, of the necessary temporary building at Bankside; and to enter into an agreement on behalf of the Council with the City of London Electric Lighting Company providing (1) that the company shall permit the Council to erect a temporary building at the company's electricity generating station at Bankside, Southwark, and to place therein all the necessary plant for the working of the tramways above referred to; (2) that the plant in question be worked by a staff in the employ of the Council; and (3) that the company be paid by the Council at the rate of 2d. per unit of electric current to be supplied for the working of such plant.

**New Issues.**—Subscriptions are being invited for £50,000 5 per cent. debenture stock at par redeemable at 105 by means of a sinking fund commencing in 1906, or the whole may be redeemed at the option of the company at any time on six months' notice at 105, in the Madras Electric Tramways (1904), Limited. The company is organised to purchase from the Electric Construction Company, Limited, who are also the promoters of this company, the Madras Electric Tramways, and to carry on the undertaking. The price fixed by the vendors for the property is £120,000, payable at £70,000 in shares and as to £50,000 in cash or debenture stock, or both, at the option of the company, and does not include any sum for goodwill. Under the articles of association there will be no initial public issue. The number of directors is to be not less than three nor more than seven. The first are Sir H. C. Mance, Messrs. J. W. Barclay, J. I. Courtenay, and J. Gray. Qualification, £250. Remuneration, £100 each per annum.—An issue of £350,000 4½ per cent. debenture stock is being made by the Metropolitan Electric Tramways, Limited, the company which is carrying out in the northern and north-western suburbs an electric tramways scheme similar in extent and character to that of the London United Tramways Company in the western and Thames Valley districts. In addition to its traction interests, the Metropolitan Company owns all the shares in the North Metropolitan Electric Power Supply Company, which is authorised by special Acts of Parliament, passed in 1900, 1902, and 1903, to supply electricity in bulk throughout an area of 325 square miles. The debenture stock is being issued at par.

**Smoking Concerts.**—The employés of the Robertson Electric Lamps, Limited, Hammersmith, held a most successful concert in the works hall, Brook Green, on March 26. The prizes won by the works fire brigade in the recent London competition were distributed in the course of the evening. The cup for the championship of London, won by the works fire brigade, was presented to the winning team. Mr. H. Hirst, the chairman of the company, occupied the chair, and was accompanied by Mrs. Hirst and several friends. Among other visitors were Captain Miller, the chief of the Leyton fire brigade, and representatives of several of the brigades taking part in the competition. Mr. Wilson, the manager, proposed a hearty vote of thanks to Mr. Hirst for so kindly taking the chair, and this was carried with musical honours. Veritys, Limited, held a smoking concert in the Council Chamber of the Holborn Restaurant on Friday, Mr. C. S. Northcote, M.I.E.E., in the chair. A splendid programme was well executed, and as a result of the evening a substantial contribution will be handed over to the funds of the Verity Athletic Club. Sixteen football matches have been played during the season, of which the club won eight, lost five, and three have been drawn. The total number of goals scored was 44, against opponents' 37. Three matches have been played against Oakfield, two being draws and one a win for Veritys.

**Woking.**—Mr. F. R. S. Bircham, chief of the electrical lighting department of the London and South-Western Railway, considers the Woking Station the best and most economically lighted on the company's system, with the exception of the signal lamps and ground discs—representing 350 globes—which have not yet been connected. The company take their current from the Woking Electric Supply Company, whose responsibility ceases where their 930 yards of cable enters the sub-station of their customers in Maybury-road. The energy is supplied at 2,000 volts and is there transformed to 200 volts—an ordinary working pressure — for the station lighting. Another 2,000-volt cable is laid to a second transforming station at the junction signal box for supplying the arc lamps in the goods yard. Everything is in duplicate, including the switchboard at the generating station. The whole of the work on the railway company's premises was carried out under Mr. Bircham's close personal supervision. Twenty-two tons of bitumen were used in laying the 2,220 yards of high-tension cable and 4,020 yards of low-tension cable. Under their contract with the electric supply company, the company will take a minimum annual supply of 70,000 units. As each circuit is metered, the railway company will know the precise cost of every portion of the installation. There are about 400 separate incandescent lamps, of 8 c.p., 16 c.p., or 32 c.p., used for lighting the station, signal boxes, etc. Except on the covered portion of the up-platform—where the lowness of the roof did not permit of it—these incandescent lamps are supplemented at regular intervals by small arc lamps of 500 c.p., of which there are 31. The latter are intended to be used when trains are in the station, and the incandescent at other times. There are 23 large arc lamps on the approaches to the station, each of 1,500 c.p. A transformer is fitted to each pole, reducing the voltage to about 40, together with lowering gear, which automatically cuts off the current, thus allowing the lamps to be handled with impunity. On the down side of the station are five flame arc lamps, of the same nominal power, but giving a warm, golden light obtained by the use of "salted" carbons. These have a particularly striking effect, but the light does not spread to such a radius as that of the ordinary arc lamp.

## PROVISIONAL PATENTS, 1904.

MARCH 18.

**6585. An improved saddle for carrying electric cables** Robert Craig Sharp, 100, Wellington-street, Glasgow.

**6600. Improvements in the manufacture of cement for use in electric lamps and for other purposes.** Cleminson Electric Lamp Attachment, Limited, and William King, 18, St. Ann-street, Manchester.

**6612. Improvements in or relating to drum supports for electric lamp and other wires.** Gregor Ackermann and Gustav Engisch, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 28, 1903, being date of application in Switzerland.) (Complete specification.)

**6617. Improvements in and relating to controlling devices for electric motors.** Robert Alfred Marples, 1, Queen Victoria-street, London.

**6619. Improvements in and relating to secondary electric batteries.** Edmond Commelin and Réné Viau, 1, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, March 18, 1903, being date of application in France.) (Complete specification.)

**6637. Improvements in galvanic dry cells or batteries.** Bernard Sherman, 16, Devonshire-square, Bishopsgate-street Without, London.

**6646. An improved call system for intermediate telephone stations.** Victor Ammer, 111, Hatton-garden, London.

MARCH 19.

**6664. Improvements in or connected with incandescent electric lamps.** George Davis, 15, Victoria-street, London.

**6666. Improvements in conducting systems for electric railways.** William Casson, 801, Salisbury House, London-wall, London.

**6667. Improvements in conducting systems for electric railways.** William Casson, 801, Salisbury House, London-wall, London.

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**6671. A flame for purposes of illumination, for power, or for heat produced without the aid of coal-gas, oils, or electricity.** Walter Moores, Frederick Edward Oldfield, and Owen George Cooper, 43, Trinity-street, Trinity-square, Southwark, London.

**6678. Improvements in electrical conductors and coils.** James Chris Anderson, 51, Deansgate-arcade, Manchester. (Date applied for under Patents Act, 1901, April 30, 1903, being date of application in United States.) (Complete specification.)

**6679. Improvements in fuses for electric blasting.** Frederick Render, 5, Bank-street, Manchester. (Complete specification.)

**6684. Improvements in telephone exchange systems.** William Aitken, Milton-road, Edge-lane, Liverpool.

**6690. An improved push-button controlled electric lift attachment.** John Bush, 90, Lausanne-road, Peckham, London.

**6716. Improvements in electric switches.** Allen H. Babcock, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

**6724. Improvements in electricity meters for alternating currents.** Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

**6731. Improvements relating to overhead trolleys for electric road vehicles and in the arrangement of overhead conductors therefor.** William Matthew Burlinson, 18, Buckingham-street, Strand, London.

**6747. Improved universal joint for electric light fittings and the like.** Thomas Herbert Marsh and Henry Herbert Stanley Marsh, 322, High Holborn, London.

**5750. Improvements in the electro-deposition of metals.** Sherard Cowper-Coles and Sherard Cowper-Coles and Co., Limited, 82, Victoria-street, Westminster, London.

MARCH 21.

**6780. An improved lifeguard for electric and other tramcars.** Hatton Gregory Harrison, 17, St. Ann's-square, Manchester.

**6792. Improved method of preliminary treatment for accumulator plates.** Henry Leitner, Lynton, Dartnell Park, Byfleet.

**6806. Improvements in and apparatus or appliances for the manufacture of conduits for electric cables.** John Holmes Sutton and Leonard Gregson, 33, Chancery-lane, London.

**6811. Improvements in electrical signalling instruments.** Herbert Watson Sullivan, 19, Great Winchester-street, London.

**6832. Improvements in and relating to the electrolytical extraction of metals from solutions.** John Frederick Webb, 1, Queen Victoria-street, London.

**6833. Improvements in electro-mechanical cut-outs.** James Ernest Spagnoletti, 53, Chancery-lane, London.

**6834. Improved means for automatically controlling the passage of electric currents.** James Ernest Spagnoletti, 53, Chancery-lane, London.

**6843. A new or improved terminal attachment for the conducting wires of electric machines and apparatus.** Arnold Sauser, 18, Buckingham-street, Strand, London. (Complete specification.)

**6857. Improvements in electrical switching apparatus.** John Reid Dick, Norfolk House, Norfolk-street, Strand, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 14, 1904.*

1903.

**6249. Electrical switches known as tumbler switches.** Sperryn and Wood.

**6337. Electric controllers.** Von Kramer.

**6490. Electric switches.** Carolan (General Electric Company.)

**6502. Electric coil-forming apparatus.** Carolan. (General Electric Company.)

**6510. Electrolytic electricity meters.** Bastian.

**6635. Electric switches.** British Thomson-Houston Company, Limited, and Wedmore.

**6660. Cradle or support for the receiver or hand set of combined table and wall telephones.** Brander.

**6671. Telephonic or electric signalling apparatus.** Higginbottom.

**6718. Controllers for electric circuits.** Von Zweigbergk.

**6719. Automatic controller for electric circuits.** Von Zweigbergk.

**6853. Electric road carriages and similar vehicles.** Draullette.

**7241. Loose-handle and quick-break combined switch and fuse.** Whipp.

**8831. Compounding of synchronous alternators for single and polyphase electric currents.** Heyland.

**9088. Contact makers for electrical recording turnstiles.** Marsh.

**9811. Methods of winding dynamo-electric machines.** Carolan. (General Electric Company.)

**11418. Regulators for alternating series arc light systems.** Lake. (General Incandescent Arc Light Company.)

**11579. Anodes for electrolytic operations.** Greenfield.

**11649. Lightning arresters.** Carolan. (General Electric Company.)

**12526. Manufacture of electric cables.** Dieselhorst and Martin.

**20547. Arm supporter for telephones and the like.** Ehret II.

**26273. Controlling devices for electric motors.** Kohler.

**28147. Electrically-operated switches or points for electric railways.** Hillyer.

1904.

**113. Telephones and time recorders therefor.** Fürst and Kragl.

**193. Equipment of electrically-propelled railway cars.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

**711. Controlling devices for electrically-driven vehicles.** Elektrizitäts-Actiengesellschaft vorm. W. Lahmeyer und Co. (Date applied for under International Convention, June 22, 1903.)

**2438. Automatic electrical switches.** Adler.

**2504. Contact shoe for electric railways.** Rosenfeld.

**3246. Apparatus for indicating electrically at a distance the movement of a needle.** Röver.

**3746. Magnetic devices for gripping and releasing bodies, applicable for use with cranes, hoists, winches, and the like** Reichwald. (Duisburger Maschinenbau Actiengesellschaft, late Bechem and Keetman.)

**4353. Electric vibrating apparatus for massage purposes.** Hoffman.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Late price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅛-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 6-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3⅜-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ⅞-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¾-1¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 76-81 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1¼ 1⅜ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9¼ 9 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 90-100 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 12-13 |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ xd |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18¼-19¼ |
| —— 4 per cent. Debentures..... | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 | .. | 35-36 xd |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,301-101,300 .. | 1 | .. | ⅜-½ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 115-118 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12¼-13¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10¼-10⅜ |
| —— 7 per cent. Preference ..... | 5 | .. | 9⅜-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14¼ |
| —— " " £10 Ord. .... | 5 | .. | 10⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 101-103 |
| Chelsea Electricity Supply ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary..... | 10 | .. | 10¼-10¾ xd |
| —— 6 per cent. Cumulative Pref..... | 10 | .. | 13-14 xd |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5⅜ 6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 103-106 |

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| Name. | Amount paid. £ | Late price. £ |
|---|---|---|
| Kensington and Knightsbridge and Notting Hill | 100 – | 103-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 – | 9⅜-10⅛ |
| London Electric, Ordinary | 5 – | 1-1½ |
| —— 5 per cent. Pref. | 5 .. | 4⅛-5 xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 – | 95-98 |
| Metropolitan Ordinary | 10 – | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 – | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 – | 95 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 .. | 98 101 |
| —— Preference | 4 .. | 100 103 |
| Notting Hill Electric Lighting | 10 .. | 13-14 |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 .. | 98-102 |
| Oxford Electric, Ordinary, 1-96 and -14,510 | 5 .. | 5⅛-6 xd |
| —— 4 per cent. Debenture Stock | 100 .. | 96-99 |
| Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures | 100 – | 98-102 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 – | 3-3⅛ |
| —— 4 per cent. Debenture Stock | 100 – | 85-90 |
| South London, Ordinary | – – | 3-3⅛ xd |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 – | 14-15 |
| —— 7 per cent. Pref. | 5 – | 8-9 |
| —— 3½ per cent. Deb. | 100 – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 – | 4⅛-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 .. | 4⅛-5⅛ |
| Westminster, Ordinary | 5 – | 12½ 13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 – | 5-6⅛ |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 – | 92-95 |
| —— 4 per cent. Pref. | 100 – | 98 101 |
| —— ,, ,, deferred | 100 – | 86-89 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 123-126 |
| —— ,, ,, ,, '96 | 100 – | 119-122 |
| —— ,, ,, ,, '01 | 100 – | 118-121 |
| Liverpool Overhead, 5 per cent. Pref. | – – | 13-13½ |
| —— Ordinary, 1-50,000 | – – | 7⅛-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 102-104 |
| Waterloo and City, Ordinary | 100 – | 88-91 |

## Electric Tramways.—

| | | |
|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 – | 4⅜-5 |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 – | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 – | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 .. | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3⅜ 4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 .. | 90-95 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 .. | 10⅛-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 .. | 103-105 p.c. |

| Name. | Amount paid. £ | Late price £ |
|---|---|---|
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 8¼-9⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 9¼-10⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 120-125 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅜-3⅛ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5⅛-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 4⅜-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 104-107 |
| —— Prov. Certs., all paid | 100 – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅛ 2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 .. | 4⅜-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 .. | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 .. | 11-12 |
| —— Debentures | 100 .. | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-12½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 22-22½ |
| —— 6 per cent. Cum. Pref. | all – | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 – | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 .. | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 .. | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 .. | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 .. | 3/16-5/16 |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 .. | ⅛-¼ |
| New General Traction, Ordinary | 5 .. | ¼ |
| —— 6 per cent. Cum. Pref. | 5 .. | 1½-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 .. | 10¾-10⅞ |
| —— 5 per cent. Cum. Pref. | 10 .. | 11¾-12⅛ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 .. | 99 102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8¼ 9⅛ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9 10 |
| —— 4½ per cent. Debenture Stock | 100 – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,152 6 per cent. Preference | 1 – | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 – | 99-101 |
| —— Deferred Stock | 100 .. | 73 76 |
| —— 6 per cent. Cum. First Pref. | 10 – | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 13½-14½ |
| —— 5 per cent. Non-Cum. Third Pref. | 5 – | 5 5⅛ |
| —— 3½ per cent. Deb. Stock, Red. | 100 – | 94 96 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 96 99 |
| Oriental Telephone and Electric Company | 1 – | ⅝ 1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 26 | 1,127 | 840 | + 287 | +10,319h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 19 | 163 | 162 | + 1 | + 158 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 19 | 41 | — | — | — | 1½ | | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 27 | 976 | 991 | − 15 | + 3,289 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 26 | 273 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 25 | 765 | 743 | + 22 | + 2,231 | 24 | 24 | March 25g | 40,964 | 7,234,105 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 24 | 319 | 334 | − 15 | − 406 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·62 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 26 | 210 | 219 | − 9 | − 135 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 27 | 1,618 | 1,686 | − 68 | + 8,798 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 23 | 907 | 892 | + 15 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 20 | 3,572 | 3,321 | + 251 | +20,095 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 27 | 730 | 795 | − 65 | + 2,315h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 25 | 4,467 | 4,511 | − 44 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 26 | 889 | 716 | + 173 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 27 | 284 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 19 | 1,795 | 1,675 | + 120 | +23,301 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 24 | 169 | 156 | + 13 | + 271 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 19 | 7,052 | 7,142 | − 89 | + 677h | 6 | 6 | ,, 31 | 357,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 27 | 3,156 | 3,120 | + 36 | − 558h | 6⅝ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 24 | 377 | 390 | − 13 | − 111 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 25 | 205 | 224 | − 19 | − 312 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 26 | 163 | 183 | − 15 | + 183 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 27 | 103 | 85 | + 7 | + 77h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 25 | 3,552 | 3,672 | − 40 | } — | 46 | 46 | March 31 | 125,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 25 | 727 | 736 | − 9 | | | | | | | | | | | |
| Dundee City Tramways | ,, 16 | 764 | 771 | − 7 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 26 | 610 | 609 | + 1 | + 8,781 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Farnworth U.D.C. | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Glasgow Corporation | ,, 26 | 13,571 | 12,643 | + 928 | +55,732h | 124 | 124 | May 31g | 655,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | ,, 23 | 2,457 | 2,183 | + 274 | + 6,479 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 19 | 1,103 | 1,083 | + 20 | — | 34 | 34 | March 31 | 53,631h | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 25 | 1,989 | 1,761 | + 228 | + 8,255 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | ,, 24 | 138 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 23 | 192 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 26 | 5,081 | 4,996 | + 90 | +15,521 | 77 | 77 | March 25g | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 19 | 9,533 | 9,511 | + 22 | + 3,075 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 27 | 1,600 | 1,603 | − 3 | + 294h | 15½ | 15½ | June 30 | 79,252 | 10,456,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 12 | 10,129 | 8,604 | +1,525 | +81,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 19 | 124 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 19 | 94 | 59 | + 35 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 26 | 3,452 | 3,114 | + 338 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Portsmouth Corporation | ,, 26 | 1,362 | 1,441 | − 79 | + 5,531 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 28 | 102 | 112 | − 10 | — | 4½ | 4½ | March 31g | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 17 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 21 | 3,659 | 3,003 | + 656 | +52,113 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 27 | 4,365 | 4,255 | + 110 | +20,205 | 53½ | 53½ | Mar. 25g | 216,309 | 56,312,043 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 24 | 842 | 891 | − 49 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 20 | 1,054 | 1,010 | + 54 | + 2,975 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,387,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 26 | 593 | 560 | + 33 | + 4,023 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 24 | 258 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**McMillan Memorial Fund.**—We are informed by the Institution of Electrical Engineers that the committee of the electrical engineers' ball unanimously decided, with the concurrence of those interested, to ask the committee of management of the benevolent fund of the Institution to receive a cheque for £56. 12s. 11d., the balance remaining in their hands after paying all expenses connected with the ball, this amount to be applied by the benevolent fund management to the McMillan memorial fund.

**Radium and the Electric Resistance of Bismuth.** A recent investigation by Mr. R. Paillot, which appears in the *Comptes Rendus*, deals with the action of radium bromide on the electrical resistance of bismuth. This investigator showed by experiment that the resistance of a spiral of bismuth wire is considerably reduced when the latter is placed in the neighbourhood of radium bromide. The action of the radium salt is instantaneous, and it remains constant as long as the wire is kept at a constant distance from the radium.

**Magnetic Investigations in the Antarctic**—Latest advices state that the chief practical interest of the "Discovery" expedition attaches to the results of the magnetic investigations. Continuous observations were taken in the neighbourhood of the magnetic pole. The subject was dealt with by Vice-Admiral Markham in a lecture before the Royal Geographical Society last year, when it was stated that the society would publish a detailed account of these investigations, which will doubtless be read with much interest.

**Electricity in Syria.**—A United States consul reports that the Beirut gasworks, which have a 99-year exclusive franchise from the Ottoman Government and first option on use of electricity, was recently purchased by Ibrahim Sabbag, a wealthy and enterprising Syrian, who is an honorary dragoman of the consulate. Mr. Sabbag is interested in securing the co-operation of American experts, being hopeful of extending the use of gas, and eventually of electricity, throughout Turkey in Asia. American electric fans have recently been admitted to Beirut, where quite a few have been sold during the past year. It is believed that electric street railways will be authorised by the Central Government before long, along with electric light, telephones, etc. We take this note from the *Electrical World*, and trust that some of our English firms will obtain a share of the proposed electrical work in Syria.

**Tesla Split-Phase Motor.**—We have received the judgment in an important trial before the Circuit Court of the Western District of New York over the Tesla split-phase motor patents numbered 511,559 and 551,569. Judge Hazel heard the case, and has decided in favour of the Tesla patents in question. The suit was brought against the manufacturer of a wattmeter in which the motoring action was produced by a split-phase arrangement. This decision reverses a previous one on the same patent, in which another judge held that the arrangement in question had been fully described and disclosed in a magazine article by Prof. G. Ferraris on April 22, 1888. Judge Hazel disagreed materially with this previous decision, and held that there was clear proof that Tesla had conceived his invention and completed it in the month of September, 1887. He also communicated the same to his patent solicitor before the date of publication of the magazine article in question.

**A Series of Transformations.**—The Great Northern Railway Company of France are going to considerable trouble in order to light the railway station at Longueau by electricity. This station is distant about three miles from Amiens, where the company has a direct-current plant. The processes through which the current will be transmitted are as follows. In the first place, the direct current will be converted by two 35-kw. Westinghouse rotary converters into single-phase current. The voltage in the rotary on the direct-current side will be 125 and on the alternating-current side 88. After this conversion it will be transformed up from 88 to 3,500 volts, and transmitted to Longueau. Here, again, it will be transformed down, the final pressure being 115 volts. In order to allow for the drop in the line, the transformers at Amiens are to be fitted with multiple contacts, so that the number of secondary coils in circuit can be varied. In this way a constant pressure at the lamps at Longueau will be secured.

**London United Electric Tramways Extensions.**—The line connecting Hammersmith Broadway—District Railway—with the City, *via* Acton, Ealing, Hanwell, Southall, Hayes, Hillingdon, and Uxbridge Town has now been constructed. On Monday evening, the 28th ult., a car conveying the engineering staff, superintendent, and other officials, including Mr. Clifton Robinson, engineer to the company, made an initial trip over the line for the purpose of testing the new works; Mr. Clifton Robinson, jun., driving most of the way. The car started at eight o'clock from the Chiswick depôt, reaching the old terminus at Southall shortly before nine, and Uxbridge terminus about 9.45, leaving on its return journey at ten. The run proved successful in every respect, the car being enthusiastically welcomed along the route, and especially at Uxbridge, where the inhabitants of the town turned out *en masse* to witness the arrival. With the completion of the depôt and sub-station at Hayes within the next few weeks the works will be ready for the official inspection of the Board of Trade, when the line will be opened for public traffic.

**The Woolwich Electric Railway Abandonment.** In our issue of the 18th ult. we expressed some curiosity as to the outcome of the competition between two municipal authorities in regard to the Woolwich Corporation's projected tubular electric railway to connect the two sides of the river. The Committee of the House of Commons found the preamble of the Corporation's Bill proved, subject to clauses being inserted, at the instance of the London County Council, providing that the Corporation should not oppose any application by the Council for power to construct a free subway, nor be entitled to compensation in the event of the Council constructing such a subway. The Corporation, after considering these stipulations, have decided that they are too onerous, and, consequently, the Bill has been abandoned, so that those travellers who sometimes find the London County Council ferry service interrupted by atmospheric vagaries such as fogs must seek for consolation in the County Council's suggested scheme. We are constrained, however, to reiterate our opinion that in this instance concerted action would have been much more desirable.

**"The Central."**—The second number of *The Central*, which is the official organ of the Old Students' Association of the Central Technical College, is in no wise behind the high standard set by the first issue. It is proposed, we gather, to publish three issues of the journal each year, in March, June, and November respectively. In the present issue the engineering laboratories and workshops at the Central are described and illustrated by Profs. W. C. Unwin and A. G. Ashcroft. These descriptions show that the equipments are thoroughly up to date, and that there are engines of a large number of types on which the students can carry out practical trials. Other articles interesting to electrical engineers are those respectively by Mr. R. S. Dahl on the "Design of Small Motors," and by

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Mr. J. M. Donaldson on "Electrical Power in the City of Montreal." In each case the author is an old student. In the conclusion of the last article Mr. Donaldson expresses the hope that the magnitude of the electrical work in Montreal will lead other members of the institution to investigate for themselves the electrical possibilities of the Dominion. The "Old Students' Notes" at the end of the volume are interesting reading, and indicate that not only is good work being done, but that the influence of the Central is world wide.

**Electrical Transmission in Alaska.**—The March number of the *Journal of Electricity, Power, and Gas* of San Francisco contains some interesting information on this subject. It states that continuous discoveries for the past six years have demonstrated the vastness and richness of Seward Peninsula, Alaska, as a goldfield. The mint returns for the past year prove it to be the greatest placer mining section of the United States, if not of the world. Into this great field, heretofore mined in the most crude and expensive manner, a new factor is about to enter that will multiply its output many times and render workable vast areas of rich ground that heretofore have been wholly unavailable by reason of the scarcity of hydraulic water and the very high price of fuel and wages. It was an unexpected discovery last year that 40 miles north of Nome water sources with a capacity of 100,000 h.p. existed on the north side of the Sawtooth Mountains. These water powers are now to be converted into electricity, which will be transmitted to the mines all over the peninsula for hydraulic uses. From an electrical point of view, this enterprise is thoroughly practical, and its development will be followed with keen interest by electricians. It will have the distinction of being the farthest north of all transmission lines. Devoted almost exclusively to the production of gold, in a field where gold is plentiful, it should prove one of the most if not the most, profitable transmission plant in the world.

**The Combined Engineering Institution.**—We recently indicated that the success of the projected central home for the joint use of the different electrical institutions of the United States might be imperilled by the withdrawal of the Society of Civil Engineers. Happily, the action of this body will not affect the consummation of this admirable scheme. Mr. Carnegie has assured the remaining parties—*i e*, the Society of Mechanical Engineers, the Institute of Mining Engineers, the Institute of Electrical Engineers, and the Engineers' Club of New York—of his continued interest in the plan by repeating his offer of a munificent contribution, the amount now promised being £312,500 (1½ million dollars). There will be four or five auditoria, one large enough to seat from 1,200 to 1,500 people, fully equipped for scientific meetings and lectures. Another feature will be an engineering museum and a library hall, where the libraries belonging to the different societies will be grouped. Each section will be administered by its respective librarian; and to each will be added literature relating to its own branch of work, so that duplication both of books and periodicals will be avoided. The libraries of the three societies at present include about 50,000 volumes. Their membership aggregates over 9,000, and the annual rate of increase is between 10 and 15 per cent. Other technical societies desiring quarters in the building represent a body of over 500 members, engaged in all branches of civil, mechanical, electrical, municipal, and other branches of engineering. The development of the project into virtually an accomplished fact cannot but be gratifying in the extreme to all interested in the movement.

**Iron and Steel Institute.**—As previously announced, the annual meeting of the institute will be held on Thursday and Friday, May 5 and 6, 1904, commencing each day at 10.30 o'clock a.m. From the detailed programme of the proceedings we note that, after the election of officers and council on the Thursday, the awards of the various medals and research scholarships for 1904 will be announced. A selection of papers will then be read and discussed. In the afternoon there will be a demonstration of pyrometers suitable for metallurgical use. On the Friday morning there will be the usual sessional meeting, at which papers will be read and discussed, and the annual dinner of the institute will be held in the Grand Hall of the Hotel Cecil on the same night. The following papers are expected to be submitted: "On Pyrometers suitable for Metallurgical Work"—report of committee; "On Coke Ovens," by C. Lowthian Bell, Middlesbrough; "On Troostite," by H. C. Boynton, Harvard University; "On the Range of Solidification and the Critical Ranges of Iron-Carbon Alloys," by H. C. H. Carpenter, M.A., Ph.D., and B. F. E. Keeling, B.A., National Physical Laboratory; "On Explosions produced by Ferro-silicon," by A. Dupré, Ph.D., chemical adviser to the Explosives Department, Home Office, and Captain M. B. Lloyd, R.A., H.M. inspector of explosives; "On the Thermal Efficiency of the Blast Furnace," by W. J. Foster, Darlaston; "On the Production and Thermal Treatment of Steel in Large Masses," by Cosmo Johns, Sheffield; "On the Manufacture of Pig Iron from Briquettes at Herräng, Sweden," by Prof. H. Louis, M.A., Assoc R.S.M., Newcastle-on-Tyne. Reports on research work carried out during the past year will be submitted by C. O. Bannister (London), by P. Breuil (Paris), by K. A. Gunnar Dillner and A. F. Enström (Stockholm), by J. C. Gardner (Middlesbrough), by F. H. Wigham (Wakefield), by A. Campion (Cooper's Hill), and by P. Longmuir (Sheffield), Andrew Carnegie Research Scholars.

**The Marconi Company and the Post Office.**—It will be remembered that both Mr. Austen Chamberlain and Lord Londonderry when at St. Martin's-le-Grand refused to afford the facilities for wireless telegraphy desired by Mr. Marconi, on the ground that there was no security for the delivery of messages outside the country. Lord Stanley, however, is now disposed to favour a provisional arrangement with the company, though recent statements that an agreement had been concluded between the company and the Post Office are premature. The basis of an agreement has been arrived at, and the Postmaster-General is drawing up certain recommendations to be submitted to the Cabinet; but he has not in any way pledged the Government. The following are understood to be the chief points in the proposed agreement: (1) The General Post Office undertakes to recognise and deal with Marconi messages on similar terms to those received and transmitted by the existing cable companies. (2) Senders of messages, on electing to avail themselves of the Marconi system, will be subject to rates which are inclusive of inland and oversea transmission; these rates to be payable to the Post Office. Similarly, the cost of wireless messages dispatched on the high seas or "on the other side" to England will be collected at the office of dispatch; the messages will be retransmitted to inland towns from Marconi stations on our coast in the same way as the messages sent by cables are now dealt with. (3) Working arrangements have been come to whereby Transatlantic messages — *i.e.*, communications between England and America and *vice versâ*—may be dealt with. (4) Special facilities are offered to voyagers on the high seas to dispatch and receive messages to and from any part of the mainland.

**Niagara Falls.**—We gather from our contemporary the *Electrical World* of New York that considerable

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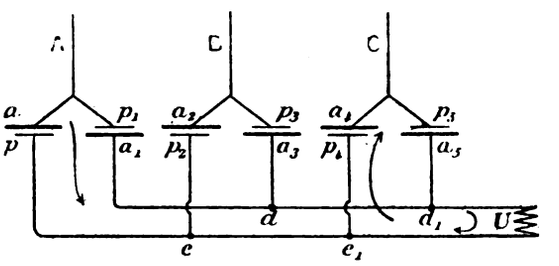
opposition is being brought against the proposals before the New York State Senate Committee for the increase in the water rights of the Niagara, Lockport, and Ontario Power Company. The reason for the opposition was given by Mr. C. M. Dow, who is the president of the Board of Commissioners of the State Reservation at Niagara. He explained that owing to the greater declivity of the river bed on the Canadian side, as well as the wider expanse of the Horseshoe Fall, it is estimated that only one-fifth of the whole volume of the river passes over the American fall. Furthermore, owing to the difference in elevation of the Canadian and American river beds, the water has a tendency to gravitate toward the Canadian fall, and the American fall is the first to show the effect of any subtraction of water from the river above. As the general depth of the water on the fall is only about 4ft., and as the elevation of the American fall is something like 6ft. or 7ft. above that of the Canadian fall, it is apparent that the American fall might be made entirely dry while water still poured over the Canadian fall. That such a discrepancy would appear in the event of the diversion of a sufficient amount of water is not simply a theory; the fact was demonstrated in 1848, when the flow of the river was diminished by an ice blockade at the foot of Lake Erie, and on a lesser scale by more recent ice gorges. From the foregoing it would appear that the diversion of 20 per cent. of the water of the Niagara River would render the American fall dry. No less than eight American companies have been authorised to take water from the falls, and there are also two Canadian companies. As most of these have unlimited right to take water, it would seem that in the future the American side of the falls is likely to be seriously interfered with, even if it is not converted from a waterfall into a dry gorge.

**Training of Engineer Apprentices.**—At the concluding meeting for the session of the Belfast Mechanical and Engineering Association, Mr. F. C. Forth, the president, read a paper on this subject. The scheme which he recommended was that apprentices who had served two years of their time and were not less than 17 years of age, and who for diligent attendance at evening classes had shown themselves worthy of special privileges, should be allowed to attend a special course of instruction at the municipal technical institute on one day per week. Admission to the technical institute to be conditional on the candidate passing an entrance examination in English, drawing and the elements of mathematics, the privilege only to be extended to specially capable apprentices, not necessarily to the general body. This proposal would, he thought, obviate in a large measure the difficulties often experienced by apprentices in attending evening technical schools in consequence of working overtime or being unfitted for study after their day's labours. Mr. Walter Wilson said that neither his late partner, Sir Edward Harland, Mr. W. J. Pirrie, or himself had ever benefited by a technical school. No lad should have an hour taken from his work in the shop for the purpose of acquiring knowledge in such a way. That should be kept for the evenings. Mr. R. Blair, assistant secretary of the department of agriculture and technical instruction, referred to the system of training adopted in America, which he had visited with the Moseley Commission. Apprentices were manufactured in two ways in the States. The method of training boys for mechanical engineers was much the same as in England, but the training of manufacturing engineers was different, and much more elaborate. The latter class, he said, were unknown in the three kingdoms, for they were the men who made the machines that engineers over here worked. The speaker quoted a number of testimonials by great American employers of labour to the value of men who had received a good technical education.

**Three-Phase Electrolytic Rectifiers.**—Mr. Emile Mors contributes to *L'Industrie Electrique* a description of an electrolytic rectifying device, with which, presumably, he is interested, for the conversion of three-phase currents into a continuous current. The apparatus involves the use of the electrolytic valve, which has long been known. The connections used in this instance are shown in the illustration herewith. Each of the wires of the three-phase system




are connected on to two electrolytic valves, in each of which there are two plates—one of aluminium and the other of some other material. As is well known, such apparatus only allows the current to pass in the one direction. The two electrolytic valves on each wire are oppositely connected. It will be seen from the connection that the aluminium electrodes are connected on to one of the wires through which the continuous current is to flow, while the other wire is connected on to the three plates of other material. With this arrangment the current in the rectified circuit is always in the same direction, and the curve of E.M.F. has undulations of exceedingly small amplitude. The author states that with a pure sine wave in the three-phase system the variation from the mean would be under 15 per cent. From the curve actually given in the article this variation seems to be even less. Mr. Mors further states that the Société du Nord-Lumière, having tried their apparatus in the sub-stations at Clichy and Courbevoie, have now decided to use them at these stations for converting three-phase currents at 25 periods and 110 and 220 volts to direct current. In both cases the voltage obtained is considerably higher than the effective pressure of the currents applied, which, the author states, has not previously been the case in other attempts in the same direction, because they have not utilised the higher part of the curve of three-phase currents. This increase in voltage in the case of three-phase currents at 215 volts allowed of 230 volts being obtained on the direct-current side. This is used to supply six arc lamps in series. The efficiency, measured by two Aron meters, has varied between 75 and 78 5 per cent., and the apparatus does not heat more than 20deg. C. over the surrounding air. We should like to have seen some information as to the magnitude of the current which has been rectified with this apparatus.

**Electrical Gold Dredging.**—Mr. C. Weston Clark contributes an interesting article to the *Electrical World* on the subject of electrically-driven gold dredgers in California. It seems that with cheap electrical power the electric dredger can profitably operate on soils containing 5dwt. of gold per cubic yard, which was quite impossible with steam-operated dredgers. The gold-carrying soil in California varies from 10ft. to 50ft. in depth, being a gravel deposit from old river channels. The bucket system of dredging is preferred, as a rule, over the one having centrifugal pumps for elevating the soil. The boats are fed by insulated cable, and are usually supplied from a three-phase system at a low voltage, but in a few cases a 4,000-volt supply is laid directly on to the boat and there transformed down. The

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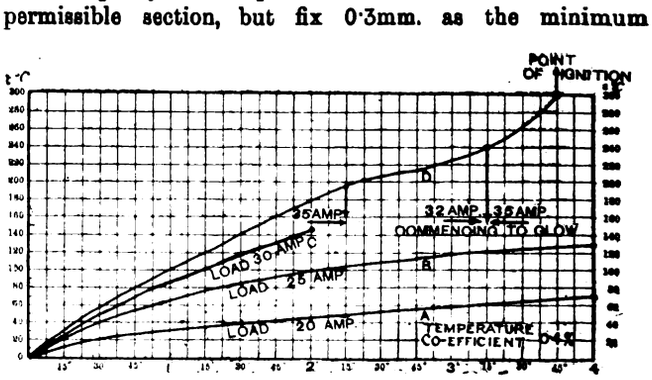
dredger digs its own channel ahead of it, depositing the soil which has been worked behind it. The soil is elevated into a grizzly or similar screening device where the rocks are washed from the soil, the rocks being delivered to the carrier that deposits them out of the way behind the dredger. The soil is then washed through shakers and riffles, leaving the gold deposited on saving tables to be taken up with quicksilver, and the worked-over soil is run out at the stern of the boat. The General Electric Company has standardised this class of equipment, and the following particulars of one recently supplied will be of interest. It consists of the following induction motors: one 50-h.p. motor, with controller and resistance for driving the bucket line; one 15-h.p. motor, with controller and resistance for operating the winches (this apparatus is for working the head lines and changing the direction of the boat to suit the work); one 40-h.p. motor direct connected to a centrifugal pump (this pump furnishes water for washing the soil); one 15-h.p motor to drive the stacker or conveying belt which disposes of the stones; one 15-h.p. motor for operating the shaking screens; one 30-h.p. motor for operating the sand-pump (this motor is worked occasionally when the sand accumulates too thickly at the back of the boat, and delivers it out on the rock pile through a long pipe); one 3-h.p. motor for operating a deck and bilge pump, used for general washing purposes. The buckets each carry three cubic feet of earth. On another dredger with buckets of five cubic feet capacity a normal speed of 22 buckets per minute was obtained. With this the dredger was able to deal with between 50,000 and 75,000 cubic yards of material per month. It is interesting to learn that this heavy chain of buckets is being started satisfactorily by the three-phase motors.

**Oil Switches for High Tensions.**—The *Elektrotechnische Zeitschrift* publishes a belated report of an interesting paper read by Herr Vogelsang before the Elektrotechnische Gesellschaft zu Köln, in which the author deals with oil switches for high tensions. After reviewing the changes which have been rung in the designs for high-tension generating plants since the first transmission scheme was carried out, the author goes on to say that modern practice has discovered two ways of constructing high-tension switches which can be relied upon to satisfy the more exacting requirements of to-day. One of these methods consists in the employment of the horn-break type of switch, while the other embodies the principle of interrupting the circuit under oil. Each has its advantages and disadvantages; the horn-break is only effective with heavy currents—the greater the current the more reliable is its action—a peculiarity which renders it especially adapted for use with fuses. On the other hand, the space which is required for its proper function is considerable. The author goes on to discuss the oil switch—incidentally describing a type constructed by Voigt and Haeffner, Frankfort-on-Maine, which is exceedingly simple. A three-pole switch is provided with six contact jaws, to engage with which there are three blades, so that each pole is interrupted at two points simultaneously. The oil is contained in a removable vessel of tin. To those who have had to do with high-tension switches of other kinds, the quiet action of the above type is somewhat surprising, the interruption of the circuit being unaccompanied by noise. Experiments have shown that the formation of an arc under oil, just as in air, depends very largely upon the speed of the break. The author is of the opinion that the advantage of providing a large number of break points, especially in oil switches designed for very high tensions, will be more appreciated in the future, and thinks this principle better than that adopted by American engineers, of employing extra long breaks under oil. He also points out that oil fuses are much less satisfactory in action than oil switches, because in their case one point of interruption only per pole can be provided. Moreover, at the moment of interruption the particles of melted metal along the path of the fuse assist the formation of an arc. For this reason oil fuses are used only for moderately high pressures, that is up to 3,000 volts, and for relatively small currents. Within this limit oil fuses have proved thoroughly reliable. On the other hand, combination oil switches, in which the ordinary switch blades are replaced by fuses, have met with considerable success, especially in mines. But the practice of employing automatic cut-outs, instead of fuses, in conjunction with oil switches is quickly gaining favour, and it would almost seem that the use of oil switches with automatic releases in place of ordinary switches and special fuses has solved the difficulty hitherto connected with the breaking of high-tension circuits. The advantages of such an arrangement are obvious, especially in that the danger of fire which, in unfavourable circumstances, attends the blowing of high-tension fuses is avoided. In regard to oil switches with maximum current releases, the action is always indirect, being effected either by continuous current through the medium of a relay or by alternating current through a rectifier. The latest phase in the development of this class of apparatus is the construction of automatic oil switches and cut-outs which can be operated from a distance. It is probable that this type of switch will find extensive employment for central-station work. Some interesting details of the several designs mentioned are included. In conclusion, it may be added that the paper in question anticipated the Bristol fire as to date.

**The Inflammability of Twin Flexible.**—A joint contribution by Messrs. J. Herzog and C. Feldmann to the *Elektrotechnische Zeitschrift* gives the results of some experiments undertaken by the authors to determine the safety factor of twin flexible cord, such as is commonly used in connection with electric lighting installations. The tests were made with rubber-covered wire suitable for use in dry rooms, and designed for pressures up to 125 volts. Each conductor of the twin cord was composed of 24 copper strands 0·2mm. in diameter, the sectional area of the two conductors being, therefore, 2 × 0·75 square millimetres. The insulation consisted of a cotton covering, a thickness of Para rubber tape, and two braidings of cotton thread over all. In regard to insulation, the wire complied with the standards adopted by the Verband Deutscher Elektrotechniker. On the other hand, however, the composition of its conductors did not conform to these standards, which indeed specify 0·75 square millimetres as the smallest permissible section, but fix 0·3mm. as the minimum




diameter for the copper strands. Referring to the accompanying diagram, Curve A represents the temperature increase of the wire under a load of 20 amperes; four minutes after switching on the current the temperature was found to have risen by 70deg. C. Curve B was plotted from observations made with a load of

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25 amperes; after four minutes the temperature rise had attained nearly double the previous value. With 30 amperes (Curve C) an excess temperature of 150deg. C. was imparted in two minutes. Finally, as shown by Curve D, the increase of temperature due to a current of 35 amperes amounted to 200deg. C. after 2 minutes 15 seconds duration. To prevent the ignition of the insulation before the completion of the observation, the current was reduced from 35 amperes to 32 amperes; the temperature increased within another minute to 240deg. C., and the wire began to glow. At this point the current was again increased to 35 amperes, and after the lapse of a further 30 seconds the insulation fired. The increase of temperature, it may be mentioned, was ascertained by measuring the resistance of the wire, assuming a constant temperature coefficient of 0·004. Now, the German safety rules allow a maximum continued load of four amperes for conductors of 0·75mm. cross-section, causing the temperature of the same to rise about 10deg. C. At the same time, the fuse must be designed to blow under the effect of double the maximum permissible current (in this case eight amperes) within the space of two minutes. But we have seen that even the fourfold of this fusing current is insufficient to ignite the flexible cord within two minutes. The experiment has also shown that the conductor is capable of carrying continuously a current of 20 amperes without its insulation being fired. Even supposing a 10-ampere or 16-ampere fuse were accidentally or purposely inserted instead of the 4-ampere one, these would be blown within two minutes by the passage of 20 amperes or 32 amperes respectively without ignition resulting. It is, consequently, wrong to suppose that the current due to a short-circuit between the conductors can fire the insulation of the wire over its whole length. But the case is different when we come to consider local inflammability. For instance, should broken strands of the core penetrate the insulation and cause the formation of an arc, to maintain which only a relatively small current is necessary, the phenomenon would involve a far greater element of danger. The small excess current might not suffice to blow the regulation fuse, while the insulation would be fired at the point of arcing. To avoid this danger, insistence on good material and workmanship is recommended. Further, it is pointed out that shop-window dressers should be warned against fastening flexible wire to draperies by means of pins, as also against the practice of knotting the flexible cord, etc. It seems a great many fires in Germany have of late been attributed to short-circuit cords, hence the above warnings.

**The Measurement of Alternating Potentials with the Help of Condensers.**—In a contribution to the *Elektrotechnische Zeitschrift* Prof. W. Peukert deals with the use of condensers (see Fig. 1) as an aid to the measure-

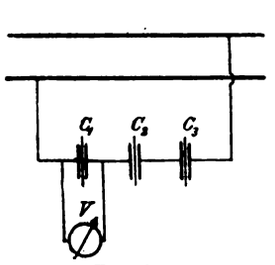


FIG. 1.

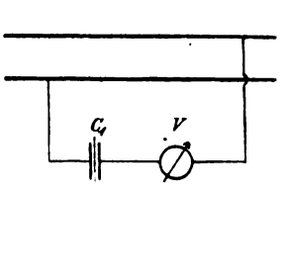


FIG. 2.

ment of high potentials, calling attention to what has been practically accomplished in this direction by different workers. He goes on to describe a modification of the principle whereby the range of a voltmeter may be increased by introducing a capacity into the circuit. Messrs. Siemens and Halske use a condenser for this purpose having a dielectric composed of porcelain plates; but the results, continues the author, may be rendered independent of the periodicity by employing an air capacity. Since the voltmeter is also an air capacity, we then have two similar condensers in series, the potential of the circuit being divided between them. Let a capacity, $C_1$ (see Fig. 2), be connected in series with an electrostatic voltmeter across an alternating potential, E. Further, let the capacity of the voltmeter be $C_2$, and the potential at the two capacities $e_1$ and $e_2$ respectively, then

$$\frac{e_1}{e_2} = \frac{C_2}{C_1};$$

or,

$$\frac{e_1 + e_2}{e_2} = \frac{C_1 + C_2}{C_1}.$$

But

$$e_1 + e_2 = E,$$

and

$$\frac{E}{e_2} = \frac{C_1 + C_2}{C_1};$$

hence

$$E = \frac{C_1 + C_2}{C_1} \cdot e_2$$

If now the capacity, $C_2$, of the voltmeter be known, we may vary the range of the instrument at will through the choice of $C_1$. For instance, if $C_1 = C_2$ then $E = 2\,e_2$, the range being doubled. It follows that the sensitiveness of the instrument may be varied within wide limits by means of this arrangement. Or, suppose we have an electrometer whose range is 200 volts and wish to measure a pressure of 1,500 volts, the capacity of the condenser required may be easily determined. Let the known capacity of the electrometer = C, and that of the condenser to be discovered, $C_x$, then

$$1{,}500 = 200\,\frac{C_x + C}{C_x}$$

whence

$$C_x = \frac{2\,C}{13}.$$

The air capacity employed consists of two metal plates, insulated from each other by glass stays, one of these plates being fixed while the other is adjustable by means of a screw motion. The capacity of such a condenser is, within certain limits, inversely proportional to the distance separating the plates, and we can, therefore, vary the capacity within these limits. In the above formula the capacity of the voltmeter is assumed to be constant, but this assumption would not hold in practice. On the contrary, we should have to find the relation between the capacity of the voltmeter and the potential at its terminals. That is to say, we must determine its capacity for any potential. The measurement of what is, after all, the very small capacity of the voltmeter may be made by connecting it in circuit with a high non-inductive resistance (graphite resistance of several megohms) across a known potential. If E represent the latter and $e_1$ the potential indicated on the voltmeter, then the relation existing between these potentials and the potential, $e_2$, on the resistance is

$$E^2 = e_1^2 + e_2^2,$$

whence

$$e_2 = \sqrt{E^2 - e_1^2}.$$

Further, if R be the non-inductive resistance, then $\frac{e_2}{R} = i_0$, the charging current of the condenser, from which and the potential, $e_1$, the capacity may be calculated when the periodicity is known. By varying the resistance, R, we obtain different deflections on the voltmeter, and are thus enabled to determine the capacity corresponding to any potential. In concluding, the author remarks that condensers have been successfully employed for the purposes described, both with electrometers and voltmeters, in the laboratory with which he is connected.

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## POWER SUPPLY IN SUNDERLAND.

The history of the electricity works in Sunderland is one of continual progress, due to the efforts of Mr. John F. C. Snell, the borough electrical and tramways engineer, and to the confidence which the members of the Corporation have in him. The works were designed in the first place for electric lighting only by Prof. Alexander Kennedy. They were then extended to supply the tramways when these were converted to electric traction. The largest development, perhaps, is that which is now nearing completion, which will allow of an ample supply of power being given to the many engineering works and shipyards within the Corporation's area. The following description will enable our readers to follow the lines on which Mr. Snell has worked in developing the undertaking. The system has been until recently partly the original three-wire, 110-volt system installed to Prof. Alexander Kennedy's specification, and partly two-wire, 220-volt system. The original three-wire system has been done away with, and a uniform system of distribution is now obtained from the two wires The principal reasons for adopting this system in preference to the more usual three wires was partly on account of the large demands which may be expected from the 21 shipbuilding and engine works in the borough, a large number of which were already electrically equipped with 220-volt motors, driven from the works' own generating plant, and also because of the engineer's steady development towards sub-station distribution in Sunderland, as will be seen from the accompanying diagram (Fig. 1) of the system. The principle of the distribution at which he is aiming is to generate three-phase currents at one station at a pressure of 5,000 to 5,500 volts, and transmit to sub-stations where the current will be transformed by motor-generators and distributed to areas, the biggest radius of which will not exceed five-eighths of a mile. In each of these sub-stations will be a large storage battery.

The original works at Dunning-street commenced to supply current in March, 1895, and were completely filled when the tramway plant was added in 1900. These works contained 11 engines, varying in horse-power from 200 to 500, and with an aggregate output of 2,165 kw. The position of the site is such that the plant is mostly working non-condensing, and coal has to be delivered into the bunkers by carts. The new works at Hylton-road are on a site of three acres acquired in 1901 by the Corporation, and both the above disadvantages have been overcome. There is on the site a deep well, from which a copious supply of water is obtained. Also, the site, which is some 90ft. above the river level, will in the future take water from the river by means of a combined motor-turbine pump, as has been done in the Newcastle tramway station. At present the condensing water is taken from the well and cooled by means of a fan draught in a Klein tower. At these new works coal is delivered by means of a viaduct direct from the Hetton Collieries into the overhead bunkers at the station. The plant now installed consists of Belliss and Morcom engines, five coupled to direct-current Silvertown dynamos, aggregating 1,280 kw., and three new sets

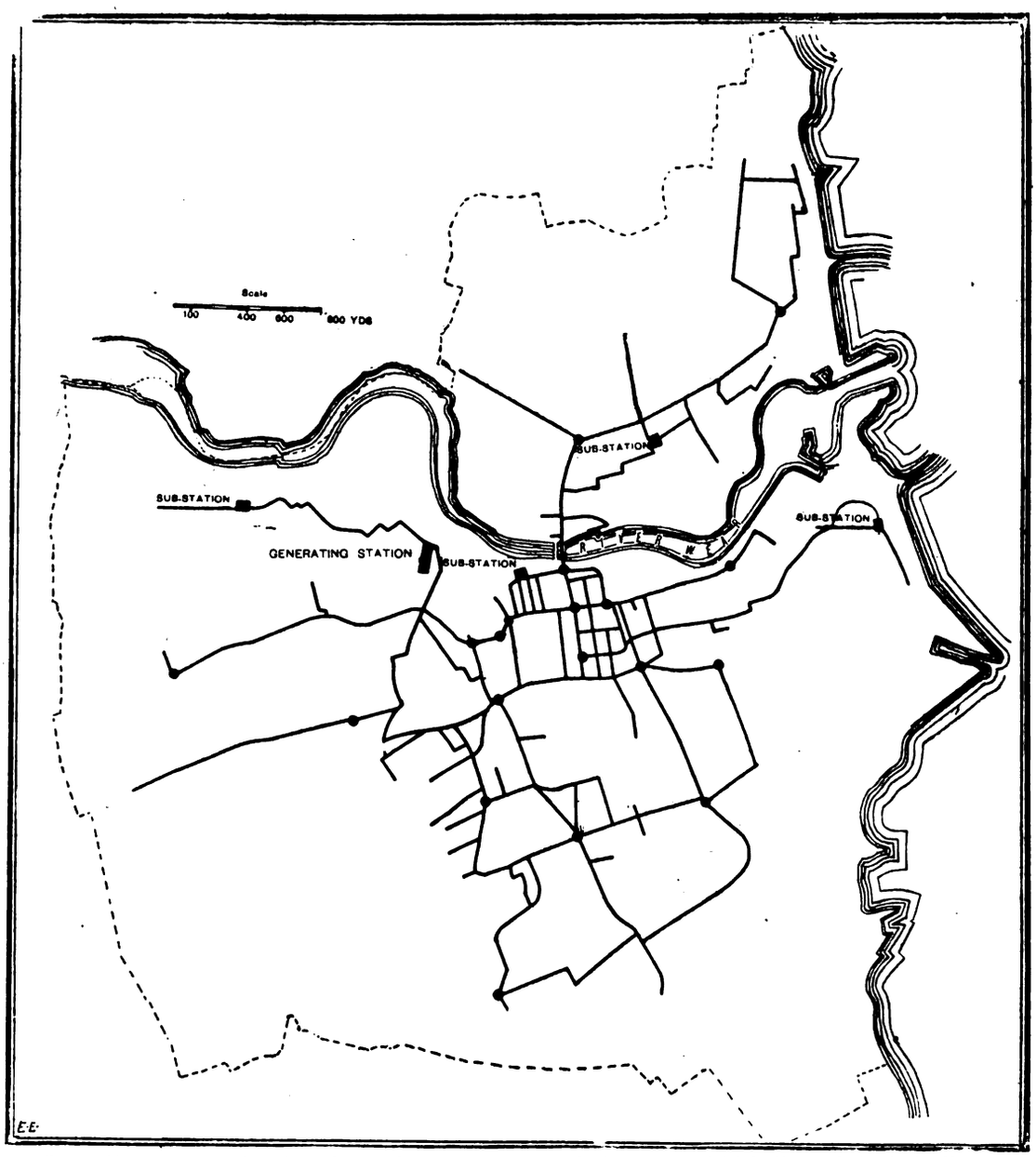


FIG.-1.—Map of the Sunderland Area, showing the relative positions of the Generating and Sub Stations and Distributing Mains.

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coupled to three-phase alternators by the Electrical Company, Limited, with a total output of 2,250 kw., making 3,530 kw. in all at Hylton-road station, or a total of 5,695 kw. for the two stations.

alternators were supplied by the Electrical Company, and each is provided with a separate exciter coupled to the end of the alternator shaft, and are wound to give 78 amperes per phase on a non-inductive load, and 91 amperes on an

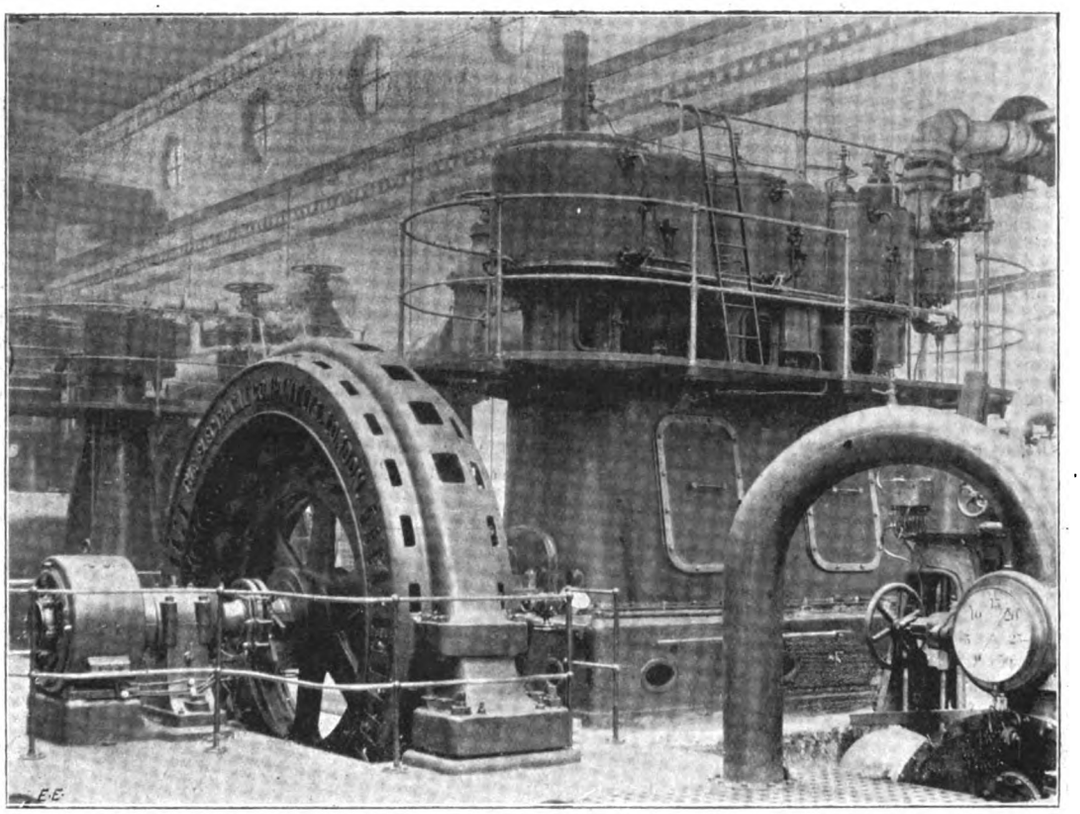

FIG. 2.—The Engine Room at Hylton Road Generating Station, with Belliss Engines and 750-kw. 5,500-volt Electrical Co.'s Three-Phase Alternators.

The engines coupled to the three-phase alternators are each of 1,100 b.h.p., triple expansion, surface condensing. The speed is 250 revolutions per minute. The steam con-

inductive load, with a power factor of 0·85, with a pressure of 5,500 volts between phases. The alternators (as can be seen from Fig. 2) are of a massive and rigid construction.

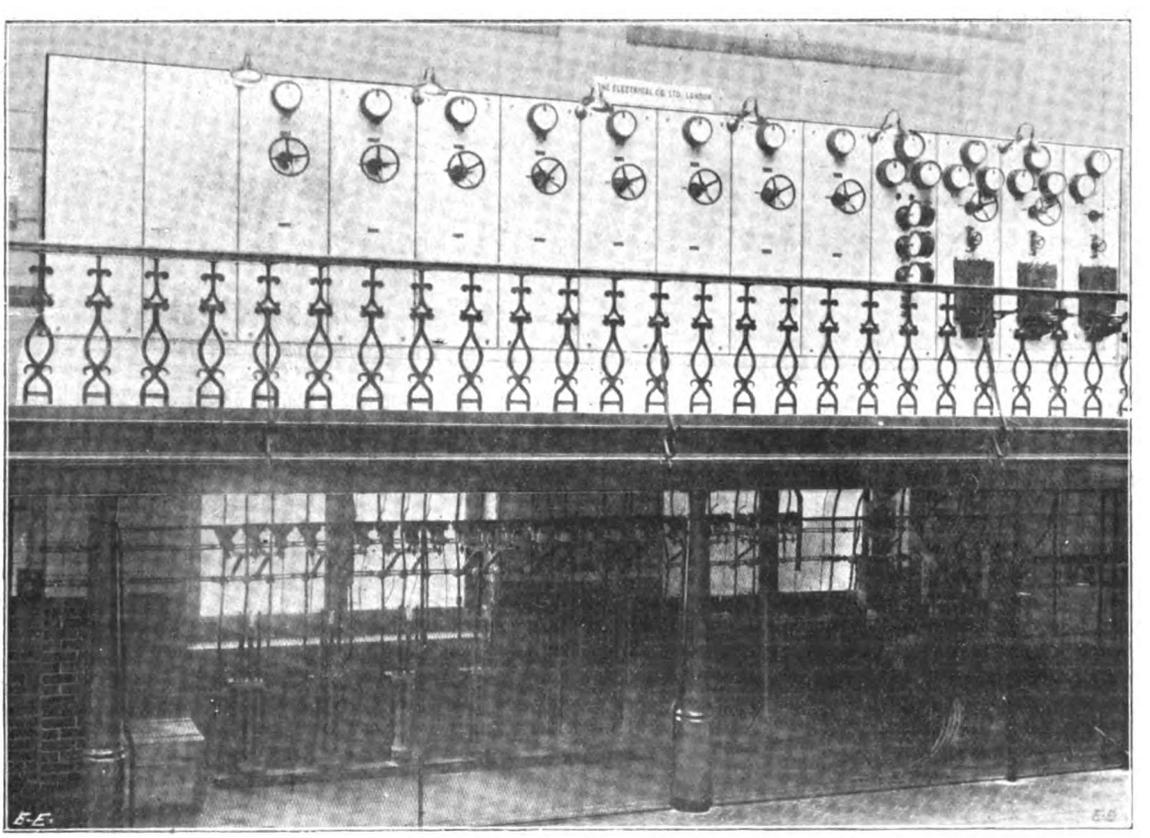

FIG. 3.—The Main Switchboard at the Hylton Road Generating Station.

sumption with a range pressure of 160lb. per square inch, and with 100deg. F. of superheat, and when exhausting into a 25in. vacuum, was 13·91lb. per brake horse-power hour at full load, equivalent to 20·26lb. per kilowatt-hour. The

The armature casting is in two parts, the upper and lower of which are bolted together, and carried by two feet at opposite ends of a diameter. These feet are bolted to two soleplates, and are also provided with the A.E.G.'s standard

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method of centreing the armature with regard to the fields, which can be quickly done at any time. There is also an adjustable screw pillar placed under the centre of the lower half of the armature, so that it is quite impossible for any strain set up in it to cause the slightest want of alignment. The laminations are packed into the armature casting, and kept in position by bolts passing through from side to side. The three-phase windings are carried in mica tubes, inserted in oblong tunnels, stamped through the laminations. Each section is wound with two cotton-covered wires in parallel, which simplifies the operation of winding, and allows of its being done rapidly. Part of the winding outside the mica tubes when finished is covered with several layers of prepared tape, and varnished. The armature windings were tested with 15,000 volts for half an hour, and the machine when running may be short-circuited without fear of damage, the short-circuit current being specified not to exceed twice the full-load current. The flywheel or inductor carrying the field magnets is secured to the shaft by two keys, which are first driven up tight, and then two rings are shrunk on to the inductor boss. The iron circuit for the fields is, of course, laminated, the laminations being carried on the periphery of the inductor between two handwheel. The synchronising panel contains three electrostatic voltmeters giving the potential between each 'bus bar and earth synchronising voltmeter and lamps, 'bus bars, voltmeter, and pilot voltmeter. Each dynamo panel contains shunt low-tension ammeter in the main circuit wattmeter, exciting current ammeter, main generator oil switch handwheel; two-way exciting switch with potential breaker and exciter field rheostat; and in front of each panel the vertical handwheel for regulating the resistance in the field circuit. The back of the board is protected by a wirework screen with door, each circuit and dynamo panel being isolated by a slate slab 1½in. thick, so that any breakdown shall be entirely isolated to its own compartment. The fittings of each compartment are similar to those previously described. There is only one set of 'bus bars, so as to simplify the board. The framework consists of channel and angle iron, and no wood or other inflammable substance is anywhere used. Below the platform, also protected by expanded metal screens, are the three-way cable boxes, at which the main cables terminate, and three-pole magnetic blow-out lightning arresters, with non-inductive water resistance discharge for each feeder; the three field rheostats; two exciting 'bus bars, together with one integrating watt-

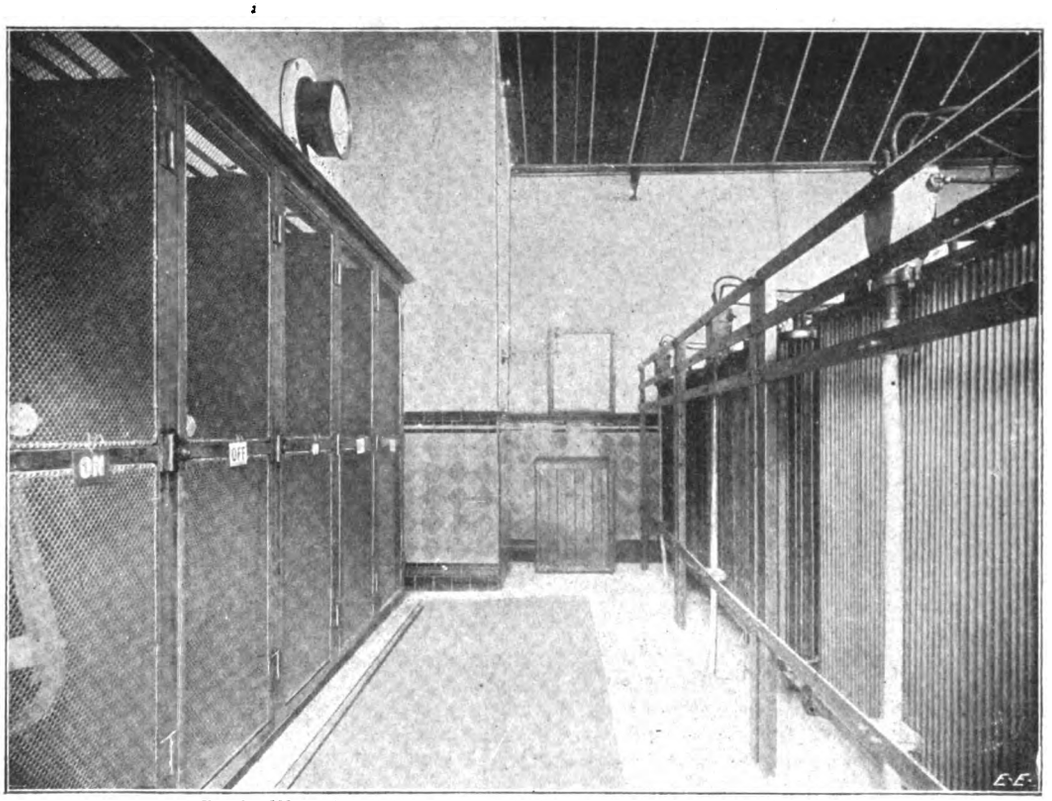


FIG. 4.—900-kw. Sub-Station at the North-Eastern Marine Engineering Co.'s Works.

circular plates, to which they are secured by bolts and nuts. To give the utmost rigidity, taper keys are also inserted, one from each side, and driven up tight. The pole-pieces are carried on the outside of laminations, into which they are dovetailed and secured by two taper keys, which construction allows of a pole-piece being removed in a short time without disturbing the armature. The pole shoes are also detachable, so as to allow of the former-wound winding being slipped off without delay should occasion arise. The field magnets are excited in series at 220 volts from the above-mentioned independent exciter, which is carried outside the tail bearing, or independently excited from a separate source.

The high-tension switchboard is carried on a raised platform constructed of Mark Fawcett's patent terra-cotta work floated over with concrete, and finished with wood block flooring. It consists at present of eight feeder panels, one synchronising panel, and three generator panels, with blank panels for future extensions. This board is of the Electrical Company's standard design, which makes it absolutely impossible for the attendant to touch any of the high-tension work. The front panels of the board are of white marble, each circuit panel carrying one shunt low-tension ammeter and one insulated oil switch meter, with current and voltage transformer for each generator. As with the switchboard itself, all cables are carried on insulators, mounted on the iron framework, so that a fire about the board should be rendered absolutely impossible. The switchboard is surrounded by an ornamental iron railing with polished teak handrail, and access is gained to it by a polished teak ladder, and the whole presents a very handsome appearance, as is shown in Fig. 3.

The boiler plant recently added includes two Galloway boilers, each 30ft. by 8ft. 6in., which are equipped with superheaters at the back supplied by the same firm. The boilers are fed by means of the Triumph mechanical stokers. Induced draught is obtained by means of a Sirocco fan, by Messrs. Davidson, of Belfast, driven by a 60-h.p. direct-current motor manufactured by the British Electric Plant Company, of Alloa. An additional surface condenser, containing 4,500 square feet of surface, has been provided by Messrs. Alley and MacLellan, Limited, of Glasgow. There has also been added another economiser containing 360 tubes by Messrs. E. Green and Son, Limited, Wakefield. The whole of the pipe work is of steel with cast-steel tee pieces and valve bodies, by Hopkinson, of Huddersfield; this pipe work being supplied and erected by the Wearmouth Foundry Company, of Sunderland.

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The three-phase current at 5,500 volts is sent from the Hylton-road station to the various sub-stations indicated in the map (Fig. 1). In addition to these, two of the largest and most important works in the area have their own sub-stations erected by the Corporation, and take the supply from high-voltage cables brought into the same. The first of these is the North-Eastern Marine Engineering Company, Limited, at South Dock, which company has installed a complete system of induction motors to the specifications of Mr. Wilson Carr, of Newcastle (their consulting engineer). To supply these works, the Corporation has put down a sub-station in a separate small building at their works (Fig. 4) which contains three standard transformers, each of the three-phase type, and each having an output of 300 kw. Each transformer is immersed in oil, and contained in a special cast-iron case with radiating gills, so as to provide a maximum cooling surface. As a matter of fact, after a week's run at about three-quarter load the temperature rise is barely perceptible. Each transformer weighs about two tons complete, and is mounted on rollers. There are two 0·1 square inch three-core feeders laid from Hylton-road to this sub-station, each of which is connected to its own feeder panel, each feeder panel containing the well-known A E G. switch fuse, ammeter transformers, and panel isolator. There is a separate panel to control each transformer, each equipped with the panel isolator, instrument transformers, and switch fuse. The whole is securely caged off and locked in the usual manner to prevent accident. The low-tension mains consist of copper strip connecting the transformers to the low-tension meter panels in an adjoining room, in which the company's distributing board is also erected. There is a low-tension panel to each transformer containing an ammeter, voltmeter, three-pole switch, and two single-phase A.E.G. wattmeters, which have been fixed on account of a possible want of balance between phases, due to the lighting circuits in the works. The primary voltage is 5,000 and the secondary 240, at a periodicity of 50 ⁓ per second. The sub-station has been constructed with every precaution against danger to person or from fire. The total number of motors to be installed is 22, with an aggregate capacity of 520 h.p., including some very fine 60-ton travelling cranes, supplied by the British Westinghouse Company. This consumer alone is expected to take some 600,000 to 800,000 units per annum. The company's enterprising directors and general manager (Mr. G. Weir) are well pleased with the installation.

The second important consumer is Messrs. William Doxford and Sons' shipyard, where there are at present 23 motors connected, representing 445 h.p., but the ultimate connections, upon which the contract with the Corporation is based, is for motors with a total output of 1,892 h.p. In this case one half of these important works is supplied from Messrs. Doxford's own generating station, in which are four triple-expansion Sunderland Forge steam dynamos, representing a total output of 800 kw., and of which Mr. W. Vidal is the resident electrical engineer.

The second half of the works, now under construction, is being driven from the Corporation's Pallion sub-station (Fig. 5), in which are installed two A.E.G. synchronous motors, coupled to compound-wound multipolar generators, each of 250 kw. at a pressure of 220 volts, the synchronous stator receiving high-tension three-phase current at 5,000 volts The field magnets are mounted on the rim of a massive inductor, and receive their current at 220 volts through the usual slip-rings. The direct-current machine consists of an eight-pole compound-wound dynamo, generating current at 220 volts; the field magnets being of the A.E.G. standard pattern, each pole winding being put on in three separate former-wound coils with air space between each, thus ensuring ample ventilation. The armature is drum-wound. The commutator is of large size to ensure ample ventilation and sparkless commutation, the speed being 370 revolutions per minute. To run up this machine there is installed a motor-generator by the A.E.G. of 30 kw. output, consisting of a three-phase induction motor receiving current at 240 volts from a three-phase oil transformer, and direct coupled to a four-pole shunt-wound 220-volt dynamo. The switchboard is in two sections, the high-tension switches, etc., being mounted on the wall at the back of the board, and consisting of two feeder panels, similarly equipped to those at the South Docks, and also two machine panels, each containing an isolator, instrument transformers, A.E.G. oil-break switch, and high-tension fuses. The instruments are, of course, mounted on the front marble panels (Fig. 4), and the oil-break switches are also operated by extended handles from the same position. All the instruments, etc., are, of course, at low tension, and the framings are thoroughly earthed. The whole of the high-tension work is caged in, and under lock and key, and so arranged that it is impossible for the attendant to come in contact with any portion of the high-tension circuits. The low-tension instruments are mounted on marble panels, and contain the

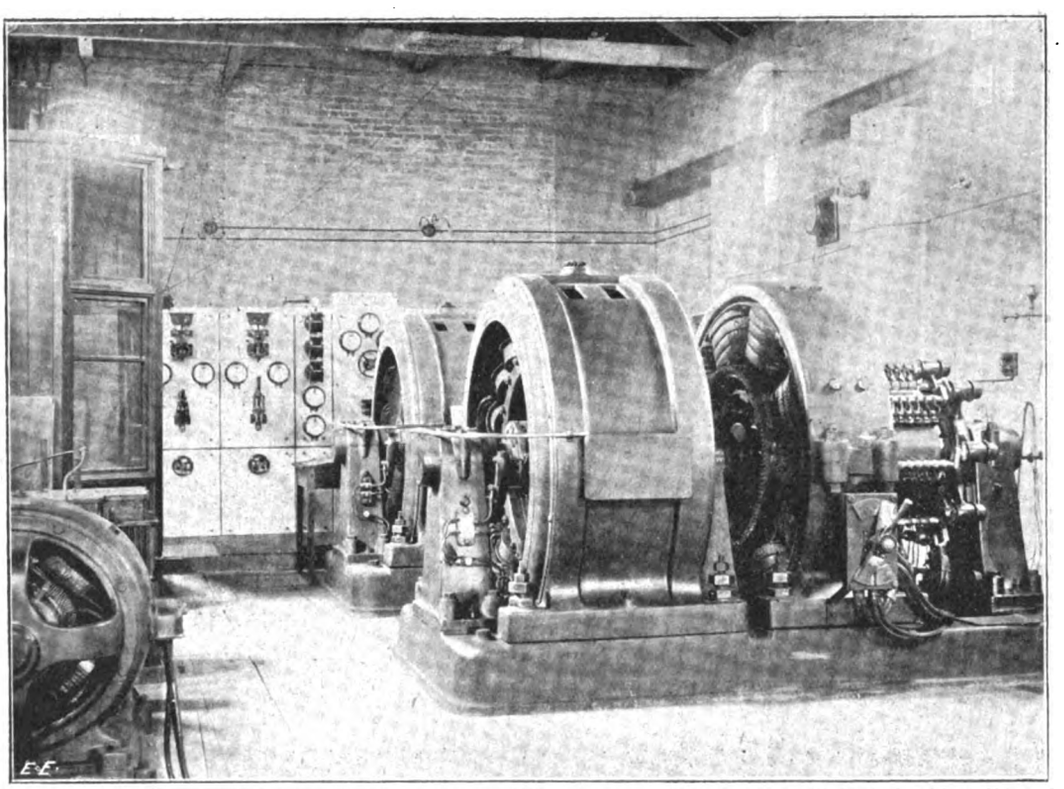

FIG 5.—The Pallion Sub-station which will supply Motors of 1,892 aggregate horse-power in Messrs. W. Doxford and Son's Shipyard.

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usual magnetic cut-outs and main switches of the standard A.E.G. type. The whole arrangement, including the field rheostats, is particularly neat in appearance. A synchronising panel is, of course, provided. The sub-station is connected both by private and National telephones to the generating station, and is equipped with a five-ton travelling crane. This consumer will have an output similar to the North-Eastern Marine Engineering Company, but will, as seen above, take the supply on the direct-current system.

At Dunning-street two synchronous motor-generators have been installed in the old station, each of 250 kw. capacity. These machines are identical with the Pallion machines above described, except that they are shunt-wound, and arranged so as to be reversible—*i e*, they are capable of being driven from the direct-current side and generating three-phase currents, or *vice versâ*. The addition of these two motor-generators has enabled the whole of the day load to be dealt with from Hylton-road. The switchboard is of a very similar character to that at Pallion It is intended to instal two 500-kw. inductor motor-generators for either tramway or lighting purposes, each inductor being coupled to two 250-kw. compound-wound machines, arranged to run in series or parallel, and it is ultimately intended to convert the whole station to a sub-station driven from Hylton-road. A large sub-station has been erected at Monkwearmouth, which will be capable of holding 2,500 kw. of plant. The first installation consists of two 125-kw. inductor motor-generators, the inductors being started up through slip-rings with a water resistance, and arranged with the usual short-circuiting lever, the multipolar dynamos being shunt-wound, and arranged to give from 220 to 250 volts. There is also a motor driven battery booster, which has a maximum output of 500 amperes at any voltage from 0 to 80. The switchboard is similar in design and principle to those described above, but also contains a booster panel with reversing switch and low-tension panels, with two 'bus bars, plugs, and the usual standard equipment of instruments. A synchronising panel has also been erected for future extensions. The machine-room of this sub-station is shown in Fig. 6. On the first floor there is a battery of 120 cells by the Electrical Power Storage Company, each cell being capable of discharging 800 amperes for one hour, with a minimum voltage of 1·85, or 260 amperes for seven consecutive hours. A milking booster and switchboard by the Sunderland Forge and Engineering Company, Limited, has also been supplied. The inside of the station is lined with glazed bricks, and the machine-room is paved with red Ruabon tiling. The battery floor, which is designed to carry 2cwt. per square foot, is composed of Mark Fawcett's patent flooring, with the spandrils filled in with concrete, brought up to a smooth surface, and with ¾in. of acid-proof bitumen asphalt. The whole installation is of a substantial construction, and is designed with a view to large extensions.

A southern sub-station at Hendon is about to be commenced, and will shortly be in operation. This will be on the same lines as the Monkwearmouth station, except that the battery-room will be on the same level as the machine-room.

In order to secure continuity in supply, Mr. Snell has arranged duplicate cables throughout the system as far as the three-phase supply is concerned. The three-core mains within a mile radius of the station are drawn into Doulton stoneware ducts. Ducts of the 12-way type have been used embedded in concrete, and the manholes are placed 80 yards apart. These are built of 18in. brickwork, the inside being lined with glazed bricks. The lowest boxes are connected to the sewers, and each box is drained to the other by means of a 2in. wrought-iron pipe embedded in concrete. The highest boxes are ventilated. The whole system has remained perfectly dry and clean. The conduits and the cables drawn through them were supplied and laid by Callender's Cable and Construction Company. Beyond the termination of this conduit system, the cables are laid solid in cast-iron trenches filled with compound, the whole being supplied and laid by the British Insulated and Helsby Cables, Limited. The joints (besides being accurately surveyed and recorded on a 44in. plan) are marked on the street by letters and figures recessed into the pavement. The cables are everywhere three-core, each ·1 square inch section, paper insulated, lead covered, and steel armoured, the armouring being carefully bonded at each joint, and the whole earthed at several points along each line, and under each manhole in the conduit system there are copper earth-plates embedded in coke, to which each cable sheathing is connected. The cables were all tested to 18,000 volts for half an hour at the respective works, and to 12,000 volts after laying, and there has not been the slightest trouble in any way. At one place in the South Docks route the cables have been taken across the dock to the North-Eastern Marine Engineering Company's works (which are situated on an island), and had to be drawn through a submerged tunnel under the dock cills; here 4in. special cast-iron pipes with easy quarter bends and with specially long sockets were fixed, the tunnel being kept dry by special pumps temporarily

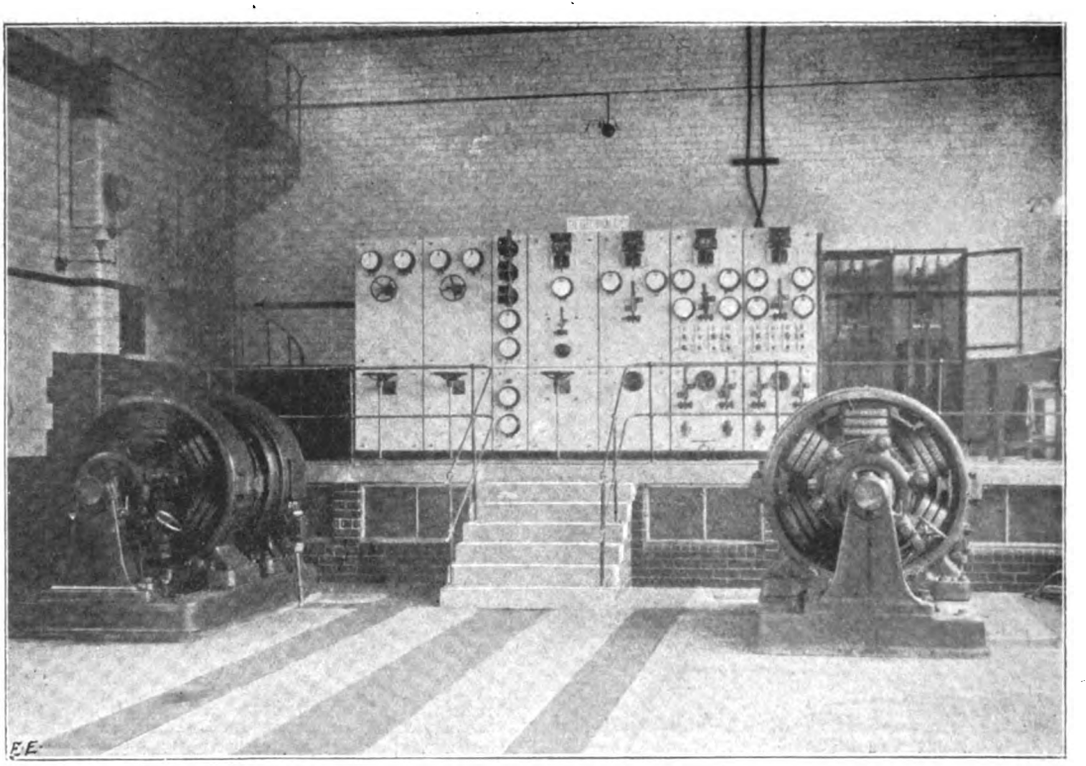

FIG. 6.—The High-Tension Switchboard and Motor-Generators in the Monkwearmouth Sub-station.

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erected for the purpose, the cables being easily drawn through these afterwards. The whole of the outside work was carried out under the supervision of the distributing engineer, Mr. J. F. Moore, A.M.I M E., and the absence of trouble throughout the contracts and afterwards reflects great credit upon him and upon the contractors.

Mr. Edward White, A.M.I.E.E, station superintending engineer, supervised the whole erection of the work inside the generating stations, and he has carried out the work with great success. The electrical contract has been supervised on behalf of the Electrical Company by Mr. A. E. Hadley, with Mr. F. J. Rynd as resident engineer. The latter has carried through the whole of this work without the slightest hitch. The whole of the work was carried out to the specification and under the superintendence of the borough electrical and tramways engineer, Mr. John F. C. Snell, M.I.C.E.

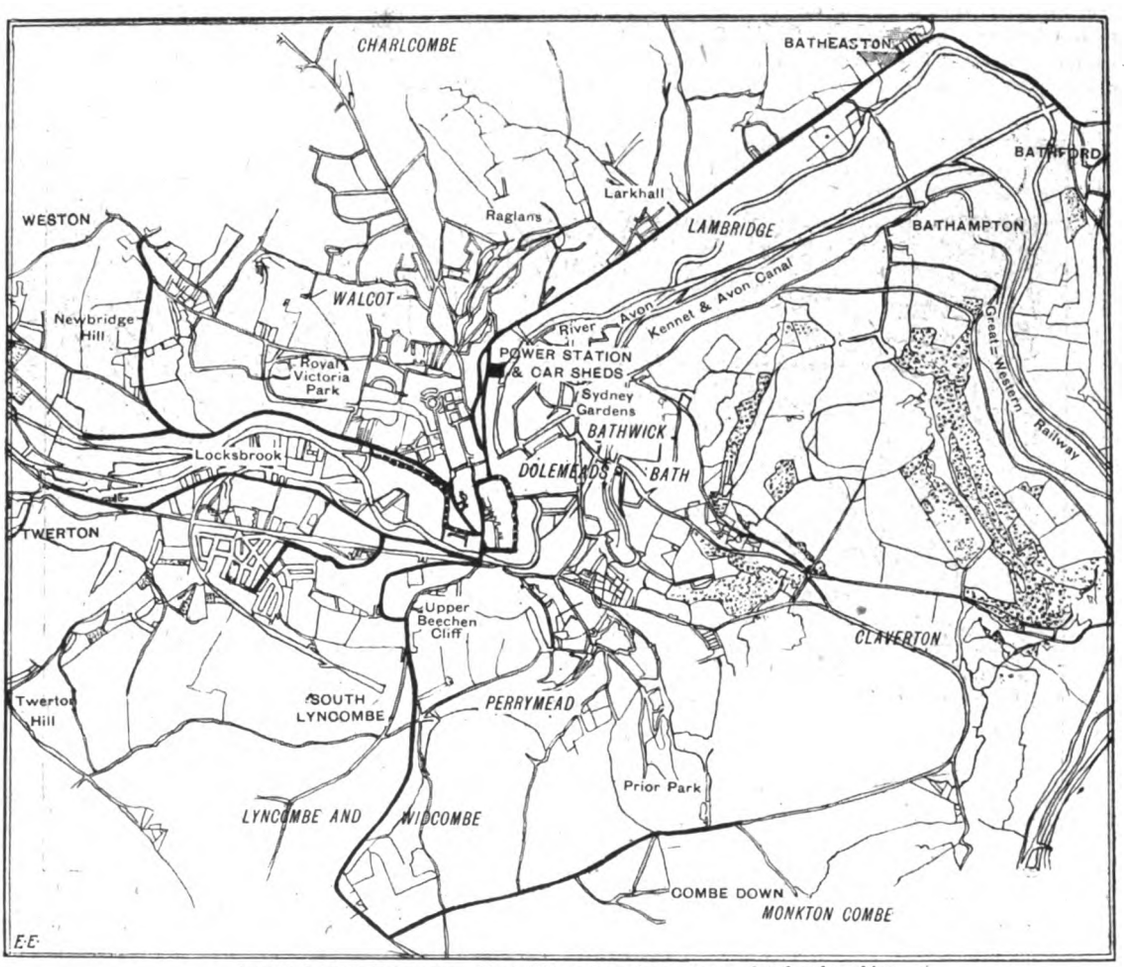
The advantage derived from the supply of light, tramways, and power load from the one generating station is clearly shown at Sunderland, as the load factor now obtained is as high as 41·6 per cent. From this it is hoped that a very material reduction in the cost of generation will be secured. Already the cost of coal, oil and stores, wages and repairs at the Hylton-road station has come down to 0·598d., although these works only started to run last November, and the superheaters are not yet in commission. In time the reduction in cost will be greater, and may enable even more favourable terms than at present to be given to the power consumers. Under the present tariff all users of over 100,000 units per quarter are charged at the rate of 1½d. per unit.

## BATH ELECTRIC TRAMWAYS.

BY B. PONTIFEX.

The ancient city of Bath, though early in adopting electric light, has only had an up-to-date system of electric tramways since Jan. 2 last, the horse cars, which were installed some 23 years ago, having been running on one route till last year. The central portion of the city lies low, and the immediate surroundings are mostly on the hillsides, so that some mechanical system was necessary to extend the lines to the outskirts of the town. The new system reaches to within four miles of the Bristol trams, and there is already some talk of interconnection. The system was projected by the Bath Electric Tramways, Limited, and Messrs. G. Hopkins and Sons, Clun House, Surrey-street, W.C., with Messrs. Harper Bros. and Co., 13, St. Helens-place, E.C., acted as engineers. Mr. R. D. Macarter is the general manager and engineer for the tramway company, and has given his personal supervision to the construction of the whole system. The British Westinghouse Company claim to have beaten the record on this line, as they have constructed and equipped the power station (675 kw.) in less than 7½ months. The ground was broken for the building foundations on May 1 last, and the Board of Trade inspection took place on Dec. 12. Traffic was commenced on Jan. 2, and the lines were officially declared open on Feb. 13.

The length of the lines now in operation comprises nearly 16 miles of single track, the total length of the routes being 12¼ miles; the construction of another mile is authorised. The system can be best described as radiating from Southgate-street in the centre of the city. One route runs along the London-road to Batheaston, and thence crosses the railway to Bathford; another traverses Wells-road and terminates opposite the convalescent home on Combe Down. The other two routes go to Weston, with a branch to Lower Weston; and to Twerton, with a branch to Oldfield Park. On this last branch single-deck combination cars are used, owing to the height—or want of it—of the railway bridge.




Map of the Bath Tramways. The full lines show the route completed and working.

The power station, car-shed, and offices are situated in Walcot-street, on the bank of the Avon, which gives a good supply of feed and circulating water. The boiler-house is 93ft. by 49ft., and the engine-house is of practically the same dimensions. The car-shed is 130ft. long by 83ft. wide, with offices overhead at the front and a large basement at the rear fitted up as a repair shop. Eight tracks run the full length of the shed, with a 30ft. pit in each track. The engine foundations had to be carried 30ft. below the engine-

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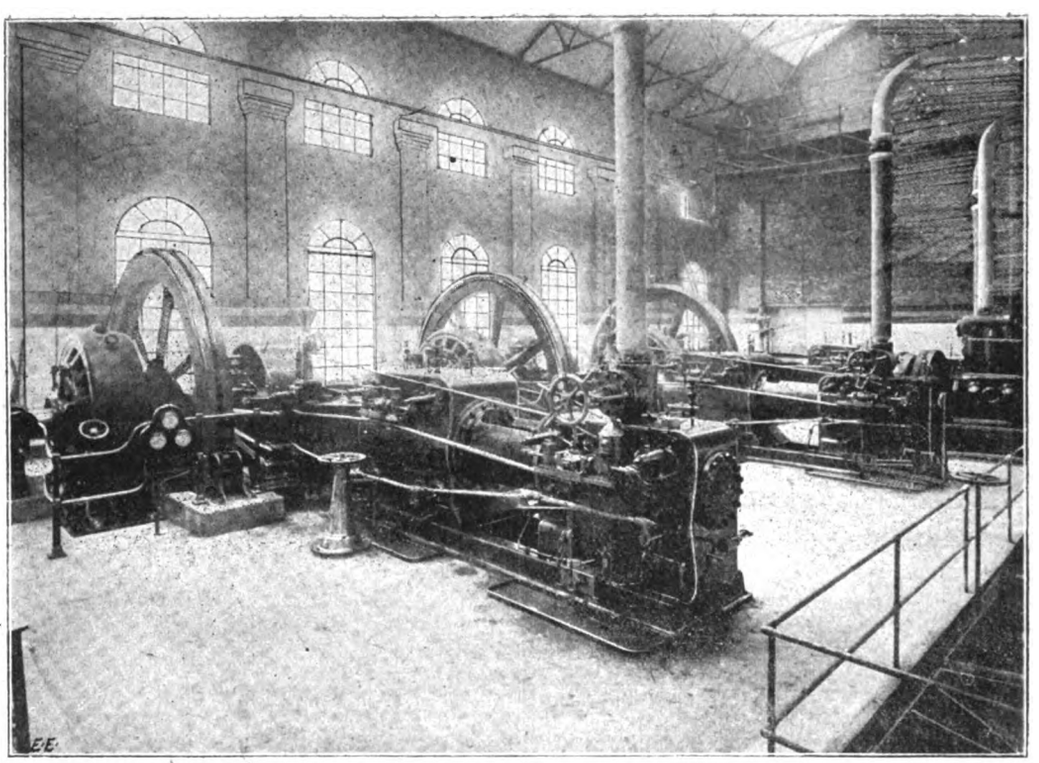
room floor in order to get below the made ground and secure solid bottom. The chimney shaft is of steel, lined with brick to a height of 60ft.; it is 140ft. high and tapers from 13ft. 6in. diameter at the base to 7ft. diameter under the cap. It rests on brick and concrete foundations, and, though self-supporting, is bolted down as an additional precaution.

The steam plant comprises three Babcock and Wilcox double-drum boilers, each with a heating surface of 3,140 square feet, and capable of evaporating 11,000lb. of water per hour, with a maximum of 13,000lb., at a working pressure of 160lb. per square inch. Grate area is 59½ square feet. The type is the usual Babcock and Wilcox standard. Each boiler is fitted with a superheater having 339 square feet of heating surface, which allows the steam to receive a superheat of 100deg. to 120deg. F. The superheater consists of 48 solid-drawn steel tubes, 1½in. diameter, and suitable pipes and cocks are provided for flooding it when necessary. The guaranteed efficiency of each boiler and superheater is: 70 per cent. at full load, 70 per cent. at three-quarter load, 68 per cent. at half load. There is a Claycross economiser of 240 9ft. tubes, with motor-driven scrapers. Feed is taken either from the town mains or the river. There are two feed pumps—one steam is also by Messrs. Masson, Scott, and Co., with a capacity of 300 gallons of water per hour. The character of the water can be judged from the following analysis:

| | |
|---|---|
| Carbonate of lime | 15·04 |
| Sodium chloride | 2·89 |
| Sulphate of lime | 2·33 |
| Sulphate of magnesia | 1·72 |
| Silica, oxide of iron, and alumina | 0·55 |
| Magnesium chloride | 0·47 |
| Total | 23·00 |

The whole of the piping has been supplied and fixed by the Sir Hiram Maxim Engineering Company. The main steam-piping is 12in. diameter and the branches 6in., with 3in. branches to the pumps. The main exhaust is 16in. diameter, with 11in. branches, and with 14in. galvanised iron pipe for atmospheric exhaust. A Holly steam-loop and gravity system is connected with all the high-pressure drains. The water is carried by gravity into a receiver 5ft. long by 5in. diameter, placed at the lowest point of the piping system, from which it is forced by a steam jet into a receiving chamber in the roof of the boiler-house, whence it returns by hydrostatic head to the boilers, with practically no loss of heat.



The Tramway Power Station at Bath, with Yates and Thom Engines and Westinghouse 200-kw. Dynamos.

and one electrically driven. The steam-pump is of the vertical slow-speed type, by Messrs. J. P. Hall and Son, and is capable of delivering 30 to 45 gallons of water per minute against the working boiler pressure. The guaranteed delivery per 1lb. of steam at full, three-quarter, and half load is 72lb., 66lb., and 59lb. of water respectively. The electric pump is by Blake and Knowles, and has three cylinders 5in. diameter by 6in. stroke, and can deliver 45 gallons per minute against the boiler pressure. This pump takes 8·5 b.h p. at full load, 7 b.h.p. at three-quarter, and 5 b.h.p. at half load. There are also two make-up pumps by Blake and Knowles, each with a capacity of 500 gallons per hour.

There are two surface condensers, by the Wheeler Condenser and Engineering Company, capable of dealing with 28,000lb. of steam per hour at normal load and 35,000lb. as a maximum. The brass tubes are ¾in. internal diameter, solid drawn and tinned inside and out. The combined air and circulating pumps have 12in. stroke and cylinders 12in., 14in., and 3½in. diameter. There is a Holden and Brooke grease separator in the main exhaust pipe, and after the water leaves the condensers the emulsified oil is removed in a Masson and Scott water purifier capable of dealing with 1,250 gallons per hour. The water softener

Coal is brought straight from the railway trucks to the storage bins by screw conveyors. A similar conveyor brings the coal from the store to the front of each boiler. This conveyor can deal with 10 tons per hour when running at 30 revolutions per minute, and has a trough 14in. diameter with coal outlets 9in. square. The overhead traveller, by Messrs. Stothert and Pitt, is driven by three Westinghouse motors, and has a span of 50ft. It is fitted with two lifting barrels for heavy and light loads, and, after erection, was tested with a load of 22½ tons.

The three main engines are horizontal tandem, single-crank, compound condensing, made by Messrs. Yates and Thom. The cylinders are 15in. and 30in. by 36in. stroke, fitted with Corliss valves, worked by Dobson trip gear. Each engine is of 320 h.p., and capable of driving the 200-kw. generators continuously at full load, and with 25 per cent. overload for half an hour when working either condensing or non-condensing. The governors control the speed within 2 per cent., and are fitted with a runaway gear, which disconnects the trippers and cuts off steam from the cylinders if the engines start racing. The crankshafts are of mild forged Siemens steel, 14in. diameter at the journals. Under condensing conditions, and with steam at 100deg. F. superheat, the consumption guaranteed at full,

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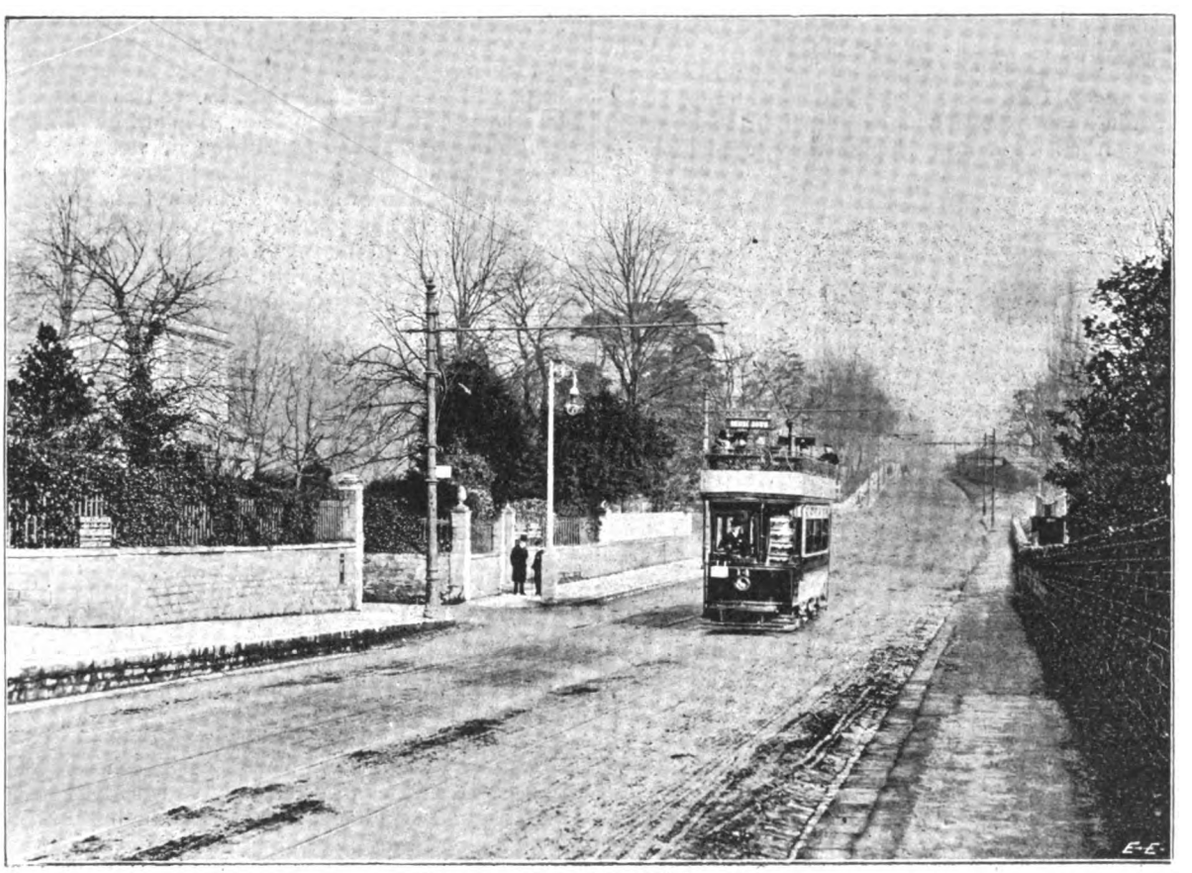
three-quarter, and half load is 15¼lb., 15¾lb., and 17lb. per horse-power hour respectively.

The main generators are Westinghouse 200-kw., direct-current, eight-pole machines, over-compounded from 500 to 550 volts. The armatures are of the slotted-drum type, with two circuit windings so arranged that the circuit will not become unbalanced by a displacement of $\frac{1}{16}$in. from the geometric centre of the fields. The insulation of both armature and field windings is flashed with an alternating pressure of 3,500 volts. With half an hour's run at 25 per cent. overload the temperature rise did not exceed 50deg. C. At full, half, and quarter load the efficiency guaranteed is 93, 91·5, and 88 per cent. respectively. The auxiliary set comprises a high-speed, compound, enclosed Westinghouse engine, direct coupled to a 75-kw. Westinghouse generator. The engine cylinders are 11in. and 19in. by 11in. stroke. The generator is a four-pole, 75-kw., direct-current machine, developing 150 amperes at 500 to 550 volts when driven at 300 revolutions per minute. The temperature test showed that with 24 hours' full-load run no part of the machine rose more than 40deg. C. in temperature. There are two 15-kw., four-pole Westinghouse boosters, the motor volts being 500 and the booster volts varying from 0 to 50 as required.

The switchboard is of the British Westinghouse standard traction type, with panels of white marble 2in. thick set in angle-iron framing. There are 13 panels altogether. The feeder cables are paper-insulated and lead-covered, made by the British Insulated and Helsby Cables, Limited, laid partly solid and partly in porcelain ducts. There are 270 yards of 0·2 square inch, 4,700 yards of 0·25 square inch, and 6,700 yards of ·3 square inch section. The return cables have a section of 0·6 square inch, and total up to one mile in length. There are nearly four miles of multi-core $^{7}/_{22}$ pilot wires, and some 8¼ miles of overhead telephone and testing wires.

The overhead line is mostly supported on brackets, from 6ft. to 28ft. in length, but in some parts of the city span wires are used in conjunction with both rosettes and side poles. The poles are in three pieces, and stand 24ft. over all from the ground. They were supplied by Messrs. Stewart and Lloyd. There is no centre-pole construction anywhere, as the roads are all too narrow to allow it. The trolley wire is of hard-drawn copper No. 00 B. & S. gauge, with stranded galvanised steel span and guard wires. The guard wires are earthed through the poles, every third one of which is bonded to the track. The cars are of the ordinary type, and both mechanical and trailing frogs are used, but it seems that the hangers are too small to be effective in checking surface leakage in a moist atmosphere such as that of Bath during the greater part of the year. The average length of the sections is half a mile, and the usual arrangements have been made for feeder pillars and a Board of Trade panel. The boxes were supplied by the British Thomson-Houston Company.

There are at present 30 cars in use, made by Messrs. Milnes and Co. (with another 10 under construction), 26 double-deck and 4 single-deck combination, for use on the Oldfield Park route. There is also one watering car. The cars are carried on Milnes's S.B. 60 single trucks with a 6ft. wheel base. The stairways are of the ordinary pattern with extended canopies, thereby gaining the extra seats on the roof and avoiding the tendency of the outside and inside passengers to jam, which is caused by the use of reversed stairs. The electrical equipment is by the British Westinghouse Company, and comprises for each car two 49 B. 30-h.p. motors and No. 90 controllers, also Westinghouse magnetic brakes. There are also hand brakes. The severe curves and gradients on this system have tried the magnetic brakes severely, and it has been repeatedly shown that they will pull up a car on gradients of 1 in 11 and hold them to allow passengers to alight with safety.



View on one Section of the Bath Tramways.

The gauge of the track is 4ft. 8½in. The steepest gradient is 1 in 11, and is four chains long, but the worst, from a driver's point of view, is 1 in 14, 18 chains in length. The sharpest curve is 37ft. radius, and there are four of less than 40ft. and 10 less than 50ft., altogether rather a trying selection for fixed trucks with a 6ft. wheel base. The thickness of the concrete bedding for the track is 6in. (concrete proportions 6 to 1), and the web of the rails is also filled in with cement. The rails are in 45ft. lengths, and weight 95lb. per yard, and are coupled with fishplates; all of these, with bolts, etc, were supplied by the North-Eastern Steel Company to the following analysis:

| | |
|---|---|
| Sulphur, not to exceed | ·08 per cent. |
| Phosphorus, not to exceed | ·08 ,, |
| Sulphur, phosphorus, and silicon together, not to exceed | ·18 ,, |
| Manganese, not to exceed | 1·0 ,, |

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In front of the hospital about 300 yards of double track are laid on 8in. by 4in. longitudinal sleepers. The rails are cross-bonded every 100ft, with crown 0000 B. & S. bonds with ⅞in. nipples. The points are 8ft. 6in. and 12ft. long, and are chiefly supplied by Hadfield's, and some by the Lorain Steel Company, who also shared the special track work and crossings. Wood paving is laid between the tracks in the centre of the city, and granite setts and macadam with granite paving in the suburbs.

In conclusion, I must express my thanks to Mr R. D. Macarter and to the British Westinghouse Company for their kind assistance in the preparation of this article.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 527.)*

*Coherer Detectors or Receivers.*

In these detectors chemical action plays a certain, though obscure, part. Lord Rayleigh in 1879 observed curious phenomena with dusty air and jets of water due to what we now call "coherer" action; and Signor Calzeechi Onesti, of Fermo, about 1885 noticed the decreased resistance of metallic filings when small sparks passed in their neighbourhood. About 1878 Prof. Hughes used a microphonic

PROF. EDOUARD BRANLY.

contact as a detector. He was really the first in this country to employ Hertz-wave methods, but was discouraged by an explanation of the action given by the late Sir G. Stokes, and made little practical use of his discovery. In a paper read before the Royal Society in 1878 he described "a tube filled with loose filings of zinc and silver," which served as a detector of electrical impulses or influence, the decrease of resistance when acted on by these impulses being very marked. In 1880 Prof. Hughes actually demonstrated the transmission of signals and the detection of the same by his microphonic detector to the President of the Royal Society and Profs. Huxley and G. Stokes. Prof. Stokes thought the results were due rather to electromagnetic induction than to ether vibrations, an explanation which is said to have discouraged Prof. Hughes, who himself correctly interpreted the action as due to the latter cause. When Hertz by his masterly researches during 1887-9 solved the problem, Prof. Hughes, as stated by him in a letter to the *Electrician* in 1889, "was forced to see others re-make the discoveries he had previously made as to the sensitiveness of the microphonic contact and its useful employment as a receiver of aerial waves."

Prof. Edouard Branly, of Paris, may be said to have invented the modern coherer about 1890 (*Comptes rendus de l'Academie des Sciences*, Nov. 24, 1890, and *Bulletin de la Société Française des Physique*, April, 1891). His apparatus, which consisted of a glass tube partly filled with metallic filings, with metallic conductors at the ends, was used by him as a *detector* only, but was afterwards adopted and improved by Lodge, Marconi, and others, and used by them as a receiver in Hertz-wave telegraphy. In Branly's experiments he connected his tube of filings in circuit with a Daniell's cell and a galvanometer. No current traversed the circuit on account of the high resistance of the filings, but as soon as a spark from a Wimshurst machine or a Ruhmkorff coil passed in the neighbourhood, the resistance fell from several million ohms to perhaps only 100 ohms, and a current was shown by the galvanometer. This action was early found to take place even when the coil or machine was 60ft. or 80ft. away, and in another room. It was also found that the tube was effectually screened from electrical influences by being enclosed in a metal box, but that if two wires connected to the terminals of the tube projected from the box (but were not connected to anything outside the box), the action took place as before. Thus we have, probably, the origin of the antennæ or aerials now used in all Hertz-wave systems. The properties of the early coherer to receive and indicate etheric oscillations naturally came to an end after the first impulse. Dr. Lodge applied an automatic tapping arrangement to the coherer which restored to it its original receptiveness. Prof. Branly made many experiments with different materials, as well as with rods and pastes made of Canada balsam, sulphur, guttapercha, etc. He also found that a row of iron or steel balls 1cm. in diameter formed a very sensitive coherer.

Dr. Lodge improved on Branly's form, not only by introducing the tapper already mentioned, but by improving the sensitiveness of the tube by placing the grains of metal in a vacuum, or sometimes in hydrogen. Metal collectors, or "antennæ," were also used to intercept a larger range of vibrations, and the sender and receiver were "tuned" to a certain extent by means of these antennæ. Dr. Alexander

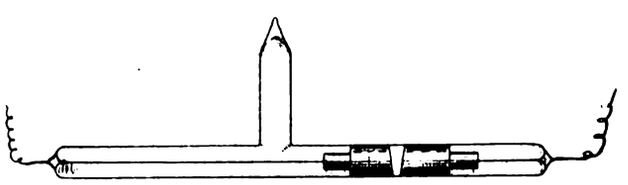

FIG. 22.—Marconi Receiver.

Muirhead, co-patentee with Dr. Lodge, applied the automatically tapped or "decohered" coherer to a Morse telegraph instrument, so that regular dash-and-dot signals might be transmitted and received, and Mr. Marconi also introduced the Morse printer at an early date.

*Marconi's Coherer.*—Mr. Marconi made numberless experiments with various kinds of filings in coherers, different forms of tappers, and, in fact, very varied arrangements of the apparatus. He found that even at the best the coherer is somewhat erratic in its action, and for long-distance work the magnetic detector, already referred to, is much superior. Mr. Marconi's coherer as now in use is shown in Fig. 22. It is made by inserting filings between two silver plugs in a glass tube from which the air is exhausted. The plugs should be a fairly tight fit, but not so large as to burst the tube from expansion when they are heated. The plugs should be slightly amalgamated at the tips. The gap between the plugs, which is about 1mm. wide, tapers slightly, and is about half filled with filings, consisting of 95 per cent. of nickel, 5 per cent. of silver, and sometimes a trace of mercury. The vacuum is about one-thousandth of an atmosphere, and the tube is exhausted through a projecting side portion, which is seen near the middle of the tube, this part being sealed up by melting the glass at its extremity as soon as the requisite vacuum is obtained. The connecting wires are fixed to the silver plugs. So sensitive is the coherer that it is best to keep it short-circuited by connecting its wires when it is not in use. It is fastened to a bone handle so as to be easily carried or moved into a required position.

*Blondel's Regenerative Coherer.*—This coherer with M. Emile Guarini's tapper is shown in Fig. 23. It consists of the usual glass tube with metal plugs, the space between which has a certain amount of filings in it. This space is connected with a side reservoir in which is a reserve store of filings, the idea being to alter the sensitiveness or restore

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the action of the coherer should it become insensitive, by introducing a further or new supply of filings from this reservoir.

*Lodge's Single-Point Coherer.*—Dr. Lodge used a single-point coherer, consisting of a needle resting with its point on a smooth aluminium disc. When the electric impulse is received the needle adheres to the disc, and the contact becomes conducting. The difficulty with such a coherer is that the fine point is liable to injury by the passage of too large a current. Dr. Lodge also used this in another form, consisting of a fine spiral of iron wire inside a cylindric box. This spiral can be turned by means of a lever outside the box and its pressure of contact with an aluminium plate varied. When the electric waves reach the coherer the contact becomes conducting, or rather the resistance of the contact diminishes greatly. A slight tap restores the coherer to its original state. The filings coherer used by Drs. Lodge and Muirhead up till the time of introduction of their new mercury and disc coherer, consisted of an exhausted glass tube with two ordinary darning needles inserted in it point to point. Between these points

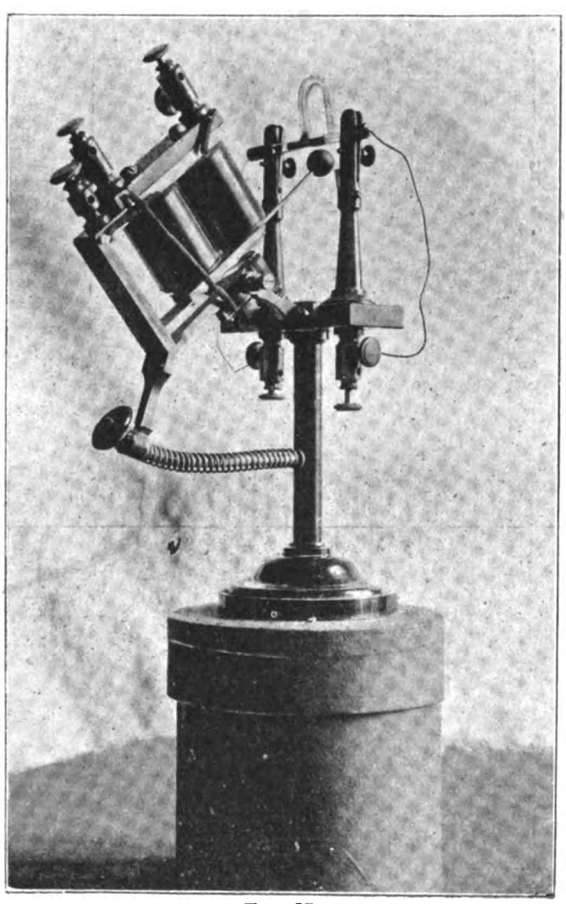

FIG. 23.

the filings were placed, and whilst one needle was fixed the other had an iron armature at its exterior (or eye) end controlled by a small permanent horseshoe magnet outside the tube. This coherer, we are informed, acted well, remained in good order for months, and was easily adjusted.

*Prof. Branly's New "Radio-Conductor."*—In most of the coherers in use up till recently metal filings or fine particles have been employed. This form of coherer is comparatively easy to construct, but is not altogether satisfactory. The numerous contacts and the modifications introduced by tapping render the apparatus somewhat fickle. Prof. Branly has recently devised a coherer or radio-conductor made by the contact of three tempered steel legs with oxidised points resting like a three-legged stool on a disc of polished steel. The oxidation is effected at a fixed temperature, and the degree of oxidation, as well as the polish, play an important part in the result. The thin layer of oxide remains intact for months. In the primary circuit of the receiver a cell of half-volt is joined by one of its poles to the upper terminal of the Morse register. The current goes through the terminal, then through a thin sheet of platinum to the pallet of the Morse, then to the relay through a variable resistance, and finally to the steel disc. The current goes through the contacts between the polished metal and oxidised metal and returns to the battery. In the secondary circuit there is one cell of a battery or an accumulator, the contact being closed by the relay. A spark having passed at the transmitting station, the first circuit is closed by the contact of the polished and oxidised metals, which becomes a conductor. The second circuit is closed by the play of the relay, the pallet of the Morse being attracted the circuit opens between the upper screw of the Morse and the soldered plate of the pallet. The pallet continues its movement owing to its inertia and strikes the lower screw of the buffer, and by this shock, which may be very feeble, operates the return of the tripod to its original state. When the opposing spring of the Morse has reapplied the pallet against the upper screw of the buffer, a new spark can act. The weakness of the shock enables the stroke of the pallet to be reduced and greater speed of transmission to be attained. The radio-conductor is protected from the action of the sparks of the transmitter at its own station by an auxiliary electro-magnet.

*(To be continued.)*

## TYPES OF DIRECT-CURRENT LOW-TENSION SWITCHGEARS.

BY W. E. WARRILOW, A.M.I.E.E.

*(Continued from page 410.)*

Fig. 5 illustrates a type of board built up with marble slabs in an iron framework. It is suitable for controlling dynamos, batteries, balancers, and feeders on the three-wire system. The battery switches are controlled by four hand-wheels mounted on panels in the centre of the board, and the spindle of each wheel is carried behind the board for gearing to a vertical shaft reaching to the switch spindle proper. This is fixed to the engine-room wall above the board, and in line with the end of the battery-room. This arrangement considerably shortens the length of the leads from the regulating cells to the switches, and thus minimises the risk of breakdown.

In certain instances, where the currents dealt with are comparatively small, the cables entering the board from the dynamos, and leaving it, to the feeders can be brought up in a vertical line directly below each panel. As the capacity of the gear increases it is necessary to lead the conductors in near the wall, and bend them over the intervening space between the wall and the gear. With large cables this is the most satisfactory arrangement, although it is possible to bridge the space with copper bar or rod and obtain an equally good result. In the last instance the cables are pushed through the wall and bolted direct to their respective terminals without any bending whatever. In Fig. 6 an arrangement of this description may be seen. It illustrates the back view of a direct-current switchboard controlling heavy currents. On the right hand is the back of the marble slabs fitted with the switching apparatus, and on the left is the engine-room wall, which is, however, provided with windows for the efficient illumination of all the connections. This last feature is not always to be met with, as the cable couplings are usually enclosed in some dark hole which even an experienced man might shrink from entering. The opposite end of this same gear is shown by Fig. 7, and here a number of heavy cables passing upwards on the right will be noticed. It will also be seen that fuses are employed on the feeders. Both the foregoing illustrations are good examples of what can be done with the connections of a heavy-current low-tension switchboard. The arrangement is likely to prove satisfactory as long as little alteration is required, but the difficulty of getting access to any special connection or fitting can be realised from a close inspection of the illustrations.

Among low-tension gears of this type there are practically no standards in the industry, and when engineers have established precedents with huge power schemes they have designed the controlling apparatus themselves. Many municipal electrical engineers also have met the particular

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requirements of their patrons with switchgears of their own design, and several excellent examples of these are to be met with. Fig. 8 represents a board which was constructed in this manner for the Glasgow Corporation to the design of its electrical engineer, Mr. W. A. Chamen. It is particularly interesting, in that it has two working faces. The first of these is arranged close alongside the engine-room wall, and is fitted with switches, fuses, links, and cable terminals. The second is mounted some 6ft. away from the first, and the instruments and switch levers are fitted to it.

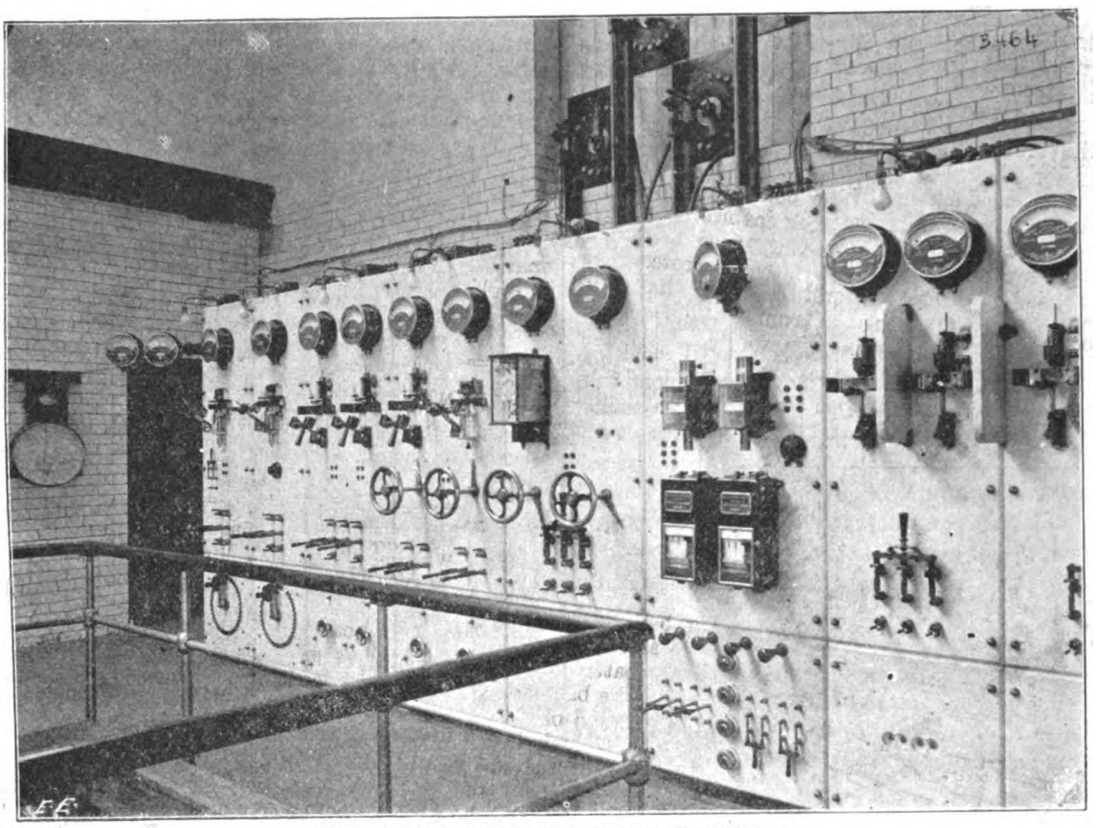


FIG. 5.—Another form of Three-Wire Board (Westinghouse).

The board is made up of dynamo and feeder panels, the former being mounted on the ground floor close to the particular machine controlled. The latter are fixed on a gallery above the dynamo boards, and are illustrated in Figs. 8 and 9, which give a clear idea of the general design of the gear. Eight 'bus bars (four positive, four negative) are suspended from the gallery supports, directly over the machine panels. Plug switches are provided on the feeder boards to enable any feeder to be connected to any bar at will. The feeder panels (1,000 kw. each) are in two rows.

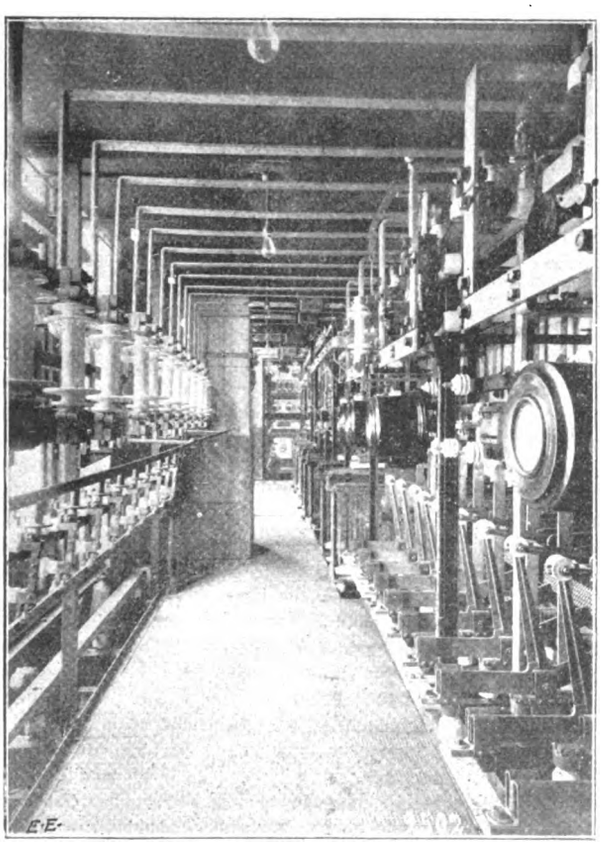


FIG. 6.—Back of Low-Tension Board (Oerlikon).

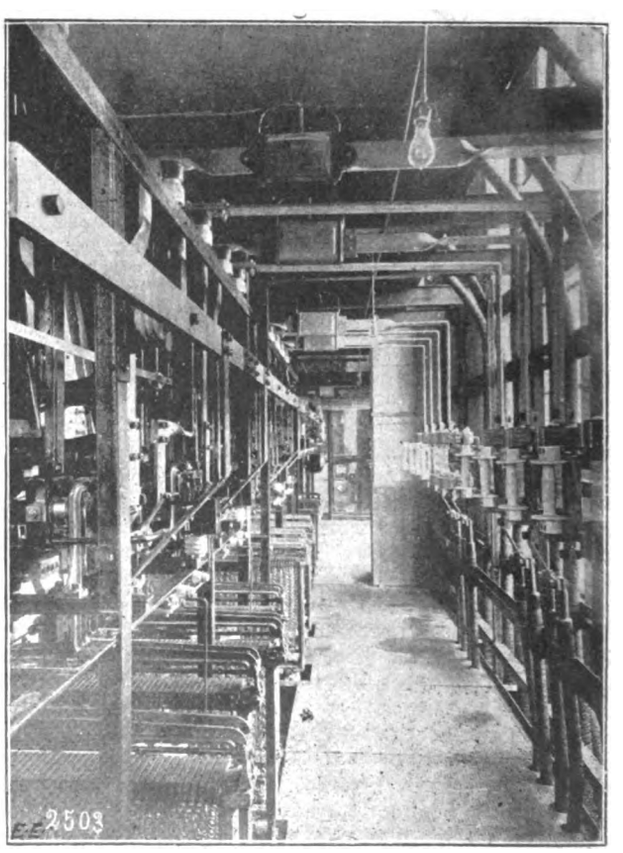


FIG. 7.—Another Back View of Low-Tension Board (Oerlikon).

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The front row contains the plug switches for the 'bus-bar connections, switch levers, and recording voltmeters and ammeters (functions combined in one instrument). The drums of the latter contain a 24 hour card, on which the feeding point pressure is recorded, in addition to the current output of the feeder. All the drums are worked from an electric clock sending impulses every half-minute. The back row of panels (Fig. 9) is mounted on the face of the wall behind the front row, a clear walking space being left between both rows. The feeder switches, operated by rods passing through the front panels, are mounted on these rear slabs, together with duplex fuses. Two fuse strips are superposed with a swinging link to short-circuit one set of strips, and bring the other set into circuit when fusing takes place. The feeder cables are coupled to the lower fuse terminals and pass down the wall to an underground tunnel beneath the engine-room floor. The complete assembly of the board occasions the passage of current through the dynamo panels to the 'bus bars above them, upwards to the feeder plugs on the gallery overhead, thence across to the switches and fuses on the wall face, and finally down this wall by cable to the tunnel and distributing network. Considerable vertical space is, of course, taken up by this, but it is quite outbalanced by the absence of straggling cable connections arranged in some dark recess. The couplings throughout the gear are of a fireproof nature (lead-covered cable and copper strip), the gallery is also non-inflammable, being of iron and glass, so that these precautions reduce the chances of a conflagration to a minimum.

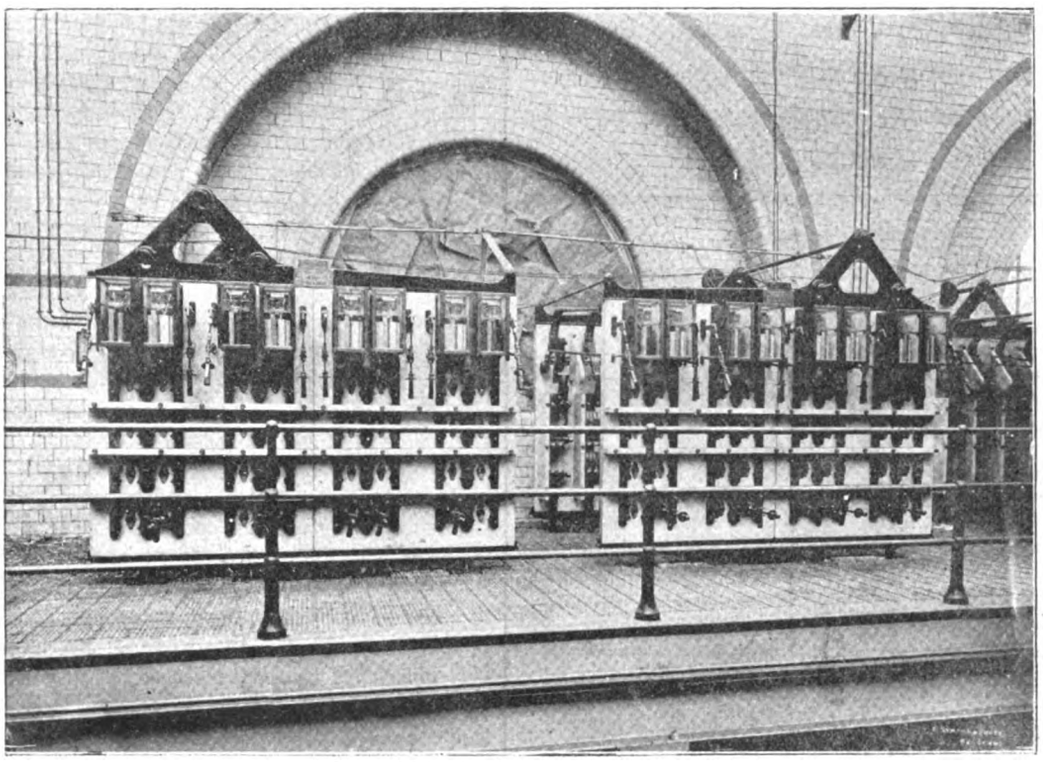

FIG 8.—Special Low-Tension Gear (Glasgow Corporation)

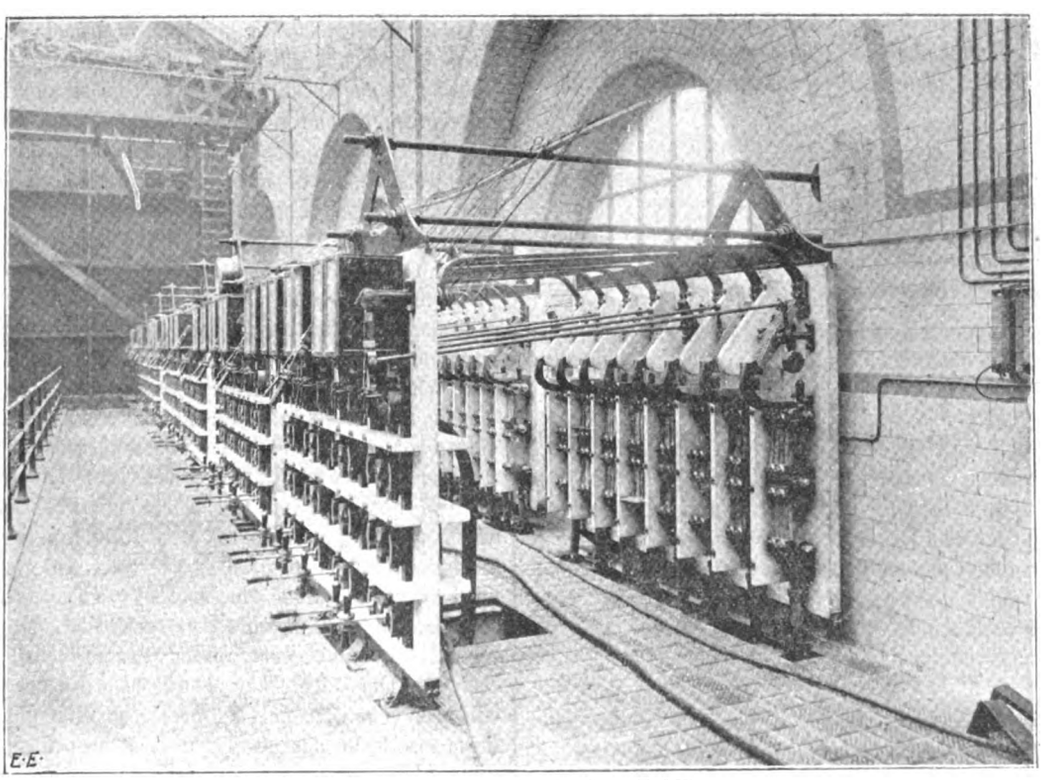


FIG. 9.—Special Low-Tension Gear—End View.

*(To be continued.)*

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## ELECTRIC POWER SUPPLY.

During the past four or five years there has taken place a series of attempts on behalf of electric power distribution companies to get a foothold in our large towns. As the electric supply in these towns in nearly every case belongs to the corporation, the fight has been one between company and municipal control. The chief argument used by the counsel for the power distribution companies has been that the supply of power in bulk to large consumers does not come within the range of legitimate municipal enterprise. It is further argued that a corporation is not justified in pledging the public credit in order to give a cheap supply of power to industries which may not be lasting in character. In spite of these arguments, and of others in which an attempt has been made to prove that the corporations are unable to give as cheap a supply as a company, the efforts of the power distribution companies to get rights within the boundaries of large towns have not been successful. The attempt made this last year to include Bristol within the area of supply of the Somerset District Electric Power Company is the nearest approach to success. In this case, however, the company will only obtain the right to supply electrical energy to large consumers after they have proved to the satisfaction of the Board of Trade that the Bristol Corporation is either unable or has refused to give the supply demanded by certain consumers at reasonable rates as compared with the terms offered by the power distribution company. This proviso practically amounts to the exclusion of the company, as the Bristol Corporation is quite alive to the advantage of having large power consumers connected to its electricity supply system. Thus its charges for power commence at 1½d. per unit, and discounts are given which vary with the power factor of the load to be supplied. In one instance, as mentioned in an earlier issue of our journal, a contract has been made with a consumer requiring 300 h.p. to 400 h.p. for nine hours a day at the low rate of $\frac{13}{16}$d. per unit. This charge is about the lowest we know of, and it is certainly below the published charges of the power distribution companies actually at work. Elsewhere in this issue will be found a description of the new generating works at Sunderland, which have been designed by Mr. John F. C. Snell with the special object of meeting economically the demand for electric power. The town of Sunderland is quite exceptional in this respect, in that there are within the borough boundary no less than twenty-one shipbuilding yards and large marine engineering works. This class of engineering undertaking has everything to gain from the introduction of electrical power, because of the large area over which their machinery is scattered. In consequence of this, steam is a most uneconomical agent for the distribution of power, as the owners of these shipyards and engineering works quite realise. As will be seen from the article in question, the Corporation of Sunderland are now supplying an aggregate of 520 h.p. by three-phase induction motors in one large works. In another instance no less than 1,892 h.p. represents the total output of the direct-current motors to be installed. In this instance the Corporation are under contract to supply one-half of the electricity required, and the other half will be taken from the firm's private plant. In both these cases the charge per unit is according to the scale rate, 1⅛d. per unit. The advantage to the Sunderland Corporation is yet to be fully realised, as the whole of the motors are not yet at work. Even now, however, the load factor on the new Hylton-road electricity works has reached the high figure of 41·6 per cent., while the cost for coal, oil, stores, wages, and repairs has come down to 0·598d. per unit. As more power consumers come on, and

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a larger proportion of the total load on the works is derived from this class of consumer and from tramways, much better results are to be expected from these new works. Sunderland, while taking a prominent position in the development of a cheap power supply to large consumers, is by no means alone in this respect. Bradford may, perhaps, claim the first place as the pioneer in this respect, but other towns, such as Edinburgh, Glasgow, and Aberdeen, are all doing good work. For instance, in connection with this latter town, we note this week the opening of a new shipyard at Torry which takes the whole of its power supply from the Corporation named. It is due to this to a considerable extent that the owner of this yard, although he only obtained possession of the site in November, was able to launch the first vessel on the last day of March. We understand that this shipyard employs electrical means of transport to a very large extent. In those towns, like Aberdeen, Cardiff, and Sunderland, where electric light, electric power, and energy for electric tramways are all supplied from a common station with more or less common plant, the competition from power distribution companies becomes practically impossible. The more important fact is, however, that in these towns the corporations have secured for the inhabitants every advantage of electrical distribution at the lowest possible price. At the same time this price provides for reasonable depreciation, so that the stability of the undertaking is secured, which is by no means necessarily the case under company management.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### ELECTRIC TRANSMISSION.

SIR,—Could you or any of your numerous readers inform me where I could see and inspect on any of the smaller English rivers the ordinary water power of a common flour mill converted and now used regularly for creating electricity for transmitting energy to any distance for mechanical purposes in the same manner—but, of course, infinitely insignificant as compared with—as at Niagara Falls.—Yours, etc.,

H. E HARBIN.

Newton Surmaville, Yeovil.

## WEST HAM'S NEW ELECTRIC GENERATING STATION.

### Formal Opening.

The formal opening of the new electric generating station erected by the Corporation of West Ham took place on Wednesday afternoon last, the Mayor (Councillor Geo. A. McDowall, J.P.) performing the ceremony. Subsequently current was switched on to the lighting and tramway mains by the Mayoress, the company then proceeding to a marquee to hear the inaugural speeches. Having declared the station open, the Mayor read a telegram from Mr. Allan Baker, chairman of the London County Council Tramways Committee, wishing the undertaking abundant success. This he (the Mayor) thought a good omen, since the usefulness of their system of tramways depended very largely on co-operation with the work of the London County Council to obtain through running over the adjoining systems, and Mr. Baker's evident goodwill towards them augured well for the success of future negotiations. In the course of an interesting address, Alderman William Ivey, chairman of the Electric Lighting and Tramways Committee, paid very high tribute to the work of the Corporation's engineers, incidentally expressing the regret which they all felt in having to part with Mr. James K. Bock, their electrical engineer, who was about to leave them to take over important duties elsewhere. The principal contractors also obtained a word of praise. Mr. Bock disclaimed any ability as an orator, but immediately belied his own words. There were several other speakers, among whom was Mr. Ferranti. We hope to give an illustrated description of the station in an early issue.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 8.

**Junior Institution.**—At 8 p.m., "The Heating and Ventilation of Factories," by Mr. Kenneth Gray.

**Manchester Students, Institution of Electrical Engineers.**—At 7.30 p.m., "Direct-Current Controllers," by Mr. H. N. Dutton.

SATURDAY, APRIL 9.

**West Hartlepool Scientific Society.**—At 7.30 p.m., annual meeting.

**Manchester Students, Institution of Electrical Engineers.**—At 2.30 p.m., visit to Messrs. W. T. Glover's cable works.

MONDAY, APRIL 11.

**Institution of Mechanical Engineers.**—Students' Section: "The Manufacture of Linoleum Floorcloth," by Mr. E. J. Stevenson.

TUESDAY, APRIL 12.

**Institution of Civil Engineers.**—At 8 p.m., "Recent Developments in Cargo and Intermediate Steamers," by Mr. Edwin William De Rusett.

**Institution of Electrical Engineers.**—Manchester Section: At 7.30 p.m., annual general meeting. Glasgow Section: At 8 p.m., "Corporation Telephones," by Mr. A. R. Bennett.

**Royal Institution.**—At 5 p.m., Prof. L. C. Miall on "The Transformation of Animals" (Lecture I.).

WEDNESDAY, APRIL 13.

**Faraday Society.**—At 8 p.m., "Alloys of Copper and Arsenic" (illustrated), by Mr. Arthur H. Hiorns; "A New Primary Battery," by Mr. E. G. P. Bousfield; "Note on Determining Accurately the Percentage of Ozone in Gases not Dissociated by Moderate Heat," by Mr. E. G. P. Bousfield.

**Institution of Civil Engineers.**—Students' visit at 2.30 to the works of the Great Northern, Piccadilly, and Brompton Railway, in course of construction.

**Electrical Contractors' Association.**—Annual dinner at Holborn Restaurant.

THURSDAY, APRIL 14.

**Institution of Electrical Engineers.**—At 8 p.m., continued discussion on "Direct-Reading Measuring Instruments for Switchboard Use," by Mr. K. Edgcumbe, associate member, and Mr. F. Punga; "Eddy Currents and Eddy-Current Losses in Cable Sheaths," by Mr. M. B. Field, member.

**Dublin Local Section, Institution of Electrical Engineers.**—At 8 p.m., ordinary meeting.

**Royal Institution.**—At 5 p.m., Prof. Dewar on "Dissociation" (Lecture I.)

**Institution of Mechanical Engineers.**—Annual dinner at Hotel Cecil.

FRIDAY, APRIL 15.

**Institution of Mechanical Engineers.**—At 8 p.m., "Compound Locomotives in France," by Mr. E. Sauvage.

**Royal Institution.**—At 9 p.m., "Korea and the Koreans," by Monsignor the Count Vay de Vaya and Luskod.

**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Grimsby, April 23, Newcastle, May 6 and 7; Buxton, May 20 and 21.

## A FEW NOTES ON THE STEAM-TURBINE.*

BY THE HON. C. L. PARSONS, A.M.I.C.E, A.M.I.E.E.

Since no paper on the steam-turbine has been read before the Newcastle-on-Tyne Section of the Institution of Electrical Engineers, the author hopes that a few remarks will not be without interest to those present. In the year 1884 electric lighting was rapidly coming to the front, and the demand arose for a good fast-running engine which could be coupled direct to a dynamo to take the place of the cumbrous system of rope or belt driving then generally in use. The steam-turbine, an ideal rotary engine, was one solution of this problem. In conjunction with this a new type of dynamo had to be designed which would run at the high speed required by the turbine, for if the speed of the turbine was lowered too much, there was loss of economy, the problem being to make the dynamo run fast enough for the turbine and the turbine to run slow enough for the dynamo, so that the two could be coupled direct without the use of gearing.

Preliminary experiments were made in 1884 with trial shafts to ascertain what exactly were the conditions required for

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 21.

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steady running at speeds up to 40,000 revolutions per minute These shafts were 1½in. in diameter and 2ft. long, the bearings being about ⅜in. in diameter. Various types of bearings were tried, but for successful running a small amount of elasticity or give was found necessary, combined with a certain frictional resistance to rapid transverse displacement. The following arrangement was finally adopted. The bearing itself consisted of a plain gunmetal bush with a collar at one end and a nut at the other. On this bush were threaded alternately a number of thin washers of different sizes. Half the washers fitted the inside of the bearing bush, while those of larger internal and external diameter fitted the hole in the bearing block. At the end came a wide washer, which fitted both the block and the bush, and formed a fulcrum, on which the bush rested, while a spiral spring between the washers and the end nut in the bush kept all the washers pressed tightly together. As it was impossible to make the rotating shaft absolutely true, a slight displacement of the bearing bush was caused, which was resisted by the friction of the washers, each sliding against its neighbours, but the shaft itself, being slightly elastic, had a tendency to centre itself on the fulcrum washer under the gyrostatic forces due to the high speed, and thus revolved steadily about its principal axis of gyration without any vibration. This type of bearing was used successfully for many years, but has now been replaced by a simpler form which answers the same purpose. This consists of a gunmetal bush surrounded by several concentric tubes fitting loosely one inside the other. Into the interstices between the tubes the oil enters in a very thin film, which has great viscosity, and hence produces considerable resistance to rapid lateral displacement of the bearing bush. The oil film also tends to centre the shaft, and forms a cushion which effectually damps out all vibrations. This form of bearing is very durable, and is still used for all speeds over 2,000 revolutions per minute. For slower speeds, bearings lined with white metal are more suitable.

In the same year, 1884, after these preliminary experiments, the first successful steam-turbine (of about 10 h.p.) was constructed, coupled direct to a type of dynamo specially designed to run at the high speed of 18,000 revolutions per minute. The turbine was made double-ended, the steam entering at the centre and passing towards both ends of the shaft, so that all end thrust was avoided. On each half of the shaft were placed 15 rings of blades or turbine wheels projecting outwards, and nearly touching the concentric outer case, between them being corresponding of fixed guide blades projecting from the case and nearly touching the shaft. Each set of this series of rings was like a parallel-flow water-turbine, complete in itself, with this difference, that the steam, after doing its work on one set of blades, passed on without losing its longitudinal velocity through the guide blades to the next set of moving blades until it finally reached the exhaust. The fall in pressure being quite gradual and the expansion being continuous, the passage way in each succeeding row of blades required, therefore, to be increased. Owing to the comparatively low velocity of the steam, due to its gradual expansion, there is no cutting of the blades, the original tool marks being perfectly plain after the machines had been running many years. This early turbine was used for many years, and may now be seen in the South Kensington Museum close to the famous old reciprocating engines constructed by James Watt, Stephenson, and others.

In these turbines the speed was higher in proportion than that of more modern types. The turbine was governed by a lantern type of throttle valve worked by the movement of a leather diaphragm, which the suction of a fan on the shaft tended to close against a spring. The admission of air to the diaphragm was controlled by an electrical governor. On the top of the magnet yoke there was a small iron bar pivoted on a vertical spindle and carefully balanced. This was moved round by the alteration of the magnet yoke against a spiral spring. A double finger or arm was keyed on the same vertical spindle; the end of each finger was flat, and, when opposite to the inlet of the air-pipe, closed it. The spiral spring was so adjusted by a movable head that the greater the voltage, the more was the air inlet closed by one of the fingers. When the inlet was open the air rushed along the pipe and partially neutralised the suction of the fan, allowed the diaphragm to extend, and thus opened the throttle valve. If the dynamo got demagnetised the needle turned the other way, and the safety finger closed the air inlet and thus cut off steam. This type of governor was very sensitive, and kept the voltage steady within 1 per cent. The steam consumption of a 32-kw. plant of this type running non-condensing was about 48lb. per electrical horse-power hour with a boiler pressure of 61lb., and about 42·b. per electrical horse-power hour with a boiler pressure of 92lb.

In 1889, owing to temporary loss of patents, the radial-flow type of turbine had to be adopted. This consisted of a series of fixed annular discs with rings of blades, between which another series of discs keyed to a shaft rotated. The guide blades were secured to the faces of the stationary discs, and nearly touched the rotating discs, while the moving blades nearly touched the fixed discs. The steam passed outwards through the successive rings of blades, then inwards along the back of the first moving disc, and again outwards through the next ring of blades until it finally reached the exhaust. In 1892 this type of turbine was first tried condensing with a vacuum of 27in. With slightly superheated steam at a pressure of 100lb., the consumption at the normal full load of 100 kw. was 27lb. per kilowatt-hour. About this time many turbines of this type were installed in various parts of England, including the stations at Newcastle, Scarborough, and Cambridge; none, however, being larger than 150 kw. Some of these can be seen at the Newcastle and District Electric Lighting Company's works. One of them can be coupled either to a single-phase alternator at 1,000 volts and 80 periods or to a continuous-current dynamo at 480 volts, the change from one to the other being made in a couple of hours.

In 1894, however, the parallel-flow type was again adopted with considerable improvements. The turbine was made single-ended, with the steam passing in one direction only, the second series of rings being replaced by three rotating pistons, or dummies, by which the end pressure of the steam along the shaft was balanced. Each of the pistons corresponded in size to the part of the turbine it balanced, and to which it was connected by a pipe. Grooves were turned in these pistons, between which the corresponding fixed collars of the cylinder projected, and being almost in contact reduced the leakage of steam to less than 2 per cent.; the amount of clearance could also be regulated by the thrust bearing at the end of the turbine shaft.

*Governing of Turbines.*—The governor can be either of the mechanical type, which keeps the speed constant, or of the electrical solenoid type, which maintains a constant pressure at the terminals of the dynamo by raising the speed of the turbine to meet the fall in voltage due to the increase of the load. The electrical governor is now seldom fitted except on the smaller continuous-current plants. The action of the governor is as follows: Steam is admitted into the turbine in a series of gusts by a double-beat valve, the length of the gusts being regulated by the governor until at full load they are practically continuous. This double-beat valve is fixed on a spindle on the upper part of which is a piston working in a separate chamber. Steam is continually being admitted under the piston, which thus moves upwards against a spring, and so opens the double-beat valve. The exhaust from this piston is regulated by means of a small plunger valve, which is continually being kept in motion by a lever worked on a cam driven off the turbine spindle by a worm and worm-wheel. In this way the valve is moving up and down the whole time, and so remains perfectly free. A separate set of levers, worked by the governor itself, alter the mean position of the plunger, and so lengthen or shorten the gusts of steam. The same worm-wheel drives a small pump, by which oil is supplied under pressure to all the bearings, being then returned to the tank to be used over and over again, resulting in a great saving in oil, as compared with reciprocating engines. Inside the cylinder itself no lubrication is required, since no parts are touching, the two end packing glands being of similar construction to the balancing pistons, also run clear, hence no oil can possibly find its way into the exhaust. Turbines are running in breweries and chemical works, where the exhaust is led straight into the vats or liquids which require to be heated, and at Heaton part of the turbine exhaust steam is specially condensed to be used as distilled water for delicate chemical processes. The cost of oil for a large turbine works out at about ·002d. per kilowatt-hour. Among the earlier machines of this type were the 350-kw. alternators put down at the Manchester-square station of the Metropolitan Electric Supply Company, of London, in place of the reciprocating engines, which had been causing immense annoyance through vibration. These turbines gave complete satisfaction, and several of them have since been converted to continuous current. Since that date the size of turbines has gradually increased, units of 500 kw. being put down in Newcastle, Scarborough, Cambridge, London, and other places. All these large plants were single-phase alternators, the voltage being from 1,000 to 2,000 and the periodicity 80 to 100 with revolving armatures.

The next important advance was made in 1900, when two alternators, each of 1,250 kw. capacity, were constructed for the city of Elberfeld, in Germany. The turbines had two cylinders arranged in tandem, and ran at 1,500 revolutions per minute. They were coupled to four-pole alternators with revolving armatures, giving single-phase current at 4,000 volts and 50 periods. The air-pumps were driven off the turbine shaft by worm and worm-wheel, the circulating pumps being separately driven. The steam consumption at full load with slight superheat was 18·8lb. per kilowatt-hour, or 11·9lb. per indicated horse-power hour. The parallel running is very good, the turbines steadying the 1,000-kw. Sulzer-Brown-Boveri alternators running at 93 revolutions per minute. The single-cylinder type of turbine has again been adopted for the larger as well as for the smaller sizes, being found cheaper as well as more efficient, besides requiring a shorter engine-room. Plants up to 10,000 I.h.p. are now being constructed with a single cylinder. As a high vacuum is most important for obtaining the best results in steam economy, ample space is allowed at the end of the turbine for the

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exhaust steam, and the condenser is generally placed in a pit straight under the turbine so that the drop in vacuum may be as small as possible between the machine and the condenser, while the length of piping required is greatly reduced. The following table shows the effect of variation of vacuum on the consumption of steam in the case of a 1,500-kw. set. For smaller sizes the variation is not so marked.

| Vacuum bar = 30in. Inches. | Difference in steam consumption per 1in. of vacuum. Per cent. |
|---|---|
| 29 | 6 |
| 28 | 5 |
| 27 | 4 |
| 26 | 3½ |
| 24 | 3 |
| 22 | 2¼ |
| 16 | 2 |

As regards the cost of obtaining these high vacua, a little investigation will show that the extra power required to maintain a higher vacuum in a given condenser (and the cooling surface need not be larger than usual) is very small in comparison with the saving of steam in the main turbine with a good vacuum. A high vacuum is of no advantage in the case of a reciprocating engine for various reasons. The low-pressure cylinder would require to be very large to deal with the comparatively enormous volume of steam, resulting in much greater cost, friction, and condensation. The exhaust passages and ports would also present many difficulties and make the whole plant very bulky and clumsy, and in no way more efficient. Another saving results from being able to return the condensed steam from the turbine direct into the boiler without having to filter off any oil as the steam is perfectly clean.

One of the most interesting examples of what can be done with steam-turbines is the Forth Banks station of the Newcastle and District Electric Light Company, Limited. It was first started in 1889, four units of 75 kw. each being put down, running at 4,800 revolutions per minute, giving single-phase current at 1,000 volts, 80 periods. These were of the double-ended, parallel-flow, and non-condensing type. Part of the engine works of Messrs. Hawthorn-Leslie were bought as a site. The boilers were placed below and more or less above them the engine-room of an area of 400 square yards. A few years later radial-flow units of 150 kw. were put down, and a condenser installed in a shaft that was sunk below high-water mark, and finally parallel-flow units of 500 kw., of which there are now three, the total power being about 2,200 kw. alternating. In addition, two units of 400 kw., giving continuous current at 480 volts for power and lighting. A total, therefore, of 3,000 kw. was installed in a very small space, the only disadvantage of the station being the heavy cost of carting away the ashes. The demand for direct current has increased so fast that a new station has been built in the Close. Two units of 1,000 kw. each have been started during the last few months, and a third of 1,500 kw. has just been ordered. The 1,000-kw. turbine is designed to run at 1,800 revolutions per minute, and is coupled to two 500-kw. continuous-current dynamos arranged in tandem. The governor is of the electrical solenoid type maintaining a constant voltage within 2 per cent. between no load and full load. The 1,500-kw. set will have further improvements. The governor will be of the mechanical type, keeping the speed constant within 2 per cent. The dynamos, each of 750 kw., will be of a new design, specially wound to give fixed commutation from no load to 50 per cent. or even 100 per cent. overload. If found desirable at a subsequent date, this set can be over-compounded for traction purposes.

Among other large continuous-current plants made recently are two 1,800-kw. tandem sets at 480 volts for Manchester Corporation, running at about 1,000 revolutions per minute. When tested on site the steam consumption was about 19¾lb. per kilowatt-hour at full load and 23 at half load without superheat, with 120lb. steam pressure. Three sets of 300 kw. each have just been completed for the Corporation of Derby. They run at 3,000 revolutions per minute, and are intended to supply current for traction and lighting. The dynamos are specially wound to give sparkless commutation for all changes of load without movement of the brushes. Curves were taken on a horn tachograph showing the variation of speed when the main circuit was made and broken on a load of 350 kw. The temporary variation did not exceed 4½ per cent., and the permanent 2½ per cent. The dynamo was tested by throwing 350 kw. off and on when running both as a shunt machine and as a compound, no movement being found necessary for the brushes, which were of brass wire. The following table shows the variation of voltage under different conditions.

| | Kilowatts. | Voltage. | Speed. |
|---|---|---|---|
| Compounding in use | 0 | 505 | 3,075 |
| " " | 336 | 565 | 3,000 |
| Shunt only | 300 | 500 | 3,000 |
| | 0 | 543 | 3,075 |
| | 0 | 520 | 3,000 |
| (Constant excitation) | 0 | 518 | 3,000 |

Many large alternators have been constructed during the last few years, including two of 750 kw. capacity erected at Bristol last autumn. The latter are of the revolving-armature type, running at 1,860 revolutions per minute, and have six poles and generate single-phase current at 2,000 volts and 93 periods. A certain number of two-phase dynamos have been constructed, including four of 500 kw. capacity for the Metropolitan Electric Supply Company, at 1,000 volts and 60 periods, and two of 1,500 kw. capacity for the Corporation of Sheffield at 2,000 volts and 50 periods, all of the revolving-armature type.

Three-phase sets are more numerous, especially for voltages of about 6,000. At present plants varying in size from 750 kw. to 3,500 kw. are being constructed, the large sets being for the Carville station of the Newcastle Electric Supply Company, all of the revolving-field type, the number of poles being either two or four. The stators are built up in a cast-iron case with ample provision for ventilation through the core, the windings being placed in tubes of tape and presspahn, which, on the whole, are the most satisfactory. Each tube is tested thoroughly electrically by flashing before being put into the stator, but it should be pointed out that an excessive pressure test, though it may not appear to cause damage, is really injurious just in the same way as a boiler is permanently strained by being tested too highly. The rotors have former-wound coils with plenty of insulation and special supports to resist the centrifugal strains due to the high speed. The pole-tips can be removed and a damaged coil replaced by the spare one in a few hours.

A plant of 1,500 kw. capacity is now being constructed for the Ultimo power station of the Sydney tramways, N.S.W. The periodicity is 25, requiring a two-pole rotor running at 1,500 revolutions per minutes. For colliery work three-phase alternators with revolving armatures generating at a pressure of 440 to 550 volts are becoming very numerous, the largest of this type being a 750-kw. set for Ashington Colliery. The output of the steam-turbine in England has increased enormously during the last two or three years, and include plants of large size for most of the large towns and power companies. On the Continent, Messrs. Brown-Boveri have some large plants in hand, including three-phase alternators of 10,000 h.p. for Messrs. Krupp's work at Essen and five of 8,000 h.p. for the Paris Metropolitan Railway, while in America the turbine has become very popular, and threatens to displace the reciprocating engine in all the larger schemes.

## TRADE NOTICES AND NOVELTIES.

### G.E.C. Bell Catalogue.

We have received from the General Electric Company, Limited, 71, Queen Victoria-street, E.C., a copy of the fifteenth edition of their Section L list, which deals with bells, indicators, pushes, telegraph instruments, lightning conductor fittings, etc. In connection with this list attention is called to several new departures. It is well known that the company's workshops in Birmingham and Manchester are provided with special automatic machinery for turning out the above class of work accurately and highly finished throughout in large quantities, thereby enabling first-class apparatus to be sold at the lowest possible price. Owing to the increased demand for a high-grade indicator at a moderate price, the company have undertaken the manufacture of a superior quality indicator to sell at the price hitherto charged for their medium quality instrument. The woodwork is strongly dovetailed and screwed, and the whole of excellent finish. Among the new types of bells, besides those for traction, ship, and mining work, the list includes an all-metal bell, the "Colonial," designed

G.E.C. Bracket Bell.

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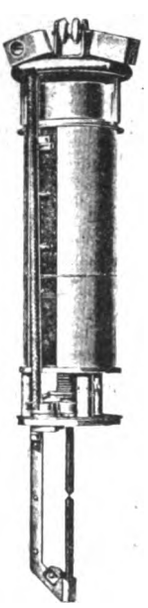
to meet the requirements for tropical climates. It can, of course, be used for ordinary house work, and is specially recommended on account of its having fixed adjustments, besides being thoroughly dustproof. Many new designs in artistic metal pushes and door pulls, to harmonise with the various styles of art work now met with, are illustrated. Mention may also be made of the firm's high-class telegraph instruments, sounders, relays, and Morse inkers, as used by the General Post Office, which are dealt with in another part of the list. The merits of the "Extra Sec" dry battery, chief of which are that it does not deteriorate even in hot climates and is very powerful, are again pointed out, while the diagrams and instructions given at the end of the list should greatly facilitate the running of bell circuits, etc.

### Exhaust Heads.

From Messrs. Alton and Co., Western Works, Hythe-road, Willesden Junction, N.W., we have a leaflet dealing with their patent centrifugal exhaust head. Notwithstanding that it has been on the market only a comparatively short time, this head, we understand, has proved a complete success. It is claimed to be especially suitable for steam hammers, as it is made entirely of cast iron, having no loose internal parts to shake to pieces and come adrift. A number of these heads have been supplied to his Majesty's dockyards, while others are in use in electric light stations and industrial works throughout the country.

### "Angold Midget" Arc Lamps.

Accompanying is a view of the "Angold Midget" arc lamp introduced by the General Electric Company, Limited, 71, Queen Victoria-street, E.C. Unlike similar types on the market, this lamp is of British manufacture, and as it combines



"Angold Midget" Arc Lamp.

the excellent features of the "Angold" ordinary arc lamp should commend itself to users. Especially worthy of note is the entirely new form of magnetic control, resulting in the lamp starting up without pumping, and running steadily while on circuit. For the rest the lamp is of the continuous-current enclosed type, designed to take a current of two amperes in parallel on circuits of 100 to 110 volts, and for two in series on 200 to 240 volts, or three in series on 250 volts. It will be found suitable for either indoor or outdoor use, as the case is quite waterproof. Moreover, as the over-all size is not more than 12½in., it is well adapted for shop windows, offices, corridors, etc, when it is necessary to have a good light without sacrificing space.

### Moy Specialities.

Three sheets which we have received from Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, N.W., deal respectively with distributing fuseboards from pressures up to 250 volts, the standard dimensions of the same, and Mordey's patent fuse for pressures up to 550 volts.

### Brooke's New Steam Trap.

A full description of Brooke's patent steam trap is contained in list No. 60, recently issued by Messrs. Holden and Brooke, Sirius Works, West Gorton, Manchester. Many advantages are claimed for this trap, and the description in question, being well illustrated, is worth getting by those to whom it applies.

### Catalogues.

CHAMBERS, SCOTT, AND CO., engineers, crane builders, and machine tool makers, Dalziel Engineering Works, Motherwell, N.B.—Pamphlet E.C., No. 1904, electric overhead travelling cranes (illustrated and descriptive). The firm states that the following information is necessary in order to base quotations: capacity and span of crane, headroom available, height of rails above floor level, distance between wall and centre of rail, speed of movements, method of operation, duty of crane. Enquiries for prices on longitudinal wiring, beams, and rail, should give length of overhead track and distance between the supporting columns.

## PHYSICAL SOCIETY.

At the meeting of this society on March 25, Dr. R. T. Glazebrook, F.R.S., president, in the chair,

A paper, entitled **"Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance,"** was read by **Prof. Fleming**. The author referred to a paper read before the society last year by himself and Mr. W. C. Clinton, in which a motor-driven commutator was employed to measure small inductances. It had since been found that very good results could be obtained in the measurement of small inductances by Prof. Anderson's method by using a telephone in place of a galvanometer and a buzzer in the battery circuit. The author had found that for long solenoids, at least 50 diameters long, the inductance could be calculated with an accuracy of about 1 per cent. by the rule: inductance in centimetres = (length of wire in one unit length of solenoid) × (total length of wire in the whole solenoid in centimetres). Numerous measurements were given showing the agreement between the measured and predicted inductance of various solenoids and the limits of the dimension ratio within which the rule was valid. It was also shown that by means of such a predetermined inductance small capacities, such as those of Leyden jars, could be easily measured. A standard of inductance graduated in microhenries suitable for electric resonance experiments and Hertzian wave telegraphy was exhibited. The standard consisted of a spiral of copper wire with special means for producing gradual variation or definite variation in the inductance thrown into a circuit.

**Mr. A. Campbell** said that they had lately measured some self-inductances of the order of 100 microhenries (100,000cm.) at the National Physical Laboratory. The method used was practically that of Max Wien as modified by Dolezalek. In the original method two contiguous arms of a Wheatstone's bridge consist of (1) the inductive coil (under test) shunted by a known non-inductive resistance, and (2) an unknown (preferably variable) inductive with an adjustable resistance in series. The other two arms are non-inductive resistances, with a slide-wire between them. The indicating instrument (either an optical telephone or a vibration galvanometer) is tuned to respond only to a particular frequency, and the source of current is worked at this frequency. Thus, although the source may give a quite irregular wave-form, the instrument practically ignores all but one sine-curve component, and the formula can therefore be easily obtained. The product and the quotient of the inductances in the network are given in terms of non-inductive resistances and $\mu$, where $p = 2\pi n$, $n$ being the frequency of the current source. From these equations the inductances can be separately determined. The modification described by Dolezalek consists in using a current source giving a nearly pure sinoidal wave and an ordinary telephone as an indicating instrument. The current generator is a "microphone hummer." In this a telephone plate (P) carries a microphone (M). A current from two accumulators is passed through M and the primary of an induction coil, the secondary being connected with a polarised magnet acting on P. Dolezalek states that, by the use of a "hummer" and a variable inductance standard, inductances of about 0·1 microhenry (100cm.) can be readily measured to within 1 or 2 per cent. For obtaining frequencies above 1,000 $\frown\!\smile$ per second, Mr. Campbell has found it desirable to replace the telephone plate by a steel bar 2·5cm. in diameter. In order to make the note in the detecting telephone pure, the latter is tuned by means of a small screw pressing against the ferrotype plate.

**Mr. W. Duddell** expressed his interest in the paper, and asked what precautions were taken to ensure that the resistances and connections used were free from self-induction and capacity. He thought that some of the variations in the figures given in Table I. of the paper might be due to these effects.

**Dr. Fleming**, in reply, said that in connection with all measurements of small inductances it was essential to continually check the measurements by the aid of a small known inductance made as he described. We were all apt to forget that the ideal "bridges" drawn on paper were not identical with real "bridges," in that the latter had small inductance and capacity in all the arms and connections, and hence formulæ obtained on the assumption that certain branches were absolutely inductionless and without capacity were not strictly correct. In some experiments he had found that great errors were introduced merely by using ordinary flexible twin wires for connections, as these had quite a sensible capacity per metre. In all methods employing the telephone as a detector we were testing the observer quite as much as the method, and not only a perfectly quiet room but a very acute ear were necessary if good results were to be obtained. It was becoming important to possess methods of measuring accurately inductances of less than one microhenry. The author sketched a plan which he said he had not yet put into practice, but which seemed promising. It involved the use of a Hertz rectangle, and the measurements were made to depend upon the identity in time period between two conducting paths connecting the same points.

**"A Hot-Wire Ammeter for Measuring Very Small Alternating Currents"** was exhibited and described by **Prof. Fleming.** The author said that in alternating-current work, particularly in taking the power factor of small transformers and of short lengths of cables, the need had been felt for an ammeter not involving the use of iron capable

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of measuring currents as small as 0·01 or less of an ampere. He exhibited an ammeter capable of being made to read currents as small as 0·002 with fair accuracy. The arrangement was as follows: Two very fine platinoid or constantin wires, about 1m. long and 0·05mm. or even 0·02mm. diameter, are supported on a wooden rod with arrangements for adjusting their tensions. These wires are 5mm. apart, and are held down at the centre by delicate spiral springs. The two wires are embraced at the middle by a small loop of paper carrying a very small plane mirror. These wires are enclosed in a box, the lid of which carries a lens. By this means the light of a straight carbon filament of an incandescent lamp, or of a slit illuminated by an arc lamp reflected by this small mirror, can be focussed on a screen of ground glass. If a current is passed through one of these wires it sags down slightly, and the square root of the displacement of the image on the screen is almost exactly proportional to the current passing. The instrument can be quickly calibrated by applying a known voltage to the ends of the wire, the resistance having previously been measured corresponding to the range of current used. Examples were given of the use of such an instrument. Suitable very fine wires of pure metals and alloys are now prepared by Messrs. Hartmann and Braun, of Frankfurt. These fine wires require "ageing" before use by intermitting a current through them for 12 hours or more.

**Mr. W. Duddell** expressed his interest in the paper and said it was difficult to make a satisfactory instrument. The author had said that with a fine constantin wire it was possible to measure currents as small as two milliamperes. He asked if this was calculated or observed. There should be a standard method of comparing these instruments, and he suggested using the current necessary to give a deflection equal to one-quarter of the scale distance. Mr. Duddell pointed out that many dynamometers were more sensitive than the instrument shown, and asked the author the order of magnitude of the currents which it was necessary to measure in aerial conductors.

**Dr. W. Watson** exhibited and described a form of ammeter for small alternating currents. The current to be measured flows through a piece of iron wire bent into the form of a right angle. This is linked with a similar shaped piece of nickel wire forming part of a galvanometer circuit. The thermo E.M.F. at the junction, produced by the heating effect of the current, sends a current through the galvanometer which can be measured in the usual way. The current to be measured is practically proportional to the deflection of the galvanometer.

**Mr. A. Campbell** described a form of ammeter by Rubens; and **Mr W. A. Price** referred to an instrument similar to that shown by the author, in which the sag of the wire is measured by the movement of an aluminium pointer.

**Dr. Fleming** said he was quite aware that electrodynamometers had been designed for measuring very small alternating currents, but they were more difficult to make and calibrate than the simple form of hot-wire instrument he now exhibited. He had no doubt that the use of a constantin wire of 0·02mm. diameter would greatly increase the sensitiveness of the instrument, though he had not actually tried it for want of time. As regards Mr. Duddell's question about the magnitude of the currents flowing into a wireless telegraph aerial, that, of course, depended upon the size of the aerial. In the case of an ordinary 180ft. single aerial, the average value was about 0·5 to 1 ampere, but that depended, of course, on the frequency of the groups of oscillations. The author said that, although in the ammeter he exhibited the sag of the working wire was indicated by a mirror, yet he had also used an index needle, and he had no doubt a good commercial instrument might be made on this plan.

A paper on "**Energy of Secondary Rontgen Radiation**" was read by **Mr. C. G. Barkla.** To measure the intensity of radiation, electroscopes were placed in a primary beam of Röntgen rays and in a secondary beam proceeding from air in a direction perpendicular to that of propagation of the primary rays. By comparison of the two rates of leak when no absorbing plates were used, and when similar aluminium plates were placed before each electroscope, it was found that the absorbability of the secondary rays differed from that of the primary by less than 5 per cent. of its value. It was, however, found that a secondary beam of the same intensity as the primary would produce a slightly different number of ions in a given volume of air, consequently the radiations differ slightly in character. The difference in what may be called the "ionising powers" was evidently greater when the primary beam consisted of more penetrating rays. The fraction of energy lost in secondary radiation was very nearly, if not entirely, independent of the character of the primary radiation. The law which the author had previously found to govern the intensity of radiation from gases, was found to be equally applicable to those light solids which are the source of a radiation differing little in character from the primary—*i.e.*, the energy of secondary radiation from these substances situated in a beam of definite intensity is proportional to the quantity of matter through which the primary beam passes. In the passage of X-radiation through air under normal atmospheric conditions, the diminution of intensity due to secondary radiation is of the order of magnitude 0·02 per cent. per centimetre. This is a large fraction of the total loss of energy for penetrating rays passing through air. Applying experimental results to J. J. Thomson's calculation of the loss of energy per centimetre due to the passage through a medium containing ions, and considering the electrons as the source of radiation, the number of these per cubic centimetre of air under normal conditions is of the order of $10^{22}$. By using the secondary radiation from copper as the primary, approximately the same fraction of the energy was lost in secondary radiation; hence we have quantitative results showing that this radiation from copper, though differing in character from the primary radiation producing it, is of the same nature. Evidence was also found pointing to the conclusion that even from metals which are the source of a secondary radiation differing greatly from the primary, the energy of secondary radiation is of the order of magnitude given by gases and light solids of the same mass.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

677. How would you calculate the number of series turns for a compound rotary similar to the 900-kw. three-phase rotaries designed by Mr. Parshall in his book, "Electric Generators," and used, I believe, in the Central London station.—W. S. P.

678. Describe a system of book-keeping for the meter department of a central station supplying about a thousand consumers.—J. H. H.

### ANSWERS.

*Question No.* 668.—Can steel be commercially manufactured by means of electricity? If so, describe some process that has been practically tried.

*Answer to No.* 668 (*awarded 7s. 6d.*).—The commercial manufacture of steel by means of electricity has recently undergone great developments in France, due to the efforts of the Société Electro-Metallurgique Française. This company was formed in 1888 for the manufacture of aluminium, silicium, etc., on the Héroult processes, but of late years it has given great attention to the manufacture of ferro-chrome, ferro-silicon, steel, etc., by means of the electric furnace. Ferro-chrome is manufactured in very large quantities, and the company was the first in France to produce this metal in an electric furnace. It is made with various percentages of carbon—from 1 to 10 per cent.—chrome varying from 60 to 70 per cent. The company commenced about three years ago to investigate the possibility of manufacturing pig iron and steel electrically. The problem of the manufacture of pig iron in an electric furnace has been solved from the technical standpoint, but the plant has not, so far, given any conclusive results from an economical and commercial standpoint, owing to the comparatively low price of pig iron. The smelting of steel, however, in an electric furnace is a different matter, as the company has already produced over 1,000 tons on the Froges-Héroult process. In this process a closed electric furnace is used, provided with two massive carbon electrodes, rectangular in section, arranged vertically side by side, which can be regulated independently one from the other, automatically or by hand. Each of these electrodes weighs about 6cwt. On starting a heat, the furnace is charged with the required proportions of ore, pig iron, iron or steel scrap, either cold or preferably heated, the required fluxes, lime, sand, etc., being added to form the elements of the slag and to ensure the purity of the steel. The smelting is done by means of the arc formed between the carbon electrodes, and, in the course of the process, carbon and other substances are thrown into the bath according to the quality of the steel to be produced. Test pieces are taken in the course of a heat to ascertain the grade of the metal, as is done in the case of the Siemens-Martin and other processes. The smelting operation is a very simple one, and there is no fear of the bath oxidising—a danger to be guarded against in the ordinary processes of steel manufacture.

The whole range of qualities have been obtained from pure ingot iron to high-carbon steel and steel with different constituent alloys such as manganese, silicon, chrome, tungsten, etc. The output depends on the temperature of the furnace, the composition of a charge, and the quality of the steel to be obtained. The average output from a single furnace at the present is about six to seven tons per day, starting with a cold charge. The heats succeed each other

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without interruption, apart from that occasionally required for repairing the lining. The furnace is also being used for the production of fine tool steel, of which it yields about two tons at one heat. The current for the manufacture of aluminium, steel, etc., is generated in a central power station situated at La Praz, in the province of Savoy. The works are on the banks of the River Arc, from which the power is derived for driving the generators. The generators are direct coupled to water-turbines of the Girard type, the number of machines being 28, making an aggregate of about 13,000 h.p. The plant consists of 25 continuous-current generators, generating current at from 60 to 120 volts, and three alternators, generating current at from 40 to 160 volts. The current for steel manufacture is supplied from one of the alternators, and is made to vary at will, dependent on the working of the furnace.

The demand for "electric steel," as it is styled, is rapidly on the increase, and, according to every probability, the manufacture will be greatly developed in the near future. It may be surmised that high-quality steel, produced in electric furnaces, will be used direct for a number of purposes for which ordinary steel is now resorted to after it has been subjected to special treatments. A vast field for it is expected in the construction of dynamo machinery and in the manufacture of boiler plates of pure steel, with a higher tensile strength than that now in use.—A. D.

*Answer to No.* 668 (*awarded* 7*s.* 6*d.*).—Steel can be successfully manufactured in large quantities at a sufficiently low cost wherever electrical power can be obtained at a very cheap rate. Steel has been produced by this means for several years in the North of Italy, where there is abundant water power, thus enabling electricity to be cheaply produced. In Sweden I also heard they were making steel electrically, and now I understand they intend starting in Canada. Some years ago Keller invented a furnace for making steel electrically. It consisted of two vertical electrodes of carbon resting on iron ore enclosed in a suitable refractory receptacle. Only small quantities of metal could be made in this way, and the operation was not continuous, as it was necessary every now and then to renew one or other of the carbon electrodes. The apparatus was gradually improved until it resembled that shown in Fig. 1. By putting several electrodes in parallel in the

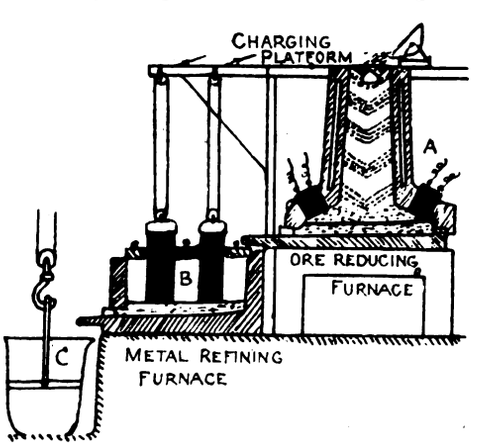


FIG. 1.

same furnace it was found possible to keep the furnace continually at work and also to produce large quantities of steel. In the ore-reducing furnace, A, shown in the sketch, the iron ore and coke are tipped in at the top, and gradually finds its way to the fusion chamber, where the carbon electrodes are. The heat rising from the bath of molten iron, which keeps collecting at the bottom, rising through the mixture of ore and iron, considerably aids the reduction of the ore. The whole arrangement resembles an ordinary blast furnace. When a sufficient quantity of molten iron has collected in the bottom of the furnace it is tapped, and the iron flows into the refining furnace, B. The plug is reinserted in furnace A, and it keeps on continuously reducing the ore. The carbon electrodes in furnace B take the place of the gas in an ordinary Siemens-Martin furnace. They are simply to keep the metal fluid whilst different refining materials and chemicals are added. A small sample is withdrawn and tested, and if the composition of steel is now satisfactory for the purpose for which it is required, the furnace B is tapped and the steel flows into the casting-pot, C. By this method Mr. Keller claims that 15 to 20 tons of steel can be made at a time, and still larger quantities if necessary.

Steel has been produced electrically by starting with cast-iron pigs instead of with the ore. A differently arranged furnace is required, and it has a larger capacity, as the pig iron presents less difficulty than the ore. The advantage of one method over the other depends entirely upon the position of the works. The making of crucible steel by the electrical furnace presents great advantages. At present crucible steel is made in small pots each holding 60lb. of steel. When a crucible steel casting has to be made, a large number of these pots have to be brought as quickly as possible to the mould, and it would be an advantage if a large quantity were made in one pot by means of electricity. Another means of making steel by electricity is the Stassano method, which is also in use in Northern Italy. Stassano claims that by his method any desired quality of steel can be produced directly from the ore in one operation.

As regards the cost of making steel electrically, the following data are obtained from actual working figures. By Keller's method, 3,800 electrical horse-power hours are required to produce one ton of steel:

| | £ | s. | d. |
|---|---|---|---|
| Price of ton of ore, 55 per cent. iron, delivered free | £0 | 8 | 0 |
| ,, ,, coke | 1 | 12 | 0 |
| ,, chemicals and sundries | 0 | 12 | 0 |
| ,, labour per day | 0 | 2 | 6 |
| ,, 200lb. of electrodes | 1 | 4 | 0 |
| ,, electrical energy (kilowatt-year, 8,400 hours) | 2 | 0 | 0 |
| | £5 | 18 | 6 |

These results were obtained from a plant working in Northern Italy, using water power to generate electricity, and as they were obtained several years ago, no doubt they could be excelled now. The item for electrical energy includes a percentage for depreciation of buildings and machinery. With Stassano's method from 4,000 to 5,000 electrical horse-power hours are required to make one ton of steel, and the cost of electrical energy per ton comes out at about £1. The expense of producing one ton of ingots of steel works out at about £4. In Stassano's method the large expenditure for coke is avoided, but not such a large quantity of steel can be made in one operation as by the Keller method. The electrical manufacture of steel will no doubt advance very much in the next few years in those countries where water power is abundant.—W. A. T.

*Question No.* 669.—Explain, with sketches, the method of magneto-electric ignition for modern medium-size gas-engines (about 100 b.h.p.). In central-station work is this method reliable? If so, what are the possible faults?

*Answer to No.* 669 (*awarded* 10*s.*).—The principal objection to magneto-electric ignition is that the permanent magnets gradually weaken, which makes it necessary to have them periodically remagnetised. In one method of magneto ignition—the "Albion system"—this objection is removed. By closing the circuit of the induction coil when the magnetic flux through it is at its maximum, and breaking the circuit when it is at about its minimum, a magnetising effect is obtained that tends to strengthen the magnetism of the magnets. The induction coil, C, is wound on the armature, A (Fig. 2). The armature is formed of ring-shaped iron stampings, a portion of the ring being cut away as shown at F. The armature is fixed. Fig. 1 shows a sketch of the magneto. G G are steel or soft-iron pole-pieces bolted to the bronze or non-magnetic spider, K. This is keyed to the shaft, D—*i.e.*, the crankshaft—or any other shaft driven by the engine. To these pole-pieces are bolted the permanent magnets, E E, similar poles being bolted to the same pole-piece. The field magnets and their pole-pieces embrace the armature, A, and as they rotate an alternating current is generated in coil, C. The make-and-break mechanism consists of an insulated contact fitted into the cover of the ignition port, and a spindle passing through the same cover. The inside end of the spindle carries an arm, which bears against the insulated contact piece, both being platinum tipped. To the end outside is fitted a lever,

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To one end of this lever is attached a spring, which keeps the arm in contact with the insulated piece, the rupture of the circuit being effected by a blow on the other end of the lever.

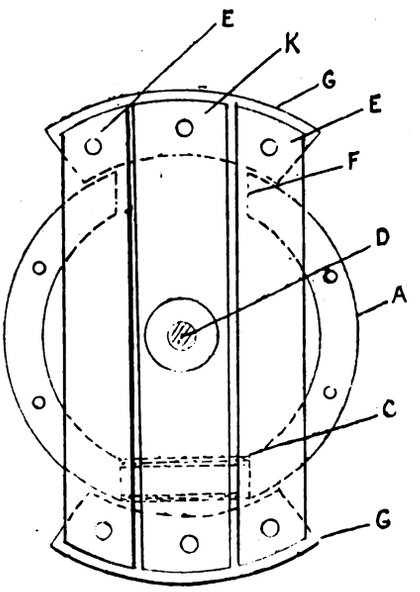


FIG. 1.

It is important with electric ignition that the points between which the spark is produced be kept in a proper condition, and in some cases provision is made for putting in new ignition points without stopping the engine. Fig. 3

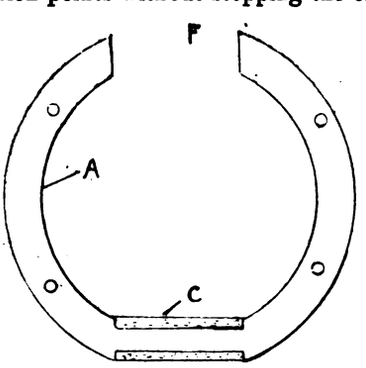


FIG. 2.

is a sketch of the make-and-break mechanism of an electric igniter, as described in the report to the Gas-Engine Research Committee of the Institution of Mechanical Engineers. This

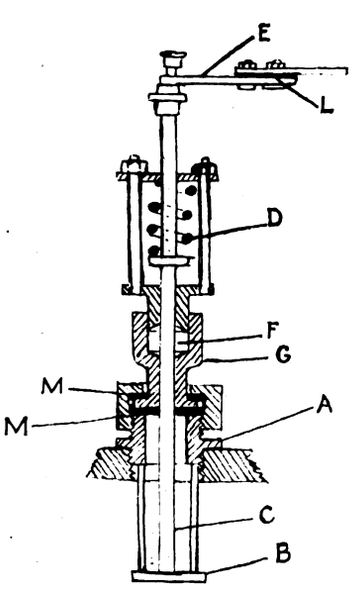


FIG. 3.

method of breaking the circuit is said to have given most excellent results. It was in use without repair for over two years, and was never seen to fail to fire a charge. Even charges so weak as to give irregular results with a hot tube could be ignited with absolute certainty. The spark was produced by breaking a low-potential circuit containing iron, current being supplied from four storage cells. The plug, A (Fig. 3), is screwed into the cylinder; the end which is inside carries two steel rods about 3in. long. To the further ends of the rods is fixed a piece, B, having screwed into it a platinum tip. The end of the sliding rod, C (also platinum tipped), is pressed against B by a spring, D, and is lifted by the lever, E, which receives motion from a cam driven by the engine. The rod, C, is insulated from the cylinder, and passes through the stuffing box, F. The piece, G, is insulated from the plug, A, by the mica washers, M M. The lever, E, is made in two parts, bolted together at L, the bolts passing through ebonite washers to prevent a circuit being made between C and the engine frame.—H. J. W.

*Answer to No.* 669 (*awarded 7s. 6d.*).—Of the many forms of magneto machines employed for electric ignition in gas-engines, perhaps the Simms-Bosch is the most satisfactory. This machine has three permanent magnets, M, to the ends of which soft-iron pole-pieces, P, are attached. Fig. 1 is a sectional sketch of one of these machines. The

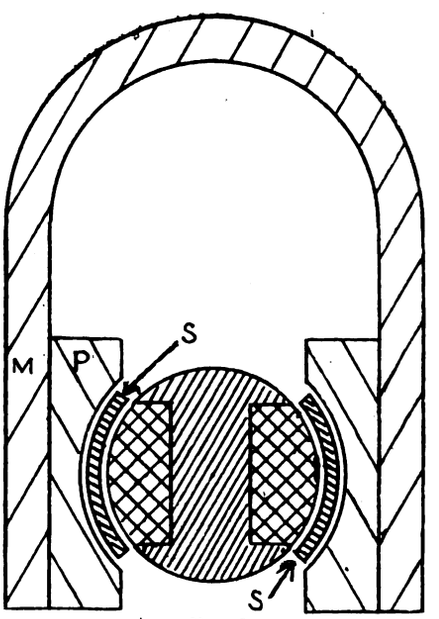


FIG. 1.

armature, a Siemens H section, is fixed, as also are the magnets. S is a reciprocating envelope or sleeve of soft iron, by the movements of which the lines of force between the poles of the magnets are deflected as desired. With this arrangement, instead of the armature moving in a magnetic field, as in ordinary dynamos, the lines of force of the field are moved relatively to the armature conductors. One end of the armature winding is connected to frame of the machine, the other end to an insulated terminal. In order to understand magneto ignition, it must be remembered that the spark has a comparatively low tension. Sparking does not place across a small gap, as when an induction coil is used, but occurs when the circuit is broken. Advantage is taken of the well-known fact that violent sparking takes place when a circuit of considerable inductance, through which a current is flowing, is suddenly broken.

Fig. 2 is a diagrammatic sketch showing Messrs. Crossley's arrangement for magneto ignition. The magneto is fixed on a bracket over the cam shaft; its one terminal, T, is connected to an insulated pin, P, by means of a wire well insulated with vulcanised indiarubber. A bell-crank lever is attached to magnets at C; one end of this lever is fastened to a spring at A, the other end, B, engaged with the pin, D, or the pawl, E. The disc, F, is keyed on the half-speed shaft, and carries the pin, D, and the pawl, E. The pawl, E, may be drawn by means of a screw out of alignment with B, leaving D only to engage the lever. When starting—it being essential to have late ignition—the pawl, E, is moved along to engage with lever. When speed is reached, the pawl is drawn back, leaving the pin, D, in action. It will be seen that the end of

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lever will fly off D at an earlier position of the stroke than it would from the pawl, E. Sparking takes place when the rod, H, strikes the lever, G, and causes it to break contact with the firing pin, P. The lever, G, is provided with a screw and clip so that the angle between its two parts may be adjusted; thus the ignition may be timed as desired. Contact is maintained until the rod, H, comes into action with the pin, P, by means of a helical spring, I. The circuit is then armature winding to frame to P by means of lever, G, and back to terminal of magneto by insulated conductor. In the writer's opinion, magneto ignition is more reliable than the ordinary hot tube; like all mechanical contrivances there is a chance of breakdown, but the chance with a good magneto ignition arrangement is a minimum. For faults that may crop up look first for an open circuit. In Fig. 2 the spring, I, might not be strong enough to maintain good contact between lever and firing pin; continual wear and jarring sometimes causes this. See that the conducting wire between P and T does not short-circuit the spark; also that the insulation of P from frame is good. It occasionally happens that what at first appears a bad fault is simply a case of dirt and grease in the wrong place. Few engineers would care to

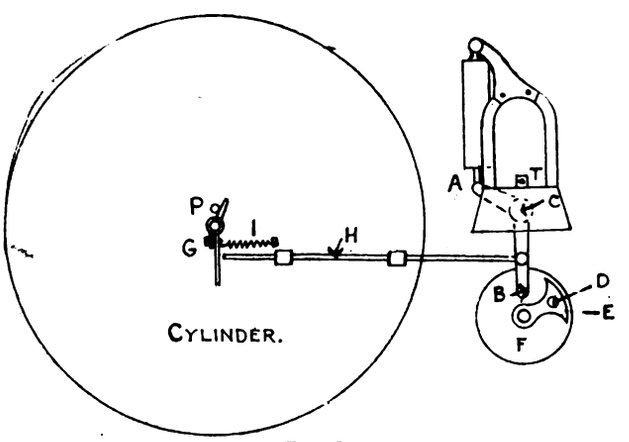


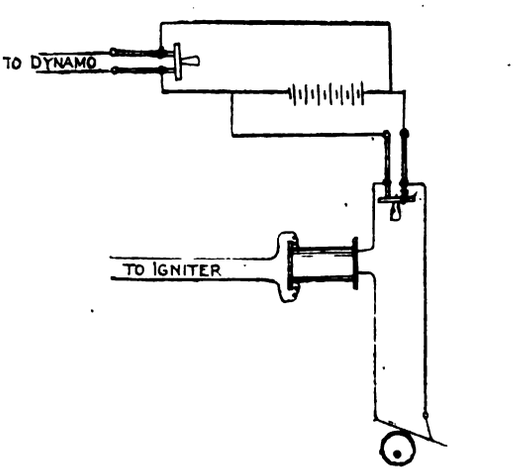

FIG. 2.

go back to the hot tube after having tried electric ignition. M. M.

*Answer to No.* 669 (*awarded* 7*s.* 6*d.*).—The igniting device of a gas-engine is one of the small details which gives considerable trouble in the running of the engine; yet it is one which it is quite easy to make entirely reliable and trustworthy by sufficient care in its installation. The primary cause of the difficulty with these igniters is generally that sufficient energy is not furnished so as to ensure a strong spark With a long flaming spark there is no difficulty in lighting even the most dense oils when vaporised and mixed with air. For furnishing current three sources are used—the primary battery, secondary battery, and some form of dynamo. Of these three, however, the primary battery may be left out of consideration, as its utility extends no further than very small operations. Of the other two types, the secondary battery and the dynamo are very much the same as regards first cost, but the expense of maintaining the former, when used alone, is much in excess of that necessary to maintain the dynamo in repair. The difficulty with the dynamo is that it will not furnish a spark for ignition until it has reached a certain speed, and the arrangement of a machine so as to give strong currents when starting the engine involves many complications. A combination of secondary battery and dynamo gives a source of current that covers all contingencies.

There are two forms of sparking mechanism—namely, the jump spark and the hammer break. Of these, the jump spark is undoubtedly the simplest, but it has the disadvantage of becoming easily fouled, so that a considerable amount of energy is required to send the spark between the tips. The hammer break is, on the other hand, quite sure to draw a spark, but is more complicated, and therefore more liable to get out of order, depending on how fully the necessities of the case have been realised. Another disadvantage of the hammer-break form is that some of producing mechanical action must be connected between the shaft of the engine and the cylinder, which is sometimes a difficult thing to provide. With the jump spark, however, there need be only a pair of flexible wires leading from the interrupter to the plug terminals. On the score of positive action, however, the hammer-break method has much to recommend it, and for large engines it is probable that its positive action more than compensates for the extra complications. The dynamo that furnishes the current for ignition is, for smaller-size engines, made of the magneto-generator type, as this gives simplicity, small first cost, and freedom from derangement; but the interrupter should be arranged so that the break and the spark shall come at a time when the E.M.F. is at its highest point. This will give the maximum sparking efficiency from a magneto, but it is often necessary to change the time of ignition with change of composition of gas or power required from the engine, and if the dynamo be positively driven from the engine shaft, this involves also a change in the driving mechanism of the igniter generator.

By careful design it is possible to construct a magneto in which the current will be sufficient during an angle of about 60deg. of rotation to give a fairly long spark; but




this, again, requires a more costly machine. To avoid this, the most convenient and reliable arrangement is a secondary battery, which is charged from the dynamo, and which in turn furnishes current to the igniter circuit. This combination may be so arranged that the battery will supply the current when starting and then be thrown off and the dynamo switched on to take its place, or the battery can be arranged to furnish current all the time that the engine is running, the dynamo charging in at the same rate all the time the current is used. This has the advantage of keeping the igniter circuit at all times under the same E.M.F.; the battery being charged and discharged with regularity, there is no danger of it ever standing without charge. This arrangement, by which a secondary battery is employed for starting and running. is shown in the accompanying diagram. It is suitable for use where current is obtained from a small dynamo driven direct from the engine. A double-pole switch is inserted in both circuits, so that when opened to prevent the battery being short-circuited, whilst by opening one the battery may be left in condition to operate the igniter whether the dynamo be running or not, so that it is wise to instal a battery with such a capacity to be able to furnish the current necessary for a considerable time, in case of accident to the dynamo. Of course, instead of the dynamo driven from the engine, the current may be taken from lighting or power circuit with the usual arrangement of keeping down the current for charging the secondary cells.

The requirements therefore necessary for successful ignition may be summarised as follows: The source of electrical energy should be a dynamo or lighting circuit, arranged, if possible, to work through a secondary battery which supplies current to the igniter circuit. The interrupter should be worked by a rotating cam on some suitable shaft on the engine, and should be of the hammer-break type. The spark should be produced by a jump spark plug, so arranged that the entire mechanism may be

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readily removed from the cylinder without disturbing any other part of the engine.—K.

## PERSONAL.

Mr. A. J. Beckett, of York, has been appointed electrical engineer for the new electric light works of the Bridlington Town Council at a salary of £4 per week.

The Lincoln City Council have decided to increase the electrical engineer's salary by annual increments of £50 until it reaches £500, he undertaking the arrangement of the proposed electric trams.

The Kettering Urban District Council have appointed Mr. W. A. Walker, of the Aldershot electrical works, as assistant electrical engineer at the Council's new works at a salary of £120 per annum.

## APPOINTMENTS VACANT.

**Gas Engineer and Manager and Electrical Engineer,** Malvern. Salary, £400 per annum. Applications to Mr. H. L. Whatley, Council Offices, Malvern, by April 23. See advertisement in last issue.

**Electrical Engineer,** Singapore. Salary £360 to commence. Applications to Mr. C. C. Lindsay, M.I.C.E., 217, West George-street, Glasgow, by April 19.

**Dynamo and Switchboard Attendant,** Fulham Palace-road Workhouse, Hammersmith, W. Wages 30s. per week. Applications by April 8.

**Electrical Engineer,** Bray, Ireland. Salary to commence at £240. Applications to Mr. P. MacDonnell, clerk, Town Hall, Bray, before 10 30 a.m. on April 11.

**Mechanical Draughtsman.** Applications to Harland and Wolff, Limited, Belfast. See advertisement.

**Cable Jointer,** Burnley Borough Council. Applications by April 20. See advertisement.

**Electrical Engineer,** York. Applications to the Resident Engineer, Central Bank-chambers, by 16th inst.

**Chief Assistant Engineer,** Preston Tramways Committee. Salary, £200 per annum. Applications by April 16. See advertisement.

# COMPANIES' MEETINGS AND REPORTS

## MARCONI'S WIRELESS TELEGRAPH.

The annual meeting of the shareholders of this Company was held on the 31st ult., Colonel Sir Charles Euan Smith in the chair.

In moving the adoption of the report (which has already been published), the **Chairman** remarked that a satisfactory feature was that for the second time since they came into existence their receipts were in excess of their expenditure. In connection with all the revenue-producing branches which they had established at the close of the preceding year, there had been satisfactory developments and increased income, and during the year Mr. Marconi had been carrying on a series of experiments in improving long-distance communication. Although Transatlantic wireless telegraphy had not been established on a commercial scale, still a great advance had been made. Scientific progress rested upon certainty and security, and that must be attended by many unforeseen difficulties. Technical difficulties would soon be overcome. At last year's meeting he told them that as the direct result of negotiations they were on the point of concluding an arrangement with the Admiralty and the Post Office. As regarded the Admiralty, the arrangements had been finally and satisfactorily concluded, and their relations with that great department were of the most cordial and encouraging character. In regard to the Post Office, the Chairman referred to the agreement which was now proposed to be entered into. This agreement, in the opinion of the directors, would not only give satisfaction to the public generally, but would also duly safeguard the interests of the Marconi Company. The details of the agreement could not be given just then, but he was in a position to say that not only did the general heads clear away all possibilities of future divergence of opinion between the Post Office and themselves, but they indicated the probability that a far larger field would be open to the operation of their system than could possibly have been anticipated some 12 months ago. The progress made had been due to the intrinsic merits of the system itself. Its development had necessarily met with many obstacles, with much prejudice from quarters where it was least expected, prejudice due to an inadequate comprehension of a very technical subject. It had been at a disadvantage as compared with other competitors in this country. But wireless telegraphy in Germany and other foreign countries received the recognition of all in authority. In concluding, he stated that the agreement with the Post Office would necessitate further expenditure, and the directors would shortly make a new issue of shares, notice of which would be given in due course.

The report was agreed to.

## WOKING ELECTRIC SUPPLY.

The ordinary annual general meeting was held at the offices of the Company last week, Mr. J. Ashby (chairman) presiding.

In moving the adoption of the report (which has already been published), the **Chairman** said that the business had been constantly increasing during the last four years. Since Oct. 1 the Company had reduced the price of current to consumers to 6d. per unit. Sixpence-halfpenny was debited, but if they paid the bill within 14 days 6d. was accepted. Notwithstanding this reduction of price, the revenue from that source had increased. The Company proposed to supply the public with current, either for heating or cooking purposes, at 2d. a unit in the future. The Company contemplated applying for powers to supply neighbouring localities, which would necessitate additional capital.

**Mr. Kilby** having seconded the motion, the report was unanimously adopted.

## PRIMITIVA GAS AND ELECTRIC LIGHTING.

The report of the Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited, for 1903, to be presented at the meeting on the 19th inst., states that the balance of revenue account is £115,405. Deducting interest paid on debentures and on unissued debentures carried to general reserve, interest, commissions, and general expenses, amounting to £31,697, there remains a net profit of £83,824. The balance brought forward from the previous year was £10,289, making £94,113. There has been written off towards amortisation of the item "discount on debentures and expenses of issue" £2,500, and placed to reserve account £15,000. There then remains at credit of profit and loss account a balance of £36,613. The directors now recommend a dividend of 5s. per share, equal to 5 per cent. for the year, on the ordinary shares, leaving £16,613 to be carried forward. Under the heading of "improvements and extensions," £37 768 has been expended in connection with the gas and electrical departments. The stock, stores, and loose plant of the electrical department, amounting to £28,194, have been transferred from the Buenos Ayres books in order to close the accounts of the department. An amount of £25,000 (nominal) 4 per cent. debentures has been issued during the year. In June last the directors were approached by the Deutsch Ueberseeische Electricitäts Gesellschaft of Berlin with an offer to take over the electrical section of this Company, and after very careful consideration of the advantages that would accrue to the shareholders, it was decided to enter into an agreement, dated Aug. 12, 1903, whereby the entire property of the electrical department has been handed over, on certain conditions, to the Deutsche Company as from June 1 last. One of the directors, on the invitation of the Deutsche Company, has accepted a seat on their Board to maintain the interests of this Company. The first of the semi-annual payments in accordance with the terms of the agreement was made by the Deutsche Company on Nov. 30 last. In consequence of the above arrangement the following items, appearing in last year's balance-sheet—that is, £1,175 on debentures sinking fund account and £8,663 depreciation reserve account relating to the electrical section—have been transferred to the general reserve account, which has also been credited with the £2,450, interest accrued on debentures at present unissued, making, with the sum of £15,000 placed to this account at Dec. 31, 1903 a total amount at credit of the account of £37,288.

## POTTERIES ELECTRIC TRACTION.

The report of the Potteries Electric Traction Company, Limited, for 1903, to be submitted at the meeting to-day, states that gross receipts for the year amounted to £97,701. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on loans and debenture stock, there remains a profit of £26,258. To this has to be added £851 brought forward from the previous account, making an available balance of £27,109. The directors propose to transfer to credit of depreciation and reserve fund £2,000, to pay a dividend on the ordinary shares of 5 per cent., and to carry forward £766. In April last an issue was made of 2,500 ordinary shares and 2,500 preference shares of £10 each. Arrangements have been made for an issue of £25,000 debenture stock at an early date to provide for the completion of works now in hand. The capital expended during the year on the doubling of the Fenton section of the main line, and on the construction and electrical equipment of the light railway between Newcastle and Stoke, and on Maybank power-house, cars, and car-sheds, etc., amounted to £33,351. Capital expenditure during the past year has only quite lately become remunerative, the doubling of the line at Fenton having been completed in November last, and the Newcastle-to-Stoke light railway having been opened for traffic on Feb. 23 this year. The directors are able, however, to recommend the payment of the same dividend on the ordinary shares as in the previous year, though on a larger capital.

## WILLANS AND ROBINSON, LIMITED.

The report of the directors for the half-year ended Dec. 31, 1903, states that the operations of the Company for that period have resulted in a loss, and that no dividend can be paid upon either the preference or the ordinary shares. Owing, on the one hand, to depression in trade, and on the other to increased competition, there has been a falling off in orders for engines, as well as in the prices obtainable, the result being that the profit for the half-year upon the engine-building and other business carried on at Rugby (after making a special reserve against depreciation on certain shares receivable in part payment for engines) is only £11 772. 5s. 10d., increased to £14,108. 13s. 8d., by an amount of £2,336. 7s. 10d. brought forward from last half-year. Against this has unfortunately to be set a loss of £22,040. 18s. 5d. at Queen's Ferry, in which is included £7,249. 3s. 5d. for depreciation. The net debit balance on the profit and loss account is therefore £7,932. 4s. 9d The Company is in need of the balance of the new capital (£83,340) which the directors were authorised to issue by the resolution passed on April 3, 1901, and as, under present conditions, a new issue of capital is not likely to be successful, it is necessary to

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borrow upon the security of the reserve fund investments. It was the directors' intention to issue the new capital a year ago, but they were advised to postpone the issue for a year, and in consequence they made temporary arrangements for an overdraft upon the Company's bankers until the capital should be issued. As this arrangement expires in July next, it is important that a new understanding be arrived at with the bank, and a resolution will be submitted to the shareholders authorising the directors to borrow up to the maximum amount permitted by the articles of association—viz, 50 per cent. of the paid-up capital, less the sum already authorised to be borrowed upon debenture stock. The amount of the balance which can be borrowed under this resolution is £83,330. The steelworks at Queen's Ferry, including the steel-foundry, will be closed as soon as existing orders can be completed; work in the boiler shop and tube works will be pushed on with energy. Extensive reductions are in course of being carried out in the Queen's Ferry staff and organisation, and every effort will be made to effect similar economies at Rugby.

## PERTH ELECTRIC TRAMWAYS.

The report of the Perth Electric Tramways, Limited, for 1903, to be submitted at the meeting on the 12th inst., states that gross receipts for the year amounted to £62,523, yielding a profit of £29,971. The corresponding figures for the previous year were, gross receipts, £56,157, with a profit of £20,591. The returns for the current year continue to expand, gross receipts for the 12 weeks to March 25, 1904, showing an increase of £2,214 over the corresponding period of last year. Mr. H. J. Somerset, the engineer, calculates that a minimum increase of £9,000 in the gross receipts for the year 1904 should be realised. The profit and loss account shows a credit balance of £22,971, and after providing for debenture interest, interest on loans, and sinking fund, leaves £8,323, to which has been added the balance of £9,908 brought forward from the previous year, making £18,232. The preference dividend to June 30 last has been paid, absorbing £9,000. A sum of £6,000 has been placed to reserve account to provide for repairs and renewals as may be required, and the balance of £3,232 is carried forward, out of which the Board has paid the preference dividend to Dec. 31 last. In order to provide for the necessary additions to plant and to take over the cars which had been obtained on hire, and generally to provide for the increasing traffic, an issue of £35,000 second debentures was made last month, the whole of which has been subscribed for. An Act of Parliament has been recently passed which will enable the Company to duplicate single tracks at any future time without applying for a special Act.

## CALCUTTA TRAMWAYS.

The report of the Calcutta Tramways Company, Limited, for 1903, to be submitted at the meeting on the 12th inst., shows gross traffic receipts £113,756, total working expenditure £55,670, and a balance, after crediting sundry receipts, of £58 812. Interest on debentures, less the amount earned by the employment of moneys in hand, has required £13,545, the interim dividend £12,783, and the special grant to the chairman, voted at last meeting, £1,000, so that the net amount dealt with, including the sum of £1,181 brought in from the last account, is £32,656. The directors recommend a dividend at the rate of 7 per cent. per annum for the half-year, making, with the interim dividend at the rate of 5 per cent. per annum already paid, 6 per cent. for the year, placing £12,418 to a depreciation fund and leaving £2 351 to be carried forward. The directors recommend that the £14.58? at present standing to reserve fund should be added to the above amount of £12,418, making a sum of £27,000 to credit of depreciation fund. As it is very desirable that this fund should consist of an actual cash reserve applicable to renewals apart from the maintenance properly charged in the revenue accounts of each year, the directors propose that it shall be separately invested, and for that purpose intend to allocate to it the needful amount from the investments now held by the Company. The period under review has been the first complete year of working by electric traction, and with a greater mileage the working expenses are rather lower, whilst receipts show an expansion corresponding more or less with the increased mileage.

## THAMES IRONWORKS.

The report for 1903 of the Thames Ironworks, Shipbuilding, and Engineering Company, Limited, to be submitted at the meeting on April 11, states that the electrical engineering department has been busy during the year, and orders have recently been secured which, with the work already in hand for the "Black Prince," will keep the department fully engaged throughout the year. It is probable that considerable extensions of this department will shortly have to be made to meet the increasing electrical requirements of the works and to keep pace with the orders now coming to hand. The accounts for the year show a gross profit of £34 015 for all branches, and the directors recommend a dividend of 5 per cent. on the preference shares.

## NEW COMPANIES REGISTERED.

**Allen and Mannock, Limited.**—Capital, 12,000. Object: to acquire and carry on, at 128, Mount-street, W., the business of architects, electrical and hot-water engineers, etc.

**Putney Motor Company, Limited.**—Capital, £5,000. Object: to acquire and carry on the business of A. E. Stewart Craig, G. L. M. Dorwald, and E. A. D. Kisch, at 17, Grand-parade, Putney, S.W., as the Putney Motor Company.

**City Automobiles, Limited.**—Capital, £10,000. Objects: to adopt an agreement between R. Clegg and A. H. Salmon for the transfer of certain premises, and to carry on the business of motorcar storers, manufacturers, etc. Registered office: 34, Queen-street, E.C.

**Automobile Company of Cardiff, Limited.**—Capital, £2,000. Objects: to carry on the business of engineers, manufacturers and repairers of, dealers in, and storers, hirers, and letters to hire of motors (whether propelled by steam, gas, air, vapour, or electricity), etc. Registered office: 20, Charles-street, Cardiff.

**Velox Motor Manufacturing Company, Limited.**—Capital, £2 000. Object: to adopt an agreement with the London Pioneer Syndicate, Limited, to manufacture and deal in motors, cycles, launches, vehicles, and carriages of all kinds, and to carry on the business of electricians, mechanical engineers, etc.

**Anti-Friction Equipment (Railways), Limited.**—Capital, £12,000. Objects: to acquire the benefit of an exclusive license granted by J. E. Cooper to T. T. Cowell on May 23, 1902, and to carry on the business of mechanical and electrical engineers, manufacturers of engineering and mechanical appliances, etc.

### Company Liens.

**Frinton-on-Sea and District Electric Light and Power Company, Limited, London, E.C.**—Discharge registered March 24 of debentures dated March 30, 1903, for £100.

**Finchley Electric Light Company, Limited, London, W.C.**—Liens registered March 24 and March 26 for £100 and £400 6 per cent. debentures (issued in place of one debenture for £500, which has been cancelled), part of £2,000 authorised. No trustees. Charged on the undertaking and all the property, including the uncalled capital.

**Chiswick Electricity Supply Corporation, Limited.**—Issue on March 16 of £1.000 4½ per cent. debentures, part of a series created by resolutions of Nov. 2, 1900, and March 8, 1901, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: Davey, Paxman, and Co., Limited, Colchester. No trustees. Total amount previously issued of same series, £32,000.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Gillingham.**—The Corporation invite tenders for the supply of engine and dynamo oil and for electrical meters. Tenders by April 11.

**Madrid.**—The Post and Telegraph Department, Carretas 10, require tenders for 50 tons of 4mm. galvanised iron wire. Tenders by April 12.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Royton and Crompton.**—The Urban District Council invite tenders for Section A of tramways—permanent way. Tenders by April 30. See advertisement.

**Rhyl.**—The Urban District Council invite tenders for carbons, meters, lubricating oils, etc., for a period of 12 months from April 1. Tenders by April 18. See advertisement.

**Belfast.**—The Corporation invite tenders for the wiring and plain fittings required at the city hall. Particulars from Mr. A. Brumwell Thomas, 5, Queen Anne's-gate, Westminster. Tenders by 11th inst.

**Lichfield.**—The Council invite tenders for a lease of the Council's powers for supply of electricity. Particulars from Mr. George Ashmall, 20, Bore-street, Lichfield. Tenders by April 16. See advertisement in last issue.

**Edinburgh.**—The Council invite tenders for extension switchboard panel and steam and exhaust pipework. Specifications, etc., may be obtained from the Resident Electrical Engineer. Tenders by April 23.

**London, E.**—The Stepney Borough Council invite tenders for the erection of the second half of the electricity generating station at the electricity works, Osborn-street, Whitechapel, E. Tenders by April 14.

**Woolwich.**—The Council invite tenders for the supply and erection of an electric crane. Particulars can be obtained from the Borough Engineer, Maxey-road, Plumstead. Tenders by 12 noon on April 14. See advertisement in last issue.

**Todmorden.**—The Corporation invite tenders for the erection of the buildings, etc., required for electricity supply and refuse destructor purposes—viz.: (Section 1) buildings; (2) chimney; (3) steel roof trusses, etc. Tenders by April 18.

**Talavera de Reina (Spain).**—The Municipality require tenders for installation and working for seven years of an electric lighting installation. They will pay an annual subsidy of 11,000 pesetas for street-lighting. Tenders by April 26.

**London, N.W.**—The St. Pancras Borough Council invite tenders for supplying two 1,000-kw. steam-turbines connected to two continuous-current dynamos, switchboards, condenser, etc, complete at the King's-road power station. Tenders by April 12.

**Belfast.**—The Gas and Electric Committee invite tenders for exhaust steam grease separators and auxiliary feed-water heater. Specifications may be obtained from the City Electrical Engineer, Belfast. Tenders by 12 noon on 15th inst.

**Barrow-in-Furness.**—The Corporation invite tenders for surface condenser, air and circulating pumps, pipework, etc., and one electrically-driven feed-pump and connections. Specifications from Mr. H. R. Burnet, Electricity Works. Tenders by April 20.

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**Bilbao.**—Tenders are required by the Technical School for a number of dynamos and motors of various types, a gas-engine, and accumulator battery. Particulars may be obtained from the Secretary of the Escuela de Ingenieros Industriales de Bilbao. Tenders by April 12.

**Manchester.**—The Corporation invite tenders for two 750 kw. turbo-generators, and for alterations and additions to high-pressure steam piping and valves. Specifications, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department. Tenders by April 13.

**Acton.**—The District Council invite tenders for (a) two 200-kw. motor-generators, balancer, and booster, (b) switchboard, (c) cables and arc lamps, (d) accumulators, (e) 10-ton crane. Specifications, etc., can be obtained from Mr. W. H. Trentham, 39, Victoria-steet, S.W. Tenders by April 12.

**Loughborough (Leics.).**—The Corporation invite tenders for erection of buildings for their electricity supply station to be erected in Bridge-street. Specifications, etc., can be obtained from Mr. Albert E. King, architect, Baxter-gate, Loughborough. Tenders by 12 noon on April 16.

**Ipswich.**—The Electric Supply and Tramways Committee invite tenders for supply of general stores and ironmongery for year ending March 31, 1905. Specifications can be obtained at the offices of the Electric Supply and Tramways Departments in Constantine-road. Tenders by 13th inst.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Bolton.**—The Tramways Committee invite tenders for various materials during year ending March 31, 1905, including lighting and overhead materials. Specifications, etc., may be obtained from Mr. Arthur A. Day, Tramways Office, Bradshawgate, Bolton. Tenders by 12 noon on 11th inst.

**Partick.**—The Town Council invite tenders for one 500-kw. steam dynamo, 76-kw. steam balancer (dynamos only), and extensions to main switchboard. Specifications, etc., can be obtained from the Town Clerk's Office. Tenders before noon on April 12. See advertisement in former issue.

**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Manchester.**—The Tramways Committee invite tenders for the supply of special (permanent-way) track work, and permanent-way points, tongues, etc. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 5 p.m. on 18th inst.

**Gillingham.**—The Corporation, having discontinued the use of their single-phase plant, invite tenders for the purchase and immediate removal of the following machinery: engines, boilers, alternators, switchgear, transformers, meters, pumps, piping, and sundry other materials. Tenders by April 11.

**Cheltenham.**—The Corporation invite tenders for the supply of slack coal to the electric works, Arle road, for six and 12 months alternatively, commencing on June 1, 1904. Particulars may be obtained from the Borough Electrical Engineer, High-street, Cheltenham. Tenders by 19th inst.

**London, E.C.**—Tenders are required for the supply and delivery of electric plant for locomotive workshops, for the East Indian Railway Company, as per specification to be seen at the Company's Offices. Tenders are to be sent to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by 12 noon on April 13.

**Salford.**—The Corporation invite tenders for the construction of partitions, iron staircase, internal and external painting, and other works at the old electricity generating station, Frederick-road, Broughton. Particulars may be obtained at the Borough Engineer's Office. Tenders by 4.30 p.m. on April 18.

**Aston Manor.**—The Borough Council invite tenders for excavation and concrete work in connection with the foundations of the proposed extensions at the electric power station, Chester-street. Specifications, etc., may be obtained from the Borough Engineer, Council House, Aston Manor. Tenders by noon on 11th inst.

**London County Council.**—The Council invite tenders for erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Specifications, etc., may be obtained at the Architect's Department (Highways Section), Trafalgar House, 13, Charing-cross, S.W. Tenders by 10 a.m. on April 26.

**London, S.W.**—The Westminster Electric Supply Corporation invite tenders for the supply, delivery and erection at their Duke-street sub-station of high-tension switchboard and low-tension switchboard. Specifications, etc., may be obtained from Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders before 10 a.m. on April 18.

**Grimsby.**—Tenders are required for wiring and supply of fittings for the electrical installation at the Alderman Dobson Schools in Harold-street, Grimsby, for the Education Committee. Specification may be obtained from Mr. W. A. Vignoles, M.I.E.E., borough electrical engineer, Corporation Electricity Works, Grimsby. Tenders not later than first post on April 18.

**Park Royal.**—The Directors of the Great Western Railway invite tenders for motor-generators, natural-draught cooling towers, electrically-driven and hand-driven overhead travelling cranes and runways, conveyors, etc. Specifications, etc., can be obtained at the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, London, S.W. Tenders by April 26. See advertisement in last issue.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto, at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Kettering.**—The tender of Messrs. Lea and Warren, Kettering, at £350, has been accepted for the wiring and fitting of the generating station.

**Cleckheaton.**—The Urban District Council have accepted the tender of F. C. Sugden and Co., 28, East-parade, Leeds, for the conversion of two through arches of generator settings (8's) to regenerators.

**Weymouth.**—The Guardians have received the following tenders for supplying a system of bells throughout the union house to communicate with the master's bedroom in case of fire: J. G. Wills and Co., £15. 10s.; W. D. Orchard, £12; and Cosens and Co., £9. 10s. (accepted).

**Nechells (Birmingham).**—The Birmingham Tame and Rea District Drainage Board and the Birmingham Corporation have accepted the following tenders for the construction of electric power transmission scheme buildings, etc.: Lee and Sons, buildings, £14,466; furnace chimney, £1,149.

**Stepney.**—The Borough Council have accepted the tender of Messrs. Parsons and Co. for the supply and erection of a steam generator with their own dynamos at £7,724; and the tender of Messrs. Babcock and Wilcox Limited, for the supply and erection of four boilers and accessories at £9,375.

**Pumpherston Oil Company.**—Messrs. Bruce Peebles and Co., Edinburgh, have received an order from the company for an electrical installation amounting to over 1,500 h.p. The installation will consist of two 750-h.p. high-speed engines, coupled direct up to alternators, and will comprise in the first instance between 50 and 60 large motors.

**Derby.**—The Council have accepted the following tenders: Sunbeam Lamp Company, incandescent lamps; Reason Manufacturing Company and Ferranti, Limited, meters; White and Co., a second-hand bitumen boiler; and G. Fletcher and Co., construction of an iron way for carrying the new tramway and lighting cables into the works from Silk Mill-lane.

**Gosport.**—The Provincial Tramways Company have accepted the tender of Mr. H. C. Sweetland for the erection of a depot for Gosport and Fareham electric tramways at Hoxford (Mr. John Glenn, C.E., 11, Queen Victoria-street, E.C., and Gosport, architect), at the following prices: Estimate No. 1, power station, £5,435; No. 2, car-shed, £3,275; No. 3, workshops, £1,060. Total, £9,770.

**Christchurch (New Zealand).**—A telegram has been received by the Agent-General from the chairman of the Christchurch Tramways Board, showing that the tenders for the installation of electric tramways have been allotted to the New Zealand Electrical Construction Company for all sections. This is a great step in advance as far as Colonial information goes. As a rule, Colonial Governments are slow to furnish their London offices with similar news regarding contracts.

**Stepney.**—The Council have received the following tenders for the supply and erection of one 1,000-kw. steam-turbine-driven double-current generator:

Supply and erection of steam-turbine generator.

| | |
|---|---|
| Willans and Robinson (Siemens dynamo—Willans turbine) | £7,198 |
| Peebles, Bruce, and Co. (Peebles—Willans) | 7,198 |
| Ditto (Peebles—Parsons) | 7,978 |
| Brush Electrical Company (Brush—Brush) | 7,347 |
| Parsons, C. A., and Co. (Parsons—Parsons) (accepted) | 7,724 |
| Ditto (Siemens—Parsons) | 7,918 |

Supply and erection of boilers and accessories: Babcock and Wilcox, Limited, £9,375 (accepted) (only tender received).

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**Gloucester City Council.**—The City Council have been recommended to accept the tender of the Gilbert Arc Lamp Company, Limited, to supply and fix 123 arc lamps for £1,395. 12s. 6d., and that of the Callender Cable and Construction Company, Limited, to do the necessary excavation, etc., for 2s. 3d. per yard run. The tender of the Electrical Power Storage Company, Limited, to undertake the maintenance of the new battery for a term of 10 years for the payment of £80 per annum has been accepted.

**Wrexham.**—The following tenders for annual supplies have been recommended for acceptance: — Engine-room stores — T. Hayes, Wrexham, bleached rags, £2. 5s. per cwt.; Rogers and Jackson, Wrexham, sandcloth, 4s. per 50 yards; H. Caldwell and Co., Wrexham and Liverpool, indiarubber cones and washers 1s. 6d., brass joint rings 6s. 6d. per dozen up to 8in.; British Insulated and Helsby Cables, Limited, Prescot, Lancs., pure rubber strip 7s. per lb., linen tape 4s. per gross yards; W. H. Keys, West Bromwich, bitumen £6 per ton, joint-box compound 2d. per lb.; Dunlop Rubber Company, Limited, Aston, Birmingham, composition indiarubber tapes, 1s. 4d. per lb.; J. C. Gittins, Limited, Wrexham, shellac varnish 6s. per gallon, fine solder 48s. per cwt. Service cut-outs — Edison and Swan United Electric Light Company, Limited, Liverpool, two-wire service, £6. 10s. per dozen. Meters—Reason Manufacturing Company, Limited, Brighton, five-ampere £1. 18s. each, 10-ampere £2. 7s. 6d. Oils—Anglo-Bosphorus Oil Company, Limited, Bristol, cylinder oil 2s. 6d. per gallon, dynamo oil 2s. 1d., castor oil 2s 11d. Carbons—Sloan Electrical Company, Limited, C. quality, £4. 3s. 9d. per 1,000 pairs. Coal—Wynnstay Collieries, Limited, Ruabon, rough washed slack 7s. 10d. per ton delivered, rough slack 6s. 10d. Ironmongery—T. Hayes, Wrexham, shovels 38s. per dozen, rammers 2s. each, bolts (all sizes) 2d. per lb., washers 1½d., whiting 2s. per cwt., benzoline 1s. per gallon, resin 2d. per lb., spirits of wine 2s. 4d. per gallon; Rogers and Jackson, Wrexham, hammers 5½d. per lb., rope 4d.; J. C. Gittins, Limited, chisels, 5d. Incandescent lamps—J. C. Gittins, Limited, 8 c.p., 16 c.p., or 25 c.p. 9s. 9d. per dozen, 32 c.p. 14s., 50 c.p. 24s., 100 c.p. 4s. (all Robertson's lamps). Consideration of tenders for cables and service boxes has been deferred.

**Gosport.**—The Provincial Tramways Company, Limited, have received the following tenders for constructing tramways for electric traction at Gosport and Fareham. Mr. J. Glenn, 11, Queen Victoria-street, London, E.C., and Gosport, engineer:

Contract No. 1.—Gosport.

| | |
|---|---|
| Pethick Bros., Plymouth | £26,757 |
| C. L. Duke, Plymouth | 26 108 |
| J. Mowlem and Co., London | 24,306 |
| W. Griffiths and Co., London | 23,302 |
| Blackwell and Co., London | 23,528 |
| Dick, Kerr, and Co., London (accepted) | 22,979 |

Contract No. 2.—Gosport to Hoeford.

| | |
|---|---|
| Pethick Bros. | 11,053 |
| C. L. Duke | 10,362 |
| J. Mowlem and Co. | 9 822 |
| W. Griffiths and Co. | 9,887 |
| Blackwell and Co. | 9 391 |
| Dick, Kerr, and Co. (accepted) | 9,607 |

Contract No. 3—Hoeford to Fareham.

| | |
|---|---|
| Pethick Bros. | 18,637 |
| C. L. Duke | 17,335 |
| J. Mowlem and Co. | 17 053 |
| W. Griffiths and Co. | 16 573 |
| Blackwell and Co | 16,771 |
| Dick, Kerr, and Co. (accepted) | 17,047 |

Contract No. 4.—Gosport to Alverstoke.

| | |
|---|---|
| Pethick Bros. | 9 060 |
| C. L. Duke | 8,588 |
| J. Mowlem and Co. | 8,459 |
| W. Griffiths and Co. | 8,275 |
| Blackwell and Co. | 8 119 |
| Dick, Kerr, and Co. (accepted) | 7,872 |

Feeder cable.

| | |
|---|---|
| Pethick Bros. | 9 040 |
| C. L. Duke | 9,132 |
| J. Mowlem and Co. | 8 585 |
| W. Griffiths and Co. | 9,132 |
| Blackwell and Co. | 9,133 |
| Dick, Kerr, and Co. (accepted) | 9,320 |

# BUSINESS NOTES.

## TRACTION.

**Belfast.**—The Corporation have requested the tramway company to reply to the Corporation's offer by the 11th inst.

**Ripon.**—The District Council have adjourned the consideration of the proposed light railway to Kirkby Malzeard for two months.

**Sunderland.**—At a Local Government Board enquiry into the proposed Roker Park extension the scheme was opposed by several residents.

**Gateshead.**—The tramway company have secured from the Board of Trade a further period of six months for the completion of the Wrekenton tramway.

**Blackpool.**—The Town Council considered the other day the question of reverting to a minimum fare of 2d. Ultimately it was decided to continue 1d. fares till Whitsun.

**Halifax.**—The Tramways Committee recommend the purchase of two one-decker cars for service between the railway station and the post office, at an estimated cost of £500 each.

**Rotherham.**—The Tramways Committee recommend that representatives be authorised to visit Southport for the purpose of inspecting the new type of cars on exhibition in that town.

**Glasgow and Paisley.**—The running of a through service has been delayed in consequence of a hitch in the arrangements between the Glasgow Corporation and the Paisley Tramway Company.

**Crewe.**—The Town Council have decided not to proceed with the proposed electric tramway for the present. The Council some time ago opposed the application of a private company, stating that they would undertake the service themselves.

**Reading.**—The employés of the Corporation last week engaged in a football match with those of the London United Tramways Company, the victory going to the home team. Subsequently all the players were entertained to tea and a social evening.

**Sheffield.**—The receipts of the Corporation's tramway for the past quarter amounted to £54,938, which is nearly £3,000 less than the previous quarter. An increase is shown as compared with the corresponding period last year, but the system has since been extended.

**Huddersfield.**—During the Easter holidays, including Good Friday to Tuesday night, the takings on the Huddersfield tramways amounted to about £1,289, which is rather less than last year, chiefly on account of the fact that on some of the routes the fares have been reduced.

**Dewsbury.**—The Dewsbury, Batley, and Birstall Tramways Company's accounts for the year ended Dec. 31, 1903, show a profit of £3,207, enabling the directors to pay a dividend of 6 per cent. on preference shares (as compared with 5 per cent. in 1902), and 6 per cent. on ordinary shares. A sum of £500 is added to reserve.

**Liverpool-Southport.**—The new electric railway was opened to the public on Tuesday. It is intended to substitute the new trains for the ordinary slow trains, but after Sunday next expresses will be run, and the whole of the new electric trains will gradually be introduced. The Southport line is the first in the kingdom of such a length to be electrically equipped.

**Portsmouth.**—The Tramways Traffic Sub-Committee recommend the building of a siding in the form of a third line in Park-road. There is plenty of road space at the spot for the building of this third line, and it will connect with the main lines at both ends. Accommodation will be given for five cars. The cost of the third line is estimated at somewhat over £400.

**West Ham.**—The West Ham Corporation electric tramways from Stratford to the East Ham tramway terminus at Upton Park were opened for public traffic on Monday. Negotiations are taking place for the mutual running of the West and East Ham cars so as to save passengers the trouble of changing at the boundary lines at Forest Gate, Plaistow, and Upton Park.

**Bury.**—At a meeting of the Tramway Committee, a deputation of ratepayers presented a request that, instead of having an outward service of cars by King-street and an inward service by Heywood-street, the cars should be run alternately. The Chairman stated that after the whole system was completed and had been working for a time, the committee would consider the suggestion.

**Wolverhampton.**—The Lorain tramway constructed by the Corporation from the Five Ways, through Horseley Fields and Willenhall-road to Coventry street, is completed. There will be an eight minutes' service. Progress is being made with the same system from Stafford-street, through Canal-street, and Wednesfield-road to Heath Town. This line will be completed by Whitsuntide.

**West Bromwich.**—The Finance Committee of the West Bromwich Town Council in their report states that the capital accounts in respect of the purchase and reconstruction of electric tramways in the borough have now been closed, and £4,638 borrowed in excess of the actual expenditure has been transferred to the loans fund, in reduction of the annual instalments for the redemption of the tramways stock debt.

**Liverpool.**—At the last meeting of the Corporation it was stated that no steps had yet been taken to construct a line from Walton to the North Docks, as, owing to the action of the Bootle Corporation, they had not been able to go through Breeze-hill on to the North Docks, but there was some hope of an arrangement being come to. A section of the Bootle Corporation recommend that they should themselves construct the line.

**Darlington.**—The contractors commenced the overhead-gear equipment last week at the Eastbourne end of the route, and have fixed up the double wires, guides, and protectors from Bright-street to Freeman's-place, passing through the cut. At this rate of progress a week will suffice to complete the work, but there is delay at the Harrowgate Hill end, where the bases to the poles have been fixed, and a start made with the fixing of the arms. It is stated that the cars will be running in May.

**British Electric Traction Co.**—The receipts of all the associated companies of the British Electric Traction Company for week ended 25th ult. amounted to £21,317, as against £20,604 for the corresponding week last year, on a total route mileage this year of 389½ miles, against 366½ miles last year. The aggregate receipts to the same date since the commencement of the year amounted to £252,212, an increase of £27,534, as compared with the corresponding period last year.

**Swansea.**—The tramway extensions are being pushed forward. The contractors are engaged on the Bryn Mill, Morriston, and Brynhyfryd sections. In addition, a portion of the contract for the Clydach section under the County Council scheme is in hand. The Wind-street section may be started in a day or two, as 600 tons of rails are expected from Middlesbrough. The Cockett Parish Council contemplate

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petitioning the Swansea County Council to extend the tramways from Cwmbwrla to Trebocth.

**Municipal Ownership.**—A *plébiscite* taken in Chicago on the question of the acquisition by the Municipality of the tramway system of the city shows a majority of three to one in favour of municipal ownership. A section of the Press conducted a strenuous campaign in favour of municipal ownership, quoting the example of London, Glasgow, Birmingham, and other English cities. The amount of the public debt of the city being limited by the State Legislature, authorisation must be secured for extended borrowing powers before the tramways can be purchased.

**Derby.**—The umpire appointed in connection with the arbitration between Mr. Arthur Cox and the Corporation with respect to the acquisition of land on the Normanton-road for the widening of that road has awarded the sum of £3,080 to Mr. Cox. The original claim of Mr. Cox in connection with the acquisition of this land was £8 600. Arrangements have been made, subject to the approval of the Council, for the purchase of a piece of land on the Osmaston-road for the widening of that road for £270, and the Council is recommended to grant £270 for this purpose.

**Proposed Light Railway.**—The special committee appointed by the Herefordshire County Council to enquire into the practicability of establishing a system of light railways or other means of communication in the portion of the county between Llangorren and Hereford heard the evidence on the question last week. The only real opposition comes from Ross, which will not benefit by the proposed scheme. It is stated that the line will serve 32,000 acres and an agricultural population of 3,776. A 2ft. 6in. gauge is suggested, and the cost is estimated at £3,000 per mile if the land is given.

**Aston.**—The Town Council have instructed the town clerk to at once prepare the formal appointment of Mr. Green as sole arbitrator in respect to the purchase of the whole of the company's lines in the borough. The Public Works Committee have arranged with the company that the agreement leasing the tramways to them shall be so varied that the date fixed for the completion of the purchase of the undertakings shall be Jan. 1, 1904, instead of Sept. 1, 1903. Instructions have been given to have the carriageway widened in Witton-lane by reducing the width of the footpath to not less than 6ft.

**West Ham.**—Major J. W. Pringle, R.E., on the 30th ult. inspected the following new routes of the West Ham Corporation tramways system: Canning Town railway station *via* Barking-road to Green-street (East Ham boundary)—route length, 1 mile 5 furlongs 1·55 chain; Portway and Upton Park route—route length, 1 mile 1 furlong 1·50 chains. The report of the inspector being satisfactory, the Board of Trade issued their certificate the next day, and the Barking-road route was opened for public traffic on Good Friday, and the Upton Park route on Easter Monday. There are now 4·66 route miles of the system open for traffic. We learn that the receipts for the four days, Good Friday to Easter Monday inclusive, amounted to over £500.

**Gloucester.**—The City Council have decided that all current required for working the light railways be supplied at the rate of 1½d. per unit., and that the current required for lighting the light railway depôt be supplied at the rate of 2½. per unit, it being understood that either the Tramways Committee or the Electricity Supply Committee may ask the Council to reconsider the question of price after the end of March, 1905. Tickets for school children will be issued as follows: ½d. tickets available for any distance on any one section of the light railways within the city, and 1d. tickets available for any distance on the line from Hucclecote, such tickets to be issued on all cars running from 8 a.m. to 9 a.m., from 12 noon to 2.30 p.m., and from 4 p.m. to 6 p.m. on weekdays.

**Dundee.**—In consequence of the unfavourable financial position, the Corporation instructed the manager of their tramways to investigate and report upon the subject. This has now been done, and the report states that the question resolves itself into whether the existing ½d. fares should be interfered with or whether the advantages likely to be obtained by an anticipated reduction in the cost of current, by a rearrangement regarding the payment to the tramway company, by a rearrangement of the Hilltown service, and a likely improvement in the Ferry-road line, would suffice to warrant the Council in giving their attention to these latter matters, and allowing the fares to remain as they were for the time being. The report predicts that when the Broughty Ferry line has been put down a considerable improvement would result to the Ferry-road branch.

**Bristol.**—The Parliamentary Committee of the Somerset County Council have reported to the Council that they received deputations from Keynsham and Long Ashton. As regards the extension to Keynsham, a petition was presented in favour of the Bill. the petition being signed by a very large number of the inhabitants of Keynsham. The committee have given the Council's consent to this extension on terms which will provide for wood paving between the outer rails in the more populous parts of Brislington and Keynsham, and after the expiration of 15 years for similar paving between the outer rails throughout the entire length of the proposed extension, or for such other paving as the Council shall approve. As regards the extension to Long Ashton, the vice-chairman of the Parish Council stated that 80 per cent. of the inhabitants were opposed to it, and the Council have refused their sanction.

**Bradford.**—The official return, giving the receipts on the city tramways for the year ending March 31, was issued on Saturday, and it shows that the total receipts in fares during that period was £194,310. 17s. 1d., which is an increase over the corresponding period in 1902-3 of £21,382. 17s. 10d. The total number of miles run was 4,546,942, and the average receipts per mile run 10·25d. The Leeds-road-Stanningley section was the most lucrative, the receipts being £28,400 and the average per mile 11·40d. The new tramway route to West Bowling, Bradford, has been opened to the public. It was inspected by Major Pringle, R.E., Board of Trade inspector, and the trial trip proved quite satisfactory. The new length of double line traverses Bowling Old-lane as far as Gaythorne-road, and opens up the thickly-populated district of West Bowling. The distance from the centre of the city to the terminus is about three-quarters of a mile. The cars will travel *via* Nelson-street, Croft-street, and Manchester-road.

**Hartlepool.**—The Corporation have approved of an agreement with the General Electric Tramways Company, Limited, under which the Corporation waive their right to purchase the tramways for a period of 21 years, the company undertaking to relay such portion as now consist of a single line, and to put the overhead equipment into thorough order; to double the lines within the borough should the West Hartlepool portion be doubled; to relay the line in Northgate from the terminus to Cleveland-street with wood blocks; to use bogie or large cars, and to run them at intervals of not more than nine minutes; to charge ½d. fares from Northgate to the cement works as an experiment for six months, on condition that if after that time if be found not to produce 7 per cent. on the capital expenditure, the company be allowed to revert to the 1d. fare; to pay £500 to the Corporation in consideration of the renewal of the lease, together with one-third of all profits realised by the working of the trams in the borough over and above a sum equal to 7 per cent. on the capital expenditure

**Walthamstow.**—As mentioned last week, the work of construction has been commenced. The light railways are being constructed under the supervision of Mr. G. W. Holmes, A.M.I.C.E., engineer to the Walthamstow District Council, and Mr. J. Enright, consulting electrical engineer. The contract for the permanent way, overhead equipment, and feeders has been let to W. T. Henley's Telegraph Works Company, Limited, who have sublet the permanent way to Dick, Kerr, and Co., Limited. The scheme embraces about 10 route miles, and is of single-track construction, with passing places at an average of four to the mile. Messrs. Edgar Allen and Co. have the contract for all the special work, and the North-Eastern Steel Company, Limited, the rails and fishplates. The overhead trolley system has been adopted, with part side bracket and part span wire form of construction. The current for working the cars will be taken from the Council's electric lighting station, at which additional plant will be installed to meet the demand. It is anticipated that the Forest-road section, which terminates at the Woodford boundary, will be open for traffic by the August bank holiday. This will enable the Council to participate in the enormous holiday traffic which is invariably drawn towards Epping Forest at that season of the year.

**London United Tramways Company's Appeal.**—Judgment has been given for the company, with costs, in their appeal against their rating by the Brentford Union. The company are actively engaged in carrying out the necessary widenings in Teddington and Hampton Hill for converting all the interlacing and single portions of their lines on the Hampton Court loop into double track. In Kingston-road the boundary fences and hedges of a number of properties have been set back on the north side of King Edward's-grove, and the block of property near St. Alban's Church will shortly be demolished. It is doubtful, however, whether the double lines will be completed to enable the "circular tour" to be made both ways on the Hampton Court loop before Whitsuntide. In connection with the proposal of the company to continue their line from Hounslow to Staines, converting what is now a local suburban tramway into a through light railway, the Brentford Urban District Council applied for a *locus standi* on the consideration of the Bill. They contended that the character of the traffic would be completely altered, and the Council desired to submit evidence showing that there should be certain widenings made in the already crowded thoroughfare through Brentford, and a certain amount of control given to the local authority over the traffic. The Court decided to disallow the application of the Brentford Council except in regard to so much of Clause 22 as related to tramway No. 7, authorised by the United Tramways Act of 1898. The Court also disallowed the *locus* applied for by the South-Western Suburban Water Company.

**Covered Cars.**—Mr. C. R. Bellamy, A.M.I.C.E., general manager of the Liverpool Corporation tramways, says, in his annual report just issued, that the experimental top covered car introduced in September, 1902, fulfilled all its expectations, and indicated that there was a general demand for such protection during inclement weather, but that it should take a more permanent character than the curtained screens first provided. On Aug. 20, 1903, the general manager reported that an opportunity had been afforded of ascertaining to what extent this car had usefully met the requirements in view during the winter and summer months, and that the best measure of public appreciation of this type of car was its increased earnings as compared with those of the ordinary type. The average increase in the car-mile earnings, including mid-winter and mid-summer months, was about 1½d. per car mile, or a total increase per car per annum of upwards of £180. As a result of the experience afforded with the covered cars in service, it was found that considerable improvements could be made in details of their construction without departing from the principles laid down in the general manager's annual report for the year 1902—viz., the provision of an outside cover capable of being brought in and out of use simply and speedily with the least interference with the amenities of outside travelling. Upon this report, and after inspection of a sample car, the committee approved of the improvements introduced by the general manager, including the substitution of glazed sides for curtains, and directed that 10 of the existing top-covered cars be fitted with the new appliances and 10 of the ordinary cars with the new top cover. These were such a pronounced success that the committee ordered the whole of the remaining top-covered cars to be fitted, together with 100 additional cars, making a total of 150, 50 of which had been placed in the service up to Dec. 31, and are being added to at the rate of five or six cars per week. The introduction of this form of cover in Liverpool has created a

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good deal of interest throughout the country, and most of the principal towns are experimenting in the same direction. There is every hope that its introduction will entirely solve the problem of overcrowding, which is really confined to the inside of the car, and make it possible to prohibit standing on the cars. A census of passengers on a typical route has been taken under conditions which ensured the maximum requirement of passengers being recorded, and this is shown in diagrammatic form in an appendix, together with lines indicating the car accommodation, which will be found to be nearly always in excess of the requirements. The congestion only arises in inclement weather, when outside riding on the upper deck of cars is unpleasant. With covered upper decks, and, therefore, with the total seating capacity always available, this difficulty will be entirely obviated. The standard Liverpool car is of the double-deck type, with reversed staircase, plough lifeguard, and revolving illuminated route indicators. It is fitted with Brill trucks having a 6ft. wheel base, and is equipped with two 25A Dick-Kerr motors, with D.B.I. controllers. In addition to the hand brake, the car is fitted with an electric rheostatic brake. The car has seating accommodation inside, on the lower deck, for 22 passengers, and inside, on the upper deck, for 36, and outside for six, affording total seating accommodation for 64 passengers. The car is 28ft. in length, 16ft 5in. in height over all, the total dead-weight being 10 tons. It is fitted with a roof covering, which has been designed to afford ample protection during inclement weather, but to be capable practically of entire removal easily and rapidly when not required. The sides are protected by balanced windows, which can be held in any desired position, or dropped to the seat back level, and the top is composed of a permanent centre running through the length of the car, carrying the trolley stand, etc., and covering a third of the total width of the roof, which affords a housing for the two sliding side panels when thrown out of use. The top deck of the car can thus be used alternately as an open top, entirely closed, or with side screens and open roof. A change has been made in the position of the conductor's bell, which was formerly fixed on the body of the car on the staircase side of the doorway. Thus, in starting a car the conductor had to stand in a position which impeded the passage both of the lower and upper deck of the car, and so as to entirely shut out his view of intending passengers who were approaching the car from the forward end, resulting, in a great many instances, in the car being started at the moment the passenger was stepping on to it, thereby forming a source of numerous claims. The bell was, therefore, removed to the platform stand which supports the canopy of the roof rising vertically from the end step. Under this arrangement the conductor stands back against the rear rail out of the way of passengers boarding and leaving the car, and in full sight of both, thus removing all risk of the car being signalled forward at the moment that passengers are attempting to board it. With the introduction of improved steel-tyred wheels, experimental work with them has been placed in hand. The results so far obtained, however, do not warrant their general adoption at present, but it is probable, when final returns are obtained and the first cost reduced, a stronger case may be made for them. The net cost of the chilled wheels now in use is under 20s. each, and they had an average life during 1903 of 33,500 miles per wheel.

## LIGHTING AND GENERAL.

**Beckenham.**—The Urban District Council are raising £10,000 for electric lighting purposes.

**Wellingborough.**—The electric light company are about to extend their mains up Queen-street and Heriot's-lane.

**Darwen.**—The Town Council have received sanction to the borrowing of £6,500 for the purposes of electric lighting.

**Longton.**—The output of electricity during March was 9,943 units, being an increase as compared with last year of 12 per cent.

**Bolton.**—The Electricity Committee estimate that the profit for the past year from their department in aid of rates will be £6,818.

**Clewer.**—At the annual assembly of the parish meeting last week a proposition as to the adoption of the Lighting and Watching Act was carried.

**New Issue.**—Allotment letters have been posted for the whole of the £350,000 4½ per cent. debenture stock of the Metropolitan Electric Tramways, Limited.

**Stockport.**—A uniform charge of 4d. per unit will in future be charged for current for lighting purposes. This will benefit 95 per cent. of the consumers.

**Newark.**—The Urban District Council have obtained a clause in the new Bill of the Derby and Notts Electric Power Company protecting the interests of the borough.

**Blackpool.**—An enquiry has been held into the application of the Corporation for sanction to borrow £3,700 for the provision of a new traction set for the electricity works.

**Sale of Wire.**—Messrs. Robert Lyon and Co. will sell 4,000lb. copper and German-silver electrical wire (cotton and silk covered) by public auction on April 12. Particulars in another column.

**Halifax.**—The Town Council will be asked at their next meeting to authorise the Education Committee to expend £450 on the equipment for classes in electrical engineering at the technical school.

**Retford.**—At the last meeting of the Council the town clerk was instructed to endeavour to obtain a still further prolongation of the electric lighting provisional order, and failing that to take no further steps.

**Worthing.**—Application is to be made for sanction to borrow £1,500, the estimated cost of electric light extensions, and for the purchase of meters, house service materials, etc., during the next nine months.

**Wandsworth.**—The County of London and Brush Provincial Electric Lighting Company have been asked by the Borough Council to reduce their charge for electricity for lighting purposes to a flat rate of 4½d. a unit.

**Gloucester.**—At Tuesday's meeting of the Gloucestershire Standing Joint Committee it was agreed to light the shire hall by electricity, at a cost of about £200. The city of Gloucester is to be invited to share a portion of the cost.

**Stourbridge.**—The promoters of the North Worcestershire electric lighting scheme have withdrawn the Stourbridge district from the scope of their application, but have deferred a decision as to Pedmore and some adjoining parishes.

**Rangoon.**—*Indian Engineering* says the Rangoon Municipal Committee have recommended the Local Government to accept Messrs. Darwood and Co.'s tender for electric lighting and traction, instead of that of the Brush Company.

**Bridlington.**—The work of laying the cables for the Corporation electric lighting scheme has begun, and it is hoped that it may be completed within nine months. The surveyor is preparing a plan showing the proposed extensions of the area of electric lighting.

**Derby.**—The Tramways Committee have, subject to the approval of the Council, accepted the tender of Messrs. Mason and Jacob for the exclusive right to advertise upon the cars for five years upon payment by the contractors of £23. 10s. per vehicle per annum.

**Lincoln.**—The Standing Joint Committee for the Parts of Holland, Lincolnshire, have decided to have telephonic communication with the police stations at Holbeach, Long Sutton, and Donnington. Some of the members favour an extension to all the police stations in the county.

**Agency.**—We are informed by Messrs. Christy Bros. and Middleton, electrical engineers, of Chelmsford, that in order to deal with largely increased business they have secured the services of Mr. E. S. Saunders, recently of the British Westinghouse Company, who will represent them in the South and West of England.

**Colchester.**—The electrical engineer's last report contains the following figures: output of electricity in units during February, 1904, 41,968 (1903, 28,529; 1902, 20,393); number of consumers at end of February, 428 (337; 248); total number of 8 c.p. lamps connected, 24,767 (20,668; 14,908). The report was passed.

**Morley.**—The borough electrical engineer, Mr. J. E. Ellis, in his last report, says that the output from the electricity works during the month of February was 15,863 units, against 13,412 units the same month last year, being an increase of 2,451 units. Sixty lamps were connected during the month, the total number to date being 11,389.

**Telegraph Strike in Canada.**—A Reuter's telegram, dated Ottawa, Wednesday, says 100 operators belonging to the Great North-Western Telegraph Company, stationed at Toronto and Ottawa, have struck, owing to the company having refused to reinstate six union telegraphists who were recently discharged. The Montreal staff of operators, it is stated, will join the strike.

**Wireless Telegraphy in the War.**—The *Times* yesterday published a telegram headed "By De Forest's wireless telegraphy, dated on board the *Times* steamer 'Haimun,' April 6, *via* Wei-hai-wei," stating that the Russian cruiser "Bayan" overhauled the *Times* boat off Dalny, and the officers, after politely examining the wireless telegraphy plant, etc., retired, passing the usual compliments.

**Rotherham.**—In a recent report on electric lighting and power for the workhouse, the Rotherham borough electrical engineer suggests a special reduced tariff if the Guardians become customers. The estimate of expenditure on capital account for the year ending March 31, 1905, approved by the Electric Light Committee, includes £3,000 for mains and £1,800 for hire of motors—the total estimate being £6,500.

**Southampton.**—The Council have decided to reduce the charge for electricity to the Tramways Committee for power purposes to 2½d. per unit from 2¼d. per unit as at present. The charge for private lighting has been reduced to a flat rate of 4½d. per unit to those consumers on the 200-volt circuit. The borough electrical engineer has been asked to submit a further report based on the proposed new scale of charges.

**Middlesbrough.**—Mr. Taylor, electrical engineer, in his last report, states that the units sold during the month amounted to 61,800, as against 41,600 last year. The revenue was £860, as against £675; whilst the costs were £340, as compared with £295. Exclusive of interest and redemption the gross profit was £520. The number of lamps connected and applied for was 43,233. Sir Raylton Dixon and Co. contemplate the adoption of electrical power for the whole of their works. They would require 40,000 units per annum, and a special scale of charges will be offered to the firm on the understanding that power be taken between certain stipulated hours only.

**Aberdeen Shipyards.**—A new yard was established near Torry village by Mr. John Duthie only in November last. It is known as the Torry Shipbuilding Yard here, and so expeditiously the work has been carried out that there are at present a large number of drifters in all stages of construction in the yard, in all eight boats being on the stocks. Two ships were launched on March 31 and April 2 respectively. The yard has been laid out and fitted up by Mr. Duthie in an exceedingly up-to-date style in every way, the whole of the machinery—punching, shearing, and other equipment—being of the newest and most improved type. An interesting feature of the establishment is the use of electricity as a motive power, the entire supply of electricity being obtained from the Corporation's mains. The largest motor is one of 50 h.p., which drives a certain portion of the shafting to which are attached a number of the minor machines, while the larger machines are each equipped with independent motors of their own. Extensive use is made of cranes for the lifting of material. A travelling crane runs between the slips and lifts all the plates and whatever is required in the construction of the vessel to the exact position in which it is wanted, thus saving a very large amount of manual labour.

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**Londonderry.**—The electrical engineer (Mr. Macrory) in his last report states that on the 23rd ult a dynamo armature broke down in the windings near the commutator connections, and on the 24th ult. a fault occurred, which was traced and repaired the same day in the conduits, the fault being due to the rubber insulation giving way in a position which had been slightly injured when a cable was being relaid in the conduits.

**Bermondsey.**—The estimate of £75,420 for street-lighting was considered at the last meeting of the Borough Council. There are now 132 arc lamps, with a total of 85,200 c.p., which have displaced 1,700 gas lamps. The committee are about to place 200 incandescent lamps in Rotherhithe-street of 28,000 c.p., displacing gas lamps of 3,604 c.p. Altogether they have provided electric lamps of nearly 10 times the candle-power of the gas lamps displaced, and the street-lighting is now carried out at 3d. in the £1.

**Brighton.**—It is reported that the Corporation's hiring out of electric motors has proved a distinct success, the annual rentals being sufficient to pay interest, sinking fund charges, maintenance, and repairs, and still allow a considerable margin to be devoted for depreciation. Motor hiring has also directly benefited the electricity undertaking by an increased output of half a million units per annum, and application is to be made to borrow £6,000 for a period of 16 years for the purchase of motors for hiring purposes.

**Croydon.**—In consequence of the development of the Addiscombe Court Estate, it has become necessary to remove a sub-station from its present position and build another. Land is to be purchased. Mr. A. C. Cramb commenced his duties as borough electrical engineer on Feb. 29, and the assistant electrical engineer (Mr. William Barr) on the 4th inst. The main extensions in Sylvan-road and Coombe-road are to be carried out at the estimated cost of £298 and £170 respectively, also the alterations to the mains in Birdhurst-road and Birdhurst-rise, estimated to cost £386.

**Blaydon.**—At the present time the street-lighting comprises 275 gas lamps, costing £750 per annum; 133 electric lamps, involving an outlay of £332. 10s.; and 34 oil lamps, costing £90; representing an annual expenditure for lighting of £1,172. 10s During the past six months 72 additional lamps have been ordered to be erected. Previous to and during the year 1902 schemes of electric lighting emanating from various sources were discussed by the Council, and eventually an electric lighting order was granted by the Board of Trade in favour of the Council applicable to the whole district. The matter is still under consideration.

**Lincolnshire and Yorkshire Electric Power Bill.**—The House of Commons Court of Referees, Mr. J. W. Lowther, chairman of committees, presiding, on the 29th ult. considered the objections raised to the *locus standi* of the following petitioners against this Bill: Yorkshire Electric Power Company, Mr. Albert H. Fryer, Lincolnshire Ironmasters' Association, and Sir Hickman B. Bacon. The Bill provides for the incorporating of a company to supply electrical energy over a wide area in Lincolnshire and Yorkshire, with power to acquire land for generating stations and lay down mains. The amount of proposed capital is £999,000. Only the last application was allowed.

**Portsmouth.**—The Lighting Committee are experimenting with 25-c.p. incandescent lamps for street-lighting. The lamp itself is enclosed in a large, clear glass globe, which is surmounted by a special reflector, the fittings having been designed by the staff at the Portsmouth station. A joint committee of the roads and works and the electric light will recommend its adoption wherever cables have been or may be laid. It is expected that a considerable saving will be effected. The price now paid for a single gas lamp is £3. 5s. per annum, whereas the Electric Light Committee will be able to supply these new lamps for £3. 3s., and when the number exceeds 500, the price will be reduced to £3.

**Holywell Telephones.**—Last week on the second reading of the Telegraph (Money) Bill in the House of Commons, Mr. J. H. Lewis invited the attention of the Postmaster-General to the lack of telephonic facilities at Holywell. He stated that deputation after deputation had been sent to London on the subject, and an appeal had been made by the local authority, but the people of Holywell were still unable to communicate by telephone with those in adjoining towns without having to meet a charge additional to the ordinary subscription for the telephone service. Lord Stanley replied that he was not conversant with the details of the case, but he promised to give the matter his attention.

**Derby.**—The extension of the mains along French-street and Buller-street is being proceeded with. The following estimate of expenditure on capital account for the year ending March 31, 1905, has been prepared by the electrical engineer and approved by the committee—viz.: mains, £3,000; services, £600; motors for hire, £1,800; extension of lighting board, £60; meters, £400; telephones to sub-stations, £40; sundries and contingencies, £600—total, £6,500. The Council is recommended to direct application for sanction to the borrowing of £5,000 for the purpose. It is proposed to fix the maximum price for current under the sliding scale system of supply at 5d. per unit, instead of 5½d. per unit as at present.

**Luton.**—The electrical engineer, in his last report, states that since Feb. 26 last, 20,345 units had been generated, an equivalent to 280 8-c.p. lamps and one motor of 3 h.p. connected, making a total of 154 consumers with 10,535 lamps and 45 motors of 160 h.p., and that at the present time over 270 additional lamps and six motors of 9 h.p. were being wired. He also reported that the number of units generated showed an increase of 120 per cent. over the number generated during the corresponding period of last year. The chairman and electrical engineer have been appointed delegates to attend the ninth annual convention of the Incorporated Municipal Electrical Association to be held in Derby and district from June 29 to July 2, 1904, inclusive.

**Heston and Isleworth.**—The Urban District Council will be in a position to supply electric current for light and power in or about the month of May, 1904. The charges have been fixed as follows: Lighting—5d. per unit, subject to discounts ranging from 5 to 10 per cent. Power—consumption not exceeding 750 units per quarter, 3d. per unit; consumption exceeding 750 units per quarter, 2d. per unit. Meters from 2s. per quarter. Where premises will be wired and fitted free, current will be supplied at 5½d. per unit. The consumer will have the right of purchasing the installation outright at any time. The Council are prepared to make arrangement with owners of houses which they do not themselves occupy for wiring and fitting houses, repayment to be made by instalments or otherwise.

**Swansea.**—The work of laying the cables at Swansea East is being carried out by the Callender Cable Construction Company, and the laying of the sections under the North Dock is already completed. Mr. H. Philbie, the engineer in charge, has laid 10 large vulcanised-bitumen cables, each armoured with a double ring of steel wire. Each of the cables was 175 yards in length, taking the shore ends, so that altogether 1,750 yards of cable were used for the purpose. They were 3in. cables, and weighed 40lb. to the yard. They were joined to a feeder pillar placed on the North Dock, and were conveyed on a punt across the dock, the cables being paid out as the punt was propelled. The cables were carried to the opposite quay, and will join the Strand mains. The shore ends of the cables will be protected by means of baulks of timber. This week the work of carrying the cables across the New Cut will be proceeded with.

**Lancaster.**—The electricity department is not only paying its way, but is able to contribute £750 to the relief of the rates. The reserve at the end of last year stood at £3,484, and after deducting the amount for the relief of the rates there is still a balance of £613 to add to the reserve, bringing it up to £4,097. The amount appearing as profit on the undertaking, £1,363, is somewhat misleading, because all that amount has not been earned. £500 is accounted for by the fact that the money for the extension of the works was not really borrowed last year, and therefore there is no redemption to pay on that portion of the capital. The electricity department has been in existence 11 or 12 years, and during that time they have had to spend a considerable amount. The original plant has gone out of date, an increase from a 400-kw plant to 1,000-kw. was required, equal to a capital expenditure, with other items, of £10,000, which is to be made up again.

**Tunbridge Wells.**—Mr. Boot, in his last report, states that the lost income from consumers who have been disconnected amounts to £617. 19s. 2d., and that a number of consumers formerly using electric light only who are now using incandescent gas as well. Lost ground may be recovered if the Electric Light Committee will work on the same grounds as the gas company. Mr. Boot says further capital will be needed for the development of the scheme, the capital outlay on which has already been £75,311, and there can be little reduction in the present working expenses without running greater risks. They had no depreciation fund, but this was provided for by the sinking fund. At the Town Council meeting on Wednesday, a letter was read from Mr. A. Tyler, of Leadenhall street, E.C., on behalf of a London syndicate, making an offer of £80,000 for the electricity works, which so far have cost £70,000. Decision was deferred until the next Council meeting.

**London Gazette.**—The public examination in the estate of Gavin Knox Gilchrist, electrical contractor, Coila, Derbe-road, St. Annes-on-Sea, Lancs., will be proceeded with on April 15, at 11 a.m., at Sessions Hall, Preston. Mr. A. Beavis has been released from trusteeship in the estate of John Hervey Redgrave, electrical engineer, lately carrying on business at 53, Regent House, Regent-street, London, and residing at St. Olafs, Gloucester-road New Barnet, Hertfordshire. A general meeting of members of the Electric Lighting and Fittings Corporation, Limited, will be held at 10, Cook-street, Liverpool, on May 9 at 11 a.m., to have an account laid before them showing the manner in which the winding-up has been conducted, and to determine the manner in which the documents of the company shall be disposed of. The resolution that it is desirable to reconstruct the British Electric Separating Company, Limited, has been passed. The company will be wound up voluntarily. Mr. Richard Phillips Pike, Swansea, chartered accountant, has been appointed liquidator.

**Dover.**—The Town Council have completed arrangements for loan of £150,000 for purchase of the electricity undertaking on May 6 next. The terms include provision that the Council be at liberty to repay the money after three years subject to penalty of £1,500. The following report has been submitted to the Council by the company's engineer, Mr. L. W. Woodman, showing estimated capital expenditure: "(*a*) for quarter ending March 31, 1904, £1,050; (*b*) for year ended March 31, 1905—average yearly cost for small mains, extensions, service lines, junctions, boxes, apparatus on consumers' premises, etc., £2,000; total buildings and plant extensions as recommended in report, £7,250; additional transformers, £100; balance owing on Ferranti set, £335; 440 yards $^{10}/_{15}$ high-tension concentric cable required for reserve, £75; power cable for Prince of Wales Pier and new swingbridge and laying same, £450—£10,210; total, £11,260." Mr. Woodman also submitted a report as to (1) provision of additional 400-kw. Parsons turbo-alternator for extension of lighting system; (2) proposed extension of buildings; and (3) auxiliary plant included in above estimated expenditure for year 1904 5. Application is to be made for sanction to a loan of £11,260.

**South Africa.**—The Paarl, Cape Colony, is among the latest towns contemplating the installation of an electric lighting and tramway system. Progress is being made with the laying of the Maritzburg electric tramways, some 3¼ miles of the rails having been already laid, and it is expected that a section will be complete and handed over for working by the end of the year. The power station and plant are practically complete, and the car-shed is well in hand. The material is arriving promptly, the points and crossings, supplied by Messrs. Hadfield and Co., Sheffield, having already been shipped, as are also

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six of the eight-wheeled bogie cars on order with the Brush Electric Company. Messrs. R. W. Blackwell and Co. are supplying the overhead equipment. Progress is being made with the erection of the new electric power station at Zomba, British Central Africa, and the complete equipment only waits on the delivery of the dynamos on order, which at last advices had reached Chinde. In connection with their water scheme, the Town Council of Aliwal North propose to obtain parliamentary sanction to the setting up of a power generating station on the Orange River for the supply of light, heat, and power to the township; also to erect a telephone and telegraph system as an adjunct to their proposed waterworks.—*British and South African Export Gazette.*

**Birmingham.**—The report of the Electric Supply Committee on the proposed extension of the Corporation's electric light undertaking, to which we referred in our last issue, will come before the City Council next Tuesday. In their introduction the committee state that by the scheme of July, 1901, a loan of £251,974 was obtained for various work, and of this there was still an unexpended portion of £167,776. Under the Corporation Act, 1903, the Council obtained powers to work tramways in the city, and in May last the Tramways Committee passed a resolution that it was desirable to proceed without delay with the provision of electrical energy for working the whole of the tramways in the city, the leases of which expired in 1906. The committee say that they were convinced that a larger scheme than that submitted to the Council in 1901 was not only necessary, but that it would prove in the end to be more economical. In the laying out of a scheme for the new station regard had been had to the demands for current for both tramway and ordinary purposes for about the next 10 years, in order that the scheme may be so planned as to admit easily of extension from time to time as need might arise. The energy required, taking this basis, was estimated at about 22,000 kw.—viz., 13,000 for ordinary lighting and power, 7,500 for tramway purposes, and 1,500 spare. For some years the annual increase in the amount of current required for private lighting and power has been about 10 per cent., rising to 16 per cent. since the reduction of charges last year. The total kilowatt capacity of the existing stations was 5,260. On the 10 per cent. rate of increase, compound, the kilowatt capacity required in 10 years would thus be about 13,640. The estimated cost of erecting and equipping the station to a capacity of 22,000 kw. was £510,000, including £130,000, the estimated cost of the necessary building. For the present the committee believe that the needs of the department would be met by the equipment of the station to a capacity of 8,500 kw.—viz., 3,500 for private lighting, 3,500 for tramway purposes, and 1,500 spare plant—at a cost of £260,620. The committee describe the scheme in its entirety, notwithstanding that they are only asking the Council's sanction to the installation of a little more than one-third of the plant at the present time. The report gives details of the arrangement of the buildings, which include an engine-house 270ft. long by 100ft. wide and 65ft. high, and says that the boiler-house will be of similar dimensions, and that there will also be a small pumping station, workshop, and engineers' stores and offices. Six sub-stations would ultimately be necessary, including the existing station at Parker-street, where certain alterations would be required. The others would be erected in convenient situations, having regard to the demands upon the system. One of the stations would be built on land belonging to the department at Court-road. The ultimate cost of the sub-stations and equipment was estimated at £132,200. For the first equipment it was proposed to instal four of such stations, one of them being the Parker-street station, at a total estimated cost of £55,186. These sub-stations would be of a total capacity of 3,900 kw. The underground cables proposed to be installed for the first equipment were: three high-tension cables to run direct from the main generating station to each sub-station. One of each of these three cables would be utilised for tramway traction supply, one for lighting supply, and one as a spare to either. The estimated cost of the first equipment was £441,142. The committee were alive to the heavy annual charges which would be entailed by the large addition to the capital of the undertaking. If during the first year or two, before the station was fully at work, there should be a deficiency in the revenue, it would be necessary to have recourse to the reserve fund, which now stood at £26,394, and to which the result of the present year's working should enable an addition to be made. With a gradually increasing revenue and the reserve fund to fall back upon the committee had no doubt that the department could bear the increased charges for interest and sinking fund until the new capital became remunerative, and in this connection it should be remembered that a large customer was assured in the tramway department. The committee recommends that the Local Government Board be asked to cancel their sanction to the previous loan so far as related to the unexpended portion, amounting to £167,776. 14s. 1d.; that the Finance Committee be authorised to apply for the necessary sanction to the borrowing of the following sums; and that, subject to such sanction being obtained, the committee be authorised to proceed with the work: Summer-lane station—first equipment, £260,620; sub-stations and first equipment, £55,186; underground cables, £123 336; meters, £2,000—total, £441,142.

## PROVISIONAL PATENTS, 1904.

MARCH 22.

6873. **Improvements in and relating to "clusters" for incandescent electric lamps.** John Henry Dale, 51, Deansgate-arcade, Manchester. (Complete specification.)

6878. **Improvements in electrical ignition apparatus.** August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

6889. **Electrical distribution.** Joseph Lester Woodbridge, 81, High Holborn, London. (Complete specification.)

6896. **Improvements in and relating to electric tramways and railways.** Frederick Walter Baynes, 51, Elmside, Exeter.

6936. **Improvements in and relating to voltametric balances.** Wilhelm Pfanhauser, 65, Chancery-lane, London. (Complete specification.)

6959. **Improvements in filaments and in methods of manufacturing the same.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

6960. **Improvements in filaments and in methods of manufacturing the same.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

6961. **Improvements in and relating to electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

6972. **Improvements in electrodes for arc lights.** Frederick Julius Gerard and Lothar Fielder, 22, Southampton-buildings, Chancery-lane, London.

MARCH 23.

7017. **Improvements in reflecters for electric glow lamps.** James Taylor Connell, 24, Southampton-buildings, Chancery-lane, London.

7021. **Improvements in and relating to means for controlling electrically-operated elevators.** Franz Eugen Klein, 28, Krummestr, Charlottenburg, Germany. (Complete specification.)

7052. **Improvements in supports or carriers for the glass globes of electric arc lamps.** William Walter Adams, 65, Chancery-lane, London.

7056. **Improvements in or relating to the production of metals of the alkali group by electrolysis.** Edgar Arthur Ashcroft, 111, Hatton-garden, London.

7061. **Improvements in electro-depositing apparatus.** The Leeds Copper Works, Limited, and J. C. Jobling, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7064. **Asymmetrical vapour conducting medium for alternating currents.** Otto Holz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

7065. **Transmitting alternating currents through a vapour.** Ezechiel Weintraub, Cannon-street, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

7066. **Alternating-current rectifying apparatus.** Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

7067. **Rectifying alternating currents.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

11828A/03. **Improvements relating to electric telegraphy.** Alexander Muirhead, 323, High Holborn, London. (Date applied for under Patents Rule 9, May 23, 1903.)

MARCH 24.

7073. **Primary battery.** Walter R. Burrows and Thomas Lyons, 1A, Netley-street. Hampstead-road, St. Pancras, London.

7118. **Electrical emergency railway brake.** Charles Mackintosh (from Nairn, N.B.), 49, Gower-place, Gower-street, London.

7129. **Improvements in and relating to telegraphic signal systems.** Charles Goodwin Burke, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 25.

7179. **Improvements relating to electric bells.** Edgar Godwin Harcourt, 18, Southampton-buildings, Chancery-lane, London.

7208. **Improvements in controlling systems for electric motors.** George Westinghouse and Louis Minturn Aspinwall, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 1, 1903, being date of application in United States.) (Complete specification.)

7209. **Improvements in multi-voltage electric generators.** George Herbert Gibson, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 4, 1903, being date of application in United States.) (Complete specification.)

7211. **Improvements in and relating to apparatus for the control of electrical switches and like devices.** Lionel Robinson and Co., Limited, and Edmund Garside, 1, Queen Victoria-street, London.

7217. **Improvements in magneto-electric machines.** Frederick Richard Simms, 4, South-street, Finsbury, London.

7238. **Improvements in electric insulators.** James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Societa Ceramica Richard-Ginori, Italy.) (Complete specification.)

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MARCH 26.

**7245. Improvements in or applicable to electric bells.** Henry Max Salmony, 95, Mortimer-street, London.

**7247. Improvements in and relating to the sealing of electrical conductors.** Leicester Richards Lee, 20, Hartington-road, Chorlton-cum-Hardy, Manchester.

**7249. Improvements in and relating to electrical fuse boxes, junction boxes, and the like.** Leicester Richards Lees, 20, Hartington-road, Chorlton cum-Hardy, Manchester.

**7267. Improvements in electrical switches.** Victor Bornand, 5, Corporation-street, Birmingham.

**7268. Improvements in arc lamp electrodes.** Richard Fleming, 83 Cannon-street, London. (Date applied for under Patents Act, 1901, March 26, 1903, being date of application in United States.) (Complete specification.)

**7299. Improvements in arc light electrodes and method of making the same.** John Thomas Henry Dempster, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 26, 1903, being date of application in United States.) (Complete specification.)

**7304. Method of and apparatus for administering "cold light" electric baths.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

**7312. Improvements in and relating to lightning arresters.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Luigi Risso, Italy.)

**27044A. Improvements in secondary or storage batteries.** George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (The Electric Boat Company, United States.) Date applied for under Patents Rule 9, Dec. 10, 1903.) (Complete specification.)

**27044B. Improvements in steering gear adapted for use in ships or boats.** George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (The Electric Boat Company, United States.) (Date applied for under Patents Rule 9, Dec. 10, 1903. (Complete specification.)

**27044C. Improvements in observation apparatus adapted for use in submarine or submergible boats.** George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (The Electric Boat Company, United States.) (Date applied for under Patents Rule 9, Dec. 10, 1903.) (Complete specification.)

**27044D. Improvements in torpedo-ejecting apparatus.** George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (The Electric Boat Company, United States.) (Date applied for under Patents Rule 9, Dec. 10, 1903.) (Complete specification.)

MARCH 28.

**7318. Improvements in pendant chains for carrying electrical fittings.** Edwin Haslam, Imperial-chambers, Albert-street, Derby.

**7325. Improved electrical apparatus for timing the speed of motorcars or other vehicles over a measured distance.** Gerald Higginbotham, 4, St. Ann's-square, Manchester.

**7327. Process for the preparation of dynamo brushes.** The British Galvanic Metal Packing Company, Limited, 65, Chancery-lane, London. (Galvanischen Metall-Papier-Fabrik Actien-Gesellschaft, Germany.) (Complete specification.)

**7349. Improvements in electrical communicators.** Henry Foster, jun., 93, Leadenhall-street, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 21, 1904.*

1903.

**4389. System of contact breaker for the primary circuit of induction coils.** Chauvin and Arnoux.

**6329. Relay working of submarine cables or the like.** Brown.

**7022. Means for varying the self-induction of induction coils and the application thereof to the measurement of the velocity of bodies in motion.** Johnson. (Elektrizitäts-Actiengesellschaft vorm. W. Lahmeyer und Co.

**7064. Electrical connections.** Lanchester.

**7139. Alternating electric current motors.** Carolan. (General Electric Company.)

**7293. Method of regulation for alternate-current electrical machines.** Winter and Eichberg.

**7377. Electric switches.** Davies.

**7462. Electric motor-control systems.** Carolan. (General Electric Company.)

**7585. Apparatus for enabling telephonic and telographic messages to be transmitted over the same line.** Turchi and Bruné.

**7587. Electrolytic meters.** Carolan. (General Electric Company.)

**7829. Electric railways for national and international communication.** Sayer.

**8112. Automatic electric signalling apparatus for tramways.** Lionel Edward Harvey, Ernest Paul Bruno Estler, Paul Traugott Julius Estler, and Hans Paul Charles Estler.

**8812. Means for automatically regulating electric circuits.** Leitner.

**10723. Control of electrically-propelled vehicles.** Raworth.

**10728. Secondary battery applicable for use as a pocket battery.** Heym.

**11242. Trolleys of electrically-propelled vehicles.** Fielding.

**11509. Electrical measuring instruments.** Evershed and Vignoles, Limited, and Evershed.

**11554. Electric switches and fuses, and boxes for the same.** Callender's Cable and Construction Company, Limited, and Ward.

**11726. Electrical power-factor indicators.** Carolan. (General Electric Company.)

**11728. Electric switches.** Carolan. (General Electric Company.)

**11894. Means for electrically igniting miners' safety lamps.** Best.

**12283. Electric cables.** Callender's Cable and Construction Company, Limited, and Callender.

**12409. Brushes for dynamo-electric machines or the like.** Lake. (Soc. Anon. le Carbone.)

**21305. Method of and apparatus for maintaining two electric motors in synchronism.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

1904.

**3790. Electric furnaces.** Keller.

**4448. Thermal cut-out for electric circuits.** Fairweather. (American Electric Telephone Company.)

**4449. Thermal cut-out for electric circuits.** Fairweather. (American Electric Telephone Company.)

**4450. Thermal cut-out for electric circuits.** Fairweather. (American Electric Telephone Company.)

**4783. Electric heating device.** Padris.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ¼-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5¾-6¼ xd |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5¾ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3¾-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 95-96 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | .. | ¾-1¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1¼-1¾ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 97-100 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 84-89 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5¾ |
| Crompton and Co. ..... | 3 | .. | 1¾-2¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 99-103 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 74-79 xd |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1¼-1¾ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9-9¼ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 93-98 xd |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 11¼-12¼ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18-19 |
| —— 4 per cent. Debentures..... | 100 | .. | 98-102 xd |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 | .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 113-116 xd |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12-13 |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9½-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10½-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | .. | 10¼-10⅝ xd |
| —— 7 per cent. Preference ..... | 5 | .. | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14½ |
| ,, ,, £10 Ord. .... | 6 | .. | 10⅝ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7-7½ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5½ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 101-103 |
| Chelsea Electricity Supply ..... | 5 | .. | 5¾-6¼ xd |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary..... | 10 | .. | 10¼-10¾ xd |
| —— 6 per cent. Cumulative Pref. ..... | 10 | .. | 13-14 xd |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | .. | 7-8 xd |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5¾-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 103-106 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5¾-6¼ |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | .. | 99-102 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 101-104 xd |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 101-104 xd |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9½-10¼ |
| London Electric, Ordinary | 5 | .. | 1-1½ |
| —— 6 per cent. Pref. | 5 | .. | 4½-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 94-97 |
| Metropolitan Ordinary | 10 | .. | 18-19 xd |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 95 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | .. | 98-102 xd |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | .. | 5½-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 96-99 |
| Royal Electrical Company of Montrea. 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98-101 xd |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | – | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | – | 95-90 |
| South London, Ordinary | | – | 3-3½ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 |
| —— 3½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4½-5 xd |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4½-5 xd |
| Westminster, Ordinary | 5 | – | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | .. | 6-6½ |
| **Electric Railways.—** | | | |
| Central London, Ordinary | 100 | – | 90-93 |
| —— 4 per cent. Pref. | 100 | – | 98-101 |
| —— ,, ,, deferred | 100 | – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-113 |
| City and South London, Consolidated Ordinary | 100 | – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 122-125 |
| —— ,, ,, ,, '96 | 100 | – | 120-123 |
| —— ,, ,, ,, '01 | 100 | – | 119-122 |
| Liverpool Overhead, 5 per cent. Pref. | – | – | 13-13½ |
| —— Ordinary, 1-50,000 | – | – | 7½-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 102-104 |
| Waterloo and City, Ordinary | 100 | – | 88-91 |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 1-260,007 | 5 | – | 4¾-5 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 125-130 |
| Blackpool and Fleetwood Tramroad | 10 | .. | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | .. | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | .. | 3¾-4½ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 95-98 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10¼-10⅝ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | .. | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 50,001-80,000 | 10 | – | 8½-9⅛ |
| —— 6 per cent. Cm. Pf., 50,001-60,000 | 10 | – | 10½ 11 |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 116 119 xd |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-3 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5½-6½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 104-107 |
| —— Prov. Cert., all paid | 100 | – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | – | 1½-2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | .. | 4⅛-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 93-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— Debentures | 100 | – | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | – | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | – | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 3¼-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | .. | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | – | ¼-⅛ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | – | ⅝-1⅛ |
| New General Traction, Ordinary | 5 | – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1½-2⅛ |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | .. | 88 93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 10½-10⅞ |
| —— 5 per cent. Cum. Pref. | 10 | – | 11½-12½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | .. | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8½-9½ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | .. | 103 106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | .. | 1 |
| —— £101,152 6 per cent. Preference | 1 | – | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | – | 101-103 |
| —— Deferred Stock | 100 | – | 82 85 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12 14 |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 12-14 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 95 97 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 99-101 |
| Oriental Telephone and Electric Company | 1 | – | ⅛-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 2 | 1,166 | 871 | + 295 | +10,631*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 2 | 184 | 185 | – 1 | + 161 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 2 | 41 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 3 | 983 | 1,017 | – 29 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 2 | £91 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 1 | 1,007 | 737 | + 270 | + 290 | 24 | 24 | March 25*g* | 40,964 | 7,234,105 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | Mar. 31 | 344 | 386 | – 42 | – 425 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | April 2 | 439 | 268 | + 171 | + 35 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | Mar. 27 | 1,618 | 1,686 | – 68 | + 8,798 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 30 | 829 | 725 | + 104 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 27 | 3,598 | 3,308 | + 290 | +20,385 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | April 3 | 943 | 761 | + 163 | — *h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 1 | 4,607 | 4,410 | + 197 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 2 | 1,233 | 806 | + 427 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | Mar. 27 | 284 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 26 | 1,815 | 1,688 | + 127 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 2 | 194 | 170 | + 24 | + 235 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 2 | 6,297 | 7,122 | – 825 | + 159*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 3 | 2,712 | 3,074 | – 352 | – 920*h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | Mar. 31 | 397 | 416 | – 19 | – 129 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | April 1 | 273 | 225 | + 48 | – 239 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·35 |
| Dover Corporation | Mar. 26 | 163 | 183 | – 15 | + 183 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | April 3 | 101 | 94 | + 7 | + 84*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 1 | 3,544 | 3,644 | – 100 | } — | 46 | 46 | March 31 | 123,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·05*h* |
| Dublin S. District, Electric | ,, 1 | 676 | 730 | – 54 | | | | | | | | | | | |
| Dundee City Tramways | Mar. 30 | 767 | 779 | – 12 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | April 2 | 718 | 555 | + 162 | + 8,807 | 10·75 | 10·75 | March 31*g* | 25,341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 2 | 13,411 | 13,174 | + 237 | +55,019*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | Mar. 23 | 2,457 | 2,183 | + 274 | + 6,479 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | April 2 | 1,197 | 1,179 | + 18 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | ,, 2 | 2,144 | 1,784 | + 360 | + 8,991 | 25 | 19 | ,, 31 | 87,707*h* | 21,965,989 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | Mar. 30 | 132 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 30 | 194 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | April 2 | 5,317 | 4,978 | + 339 | + 894 | 77 | 77 | March 25*g* | 252,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | Mar. 25 | 10,016 | 10,114 | – 98 | + 2,975 | 103 | 101 | Dec. 31 | 504,504 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | April 3 | 1,547 | 1,583 | – 36 | + 258*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | Mar. 12 | 10,129 | 8,604 | +1,525 | +81,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 19 | 124 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | April 2 | 11,563 | 10,095 | +1,468 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 2 | 135 | 42 | + 93 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 2 | 3,611 | 3,122 | + 489 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 2 | 488 | 157 | + 331 | + 331 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 2 | 1,706 | 1,423 | + 283 | + 5,814 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 4 | £1,148 | 119 | + 29 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,231 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Mar. 17 | £469 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | April 4 | 4,377 | 3,141 | +1,236 | + 59 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 3 | 4,371 | [illegible] | — | — | 53½ | 52½ | Mar. 25*g* | 216,309 | 56,312,049 | 4,926,083 | 0·924 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | Mar. 24 | 842 | 891 | – 49 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 27 | 1,101 | 1,062 | + 139 | + 3,014 | 13·48 | 13·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | April 2 | £52 | £576 | + £76 | + 4,105 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 8,585,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |
| West Ham Corporation | Mar. 31 | £263 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Personal.**—We have to congratulate Lord Kelvin on having been returned unopposed as chancellor of Glasgow University. In view of the great services which Lord Kelvin has rendered to the university during the past 50 or 60 years, the honour done him is well deserved. We trust that he may continue his connection with the university for many years.

**Telephonic Extension.**—The Post Office extension of their trunk telephone system between Liverpool and Paris, Calais, Orleans, and Chartres was successfully inaugurated on Monday. Manchester, Leeds, and Birmingham also benefit by the extension. Through communication was easily and quickly established between Liverpool and Paris, and there were numerous calls during the forenoon.

**The New Magnetic Observatory.**—Operations are to begin at once for the erection of the new magnetic observatory at Eskdalemuir, Dumfriesshire, which is to supersede the one at Kew. Representatives of the Government and the Duke of Buccleuch, from whom the land at Eskdalemuir has been bought, have visited the site. A quarry near it is to be immediately opened, and by May 100 men are to be at work.

**New Elements.**—According to the daily Press, Prof. Baskerville, of the University of North Carolina, recently stated at the Chemists' Club there that he had discovered two new elements, which he has called carolinium and berzelium. These he claims to have isolated from thorium dioxide, and apparently they have strong radioactive properties. There is, however, no information in the announcement to distinguish these elements from the known properties of what has been termed "thorium X."

**Electrification of Alpine Tunnels.**—The question of working the various Alpine tunnels is being seriously discussed in Switzerland. The Erstfeld-Bellinzona section has been used as an experiment, and the results obtained promise so great an economy in the working of the whole of the St. Gothard line, that the adoption of electric traction may be expected at no distant date. Steam traction is very costly, amounting to about 11d. per train mile, while the highest estimate for electric traction does not put the cost at more than 8d. The question of electric traction for the Simplon Tunnel is also being raised.

**Telephones in High-Tension Stations.**—Messrs. Siemens and Halske, of Berlin, have recently patented a telephone which is intended for use exclusively in situations where cross-connections may occur between the telephone conductors and high-tension circuits. The feature of the instrument is that there are no metal parts outside the case which can be touched. Instead, everything is made from either hard or soft rubber, and all the metallic parts of the instrument are contained in a walnut case. The instrument is also provided with high-tension fuses, suitable for 3,000, 5,000, or 10,000 volts, depending on the voltage used in the station or district in question.

**Radium.**—The director of the municipal observatory at Paris considers that radium has before it an undoubted field of usefulness in meteorology. Up to the present all methods of measuring the intensity of variations in the electricity of the air have been very defective, especially in times of frost, owing to the extent to which water has to be used for this purpose. Radium, however, has dispelled the difficulty arising from frost, thereby greatly facilitating the study of aerial electricity. It was announced the other day that the Goldsmiths' Company had voted £1,000 towards the fund organised by the Royal Society for the appointment of a committee of experts to conduct an enquiry into the origin and probable uses of radium.

**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on the 11th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. The Right Hon. the Marquis of Salisbury, Mr. W. B. Anderson, Mr. J. Benson, Mrs. G. E. Broün-Morison, Mrs. Douglas Cow, Mrs. J. Mackenzie Davidson, Mr. J. A. W. Dollar, Mr. Bayntun Hippisley, Mr. E. W. Linging, Mrs. Master, Mr. J. C. Prince, Mr. E. A. Short, Mr. H. L. Tidy, Mr. W. Watson Taylor, and Mr. C. S. Whitehead were elected members. The special thanks of the members were returned to Mr. Francis Gaskell for his donation of £50 to the fund for the promotion of experimental research at low temperatures.

**Incombustible Celluloid.**—MM. Mabille and Leclerc, Paris, have recently patented a process for making incombustible celluloid. According to the description deposited, a solution of celluloid and a mixture of ether and alcohol is prepared, to which a solution of iron salts is added. After that another mixture of ether and alcohol is poured over it, and a clear liquid of the consistency of syrup results. After the solvents have been evaporated an incombustible and non-inflammable celluloid mass is said to remain. At any rate, if the celluloid should be heated, the gases of the chlorine components would extinguish the flames. If this material can be worked with the same ease as the ordinary celluloid, it should be a boon to manufacturers of electrical accessories, and there should be a great future before it.

**Power Supply in Sunderland.**—In our article last week under the above head, there is an error as to the name of the firm who supplied the electric travelling cranes in the North-Eastern Marine Engineering Company's works. We stated that these were of 60 tons capacity, and were supplied by the British Westinghouse Company. This is incorrect, as the whole of the motors and equipment were supplied by the British Thomson-Houston Company through various crane builders. We understand that there are 11 cranes in the works in question on which electric motors are used. Three of these are of 60 tons capacity, one is of 40 tons, five are of 25 tons, and the remaining two are of 10 tons each. The total horse-power of the motors on these cranes is no less than 846. These motors are all of the three-phase type, and this is probably the largest installation of cranes operated with three-phase motors in the United Kingdom.

**Wireless Telegraphy.**—Mr. Marconi stated in an interview the other day that the Marconi Wireless Telegraph Company hope to have a commercial service between England and the United States in full swing shortly, and that the stations on both sides are rapidly being perfected. Concerning the De Forest system, Mr. Marconi remarked that the fact that he was now taking action against that company in the United States for infringement of patents indicated that he considered their system an imitation of his. It is announced that the Lighthouse Board at New York have requested the company to remove its apparatus from the Nantucket lightship on account of the company's refusal to receive messages sent by the German system. Wireless messages were last week sent, with perfect distinctness and accuracy, from Heligoland to a ship in Hamburg Harbour and to Amsterdam simultaneously, the distance covered being over 310 miles.

**Radioactivity and Ozone.**—An interesting article by Messrs. Franz Richarz and Rudolf Schenck on the analogy between radioactivity and the behaviour of ozone appears in the last issue of the *Journal* of the Chemical Society. The authors show that freshly-prepared ozone,

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or ozone that is decomposing under the influence of desozonising agents, accelerates the condensation of water vapour. The presence of gaseous ions, to which this phenomenon points, is confirmed by the considerable conductivity exhibited by ozone. In respect of this ability to produce gaseous ions ozone is similar to radium and other radioactive substances. Further, a current of ozonised oxygen causes a zinc sulphide screen to fluoresce, although barium platinocyanide and zinc oxide are unaffected. Another point of analogy is the fact that radium salts and ozone both decompose with considerable development of heat.

**Steam v. Electricity.**—It was predicted some time ago in the *North American Review* that the conversion of the trunk lines of American railways from steam to electric traction would result in an immediate profit, even allowing for the interest on the capital required to be sunk, which profit, it was anticipated, would be realised chiefly from economy in working. Some confirmation of this view is provided by the recently published accounts of the elevated railroad in New York, the economical conversion of which to electric traction presented more difficulties than in the case of trunk lines. In the first quarter's working the cost has fallen from £280,000 to £260,000, a saving of £20,000, while the earnings have risen from £571,000 to £654,000. The total gain for three months is therefore over £102,000. The chief reason of the increased earning power is the increased speed of the trains, which is about 25 per cent. In this connection it may be mentioned that the Belfast and County Down Railway contemplate the electrification of one of their branch lines.

**New American Tube.**—The island of Manhattan, which forms part of the State of New York, has long been confronted with the problem of how to facilitate the conveyance of its huge army of workers between their homes and the industrial quarter. The solution, however, is expected to be furnished by the underground electric railway which is to be opened shortly. It has been the design of the engineers to keep as near the surface as possible, so that access to the subway from the street may be by short staircases. It is anticipated that an automatic block system, which shuts off power and applies brakes, will render collisions practically impossible, and an ingenious device applied to the controller in the head car of a train shuts off the power the instant the motorman's hand is taken from the controller handle. Should a man die suddenly at his post, the train would come to a stop within a short distance. The tube is to be well ventilated and illuminated, and each station will have some distinct characteristic, enabling passengers to identify it at a glance. The total cost exceeds £9,000,000.

**Electric Wave Detector.**—Prof. J. A. Ewing, F.R.S., and Mr. L. H. Walter have brought out a new magnetic detector of electric waves for the wireless telegraph. The electric waves cause a change in the hysteresis of a magnetic metal exposed to reversals of magnetism by means of a revolving magnetic field. The hysteresis causes the magnetic metal to be dragged after the field as it revolves, and this drag is opposed by a spring so as to give a definite deflection of the metal, which is suddenly changed by the electric waves passing through the metal, thus indicating a signal. The change is a diminution of the deflectors with ordinary means, but when the magnetic metal is a fine insulated steel wire, there is a large increase of the deflection. The revolving field is an electromagnet, with wedge-shaped pole-pieces, between which a long bobbin of steel wire is pivoted so that the magnetic drag tends to make it turn on its axis. A spring controls it, and a mirror shows the deflection. The bobbin is wound non-inductively with No. 40 gauge hard-drawn steel wire, insulated with silk, immersed in oil. The inventors attribute the result to an increase of magnetisation and hysteresis in the steel wire by the oscillatory circular field.

**Electric Traction and Power in Nice.**—The annual report of the United States Vice-Consul at Nice states, in regard to the electric tramways, that the communities on the lines which have already been decided upon by the authorities are clamouring for the beginning of work, but there does not seem to be much anxiety on the part of outsiders to take up the different concessions, while local elements are altogether lacking in the necessary initiative for such enterprises, although there are several such lines which would be good paying investments if properly built and managed. Concerning electric power, a group of financiers has in hand a project for the building of an electric power plant in the upper Roya Valley. They claim that the high prices charged by the existing company render the general use of electric power impossible. They further claim that this results from the high initial cost of the works, and that the latest discoveries and systems will greatly reduce this cost. As the existing gas and electric power company has a monopoly until 1913, the new group ntends to begin operations by furnishing Mentone.

**New London County Council Loan.**—At a special meeting on Tuesday the London County Council decided upon the issue of £5,000,000 London County consolidated 3 per cent. stock. The price has been fixed at £90, and as a half-quarter's and a quarter's dividends will be paid on June 1 and Sept. 1 respectively, and the purchase money will not be fully payable till Oct. 6, the investor reaps an advantage of some 13s. per cent. If the price be paid in full on May 4, the discount will amount to about 9s. 3d. per cent. Certain members of the Council considered £90 unnecessarily low, but Lord Welby pointed out that in the present state of the money market a higher price could not be expected. It is anticipated that the issue will be well subscribed, and it is understood that special consideration will be given to applicants for moderate amounts. The Council have the option of redeeming the stock at par after March 19, 1920. The new loan is to be applied to the discharge of county bills, deficiency on capital account, acquisition, electrification and extension of tramways, and expenditure on fire brigades, parks, and housing. This brings the total of the Council's loans to some £35,000,000.

**Technical Education in Germany.**—Dr. Frederic Rose, British consul at Stuttgart, has issued another of his series of reports, which deals with technical schools for special branches of the metal industries, and may be regarded as a continuation of his earlier report on special schools and courses for mechanical engineering and electrotechnics. The courses described in both reports belong to secondary or middle technical education, and should not be confounded with the higher technical instruction given at the technical universities. The schools discussed in the present report "are intended to take the place of the apprentice instruction in the workshops of factories, and may therefore be regarded as an attempt to solve the problem whether for certain branches of certain industries, with their highly specialised modern requirements, apprentice instruction in the works themselves or in a special technical school with a combined theoretical and practical curriculum is preferable and more productive of practical and profitable results." Dr. Rose discusses at considerable length the respective advantages and disadvantages of those two modes of early technical training, and describes in detail the system of training at various schools in Germany, nearly all founded in quite recent years, and all dealing with metal industries. Of these,

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three are devoted to steel and iron ware, one each to bronze, copper, sheet metal, and precious metals and jewellery, while three are given up to clock and watch making and two to general mechanical and artistic iron-work. Beyond this, Dr. Rose states that combined theoretical and practical instruction is given on a complete scale by the administrative bodies of the State railways.

**Compulsory Patent Licenses.**—In the *Board of Trade Journal* for April are reprinted for the public information the provisions of Section 3 of the Patents Act, 1902, repealing Section 22 of the principal Act. This section provides that where the reasonable requirements of the public with respect to a patent have not been satisfied, a petition may be presented to the Board of Trade, which body, if satisfied that a *primâ facie* case has been made out, shall refer the matter to the Judicial Committee of the Privy Council. If the Judicial Committee uphold the petition, the patentee may be ordered to grant licenses on such terms as the committee think just, or, alternatively, the patent may be revoked, if the committee consider that the reasonable requirements of the public will not be secured by the grant of licenses. Sub-Section 6 specifically directs that the reasonable requirements of the public shall be deemed not to have been satisfied if by the failure of the patentee to work his invention to an adequate extent, or to grant licenses on reasonable terms, (*a*) any existing industry or the establishment of any new industry is unfairly prejudiced, or (*b*) the demand for the patented article is not reasonably met. The measure is specially designed as a preventive of the buying-up by earlier patentees of improved inventions which they have no intention of working.

**Municipal Wiring.**—The London Electrical Contractors' Association have strongly opposed recent attempts by local authorities to obtain powers to sell electrical accessories, such as lamps, motors, etc. We gather that in the case of the St. Marylebone Bill this opposition has resulted in a certain degree of compromise. The clause which occurs in Sub-Section 1 of Section 16 of this Bill has been amended by the St. Marylebone Council so as to read as follows: "The Council may provide, sell, let for hire, and fix, set up, alter, repair, and remove (but shall not manufacture) lamps, meters, electric lines, fittings, motors, apparatus, and things for lighting and motive power, and for all other purposes for which electrical energy can or may be used or otherwise necessary or proper for the supply, distribution, consumption, or use of electrical energy (in this Act referred to as 'fittings'), and may provide all materials and do all works necessary or proper in that behalf, and may require and take such remuneration in money or such rents and charges for and make such terms and conditions with respect to the sale, letting, fixing, setting up, altering, repairing, or removing of such fittings, and for securing their safety and return to the Council as the Council may think fit, or as may be agreed upon between them and the person to or for whom the same are sold, let, fixed, set up, altered, repaired, or removed, provided that the Council shall not execute wiring on private property beyond the meters except through a contractor." This last clause has been inserted by the committee formed of the whole Council, and will preclude the Council from carrying out wiring on consumers' premises. They still, however, maintain the right to sell, hire, and fix every class of electrical device for consuming energy.

**London Telephones.** — The numerous complaints which have been made by correspondents in the columns of the *Times* about the inefficiency of the London telephone service were replied to by Mr. W. E. L. Gaine on behalf of the National Telephone Company on Friday last. In his letter Mr. Gaine explains the reason for certain of the implications made by Mr. E. G. King as being due to a want of understanding of the telephone system. For instance, when a calling subscriber is informed that the person to whom he wishes to speak is engaged, it does not follow that the person is using his instrument. It may mean that the junction of the wires required to get into communication with this subscriber is engaged. The paragraph in which Mr. Gaine refers to the American practice calls the correspondent's atttention to the following points, which he had omitted to notice: "(1) In New York there is no unlimited service, every call being paid for, with the result that thousands of trivial and useless calls which pass over the London wires and impede important traffic do not pass over the New York wires at all; (2) in New York the telephone is invariably handled by principals who take trouble to operate properly, whilst in London it is relegated to the office boy, who makes every conceivable operating mistake and causes confusion in a complicated and intricate system; (5) the charges in New York are just three times more than they are in London; and (4) in New York a man will have as many lines as are necessary to carry his traffic, in London a subscriber expects one line to carry five times the traffic it is capable of carrying." The complaint is also made that, whereas in America there is little difficulty in providing an efficient service, in London every possible impediment has been placed in the way of the National Telephone Company. The fault arises out of the fact that, while the company have for years had the license to give a telephone service, they have never had powers from Parliament to run wires either underground or overhead.

**Electric Glass Furnace.**—Electric furnaces are giving good results at the large glass factories at Matrei, in Tyrol, and at Plettenburg, in Westphalia. The accompanying

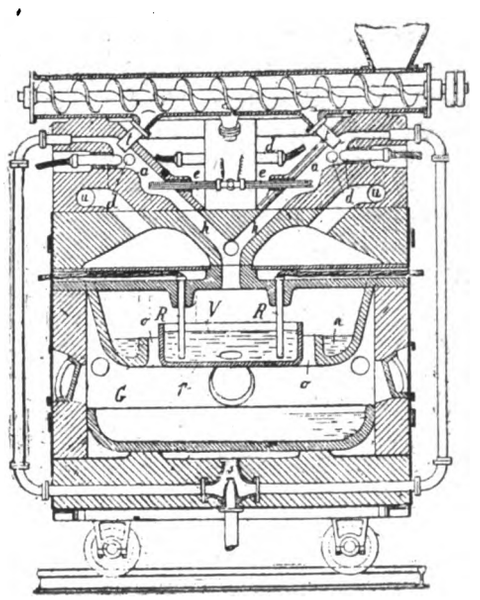


illustration shows the tubes, *t t*, through which the raw material enters the top of the furnace, whence it is conducted in front of the arcs, *a a*. The heat of the arc fuses the material, which then drops into the receptacle, V, where its temperature is considerably raised by means of the resistances, R. From V the molten glass, of its own accord, descends into the crucible, G, which is heated by an upward flame, P. The latter is formed by the gas which is developed during the fusion of the material. This gas is collected and conducted to P by means of the lateral tubes, *r*. Although this furnace has given satisfactory results, a new type has been constructed in which the raw material, before having been exposed to the heat of the arc, is made into

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a paste with water. It is then pressed and dried, and finally it passes, in the shape of a ribbon, through the arcs between a number of electrodes, out of which it emerges completely fused. The heating is chiefly done by radiation, and care is taken to prevent impurities from the carbon entering the molten glass.

**Electric Traction Tests at St. Louis.** — The commission appointed to supervise the electric railway and tramway tests at the St. Louis Exhibition is now complete in its organisation, and arranging for a most useful series of trials during the course of the year. Two tracks will be available for the purpose of the trials, one of which is 1,400ft. long and the other 2,000ft. Upon these tracks, which are parallel, it is proposed to carry out the trials on operating gear, acceleration, braking, coasting, motor heating, etc. Independent trials of car and train friction will also be made. In order to supervise this extensive work, four engineering sub-committees have been appointed. The first of these will deal with the tests on city and suburban equipments, the second committee will deal with interurban equipment, the third with tests of heavy traction equipments, while the fourth, which will perhaps have the most interesting work in hand, will deal with new electric railway systems. The chairman of this last committee is Mr. Bion J. Arnold. It is also hoped that facilities for conducting high-speed tests will be available, in which case the question of the train resistance at very high speeds will be investigated. It is also proposed to go into the question of the performance of cars equipped with controllers so arranged that the acceleration is automatic, as compared with the performance under similar conditions where the rate of acceleration depends upon the handling of the controller by the motorman. In the test on electrical losses an effort will be made to determine, of course, the average losses at different schedule speeds with a given rise in temperature, and with different periods of stops and lay-overs. The train resistance tests recommended are with single cars, and also with trains made up of different numbers of cars at various speeds, from 40 miles per hour upwards, and measured in different ways—viz., by direct measurement of instantaneous power input when running at uniform speed, and by the coasting method. In the test of control systems it is proposed to investigate not only the efficiency of different systems of control, but the effect of automatic acceleration on the power consumption, etc.

**Action of Light on the Velocity of Formation of Accumulators.**—As pointed out in a paper recently published in the French electrical papers, D. Tommasi had for some time past observed the striking fact that the negative plate of an accumulator, when exposed to the action of light, would form more rapidly than in the case of its being left in the dark. This reducing effect of light was observed in any case quite independently of the composition of the active mass contained in the accumulator plate, the density of the sulphuric acid serving as electrolyte, and the working temperature. In order to further ascertain the part played by the luminous energy in the formation of accumulators, Tommasi made the following experiment: Of two accumulators of his own type, consisting of a glass vessel, each filled with acidulated water and containing three negative and two positive plates, the one, A, was exposed to the action of sun rays, while the other, B, was placed into a paste-board box coated with tar and closed everywhere, so as to exclude any light rays. After having been mounted in series, the two accumulators were exposed to a charge of two to three amperes. Now, whereas in the course of the first 30 hours no appreciable difference was noted, the negative plates exposed to light after this time had passed were found to assume a more strongly grey coloration, whence it was inferred that they were further advanced. This difference in coloration due to the more or less great amount of reduced lead oxide, after first increasing, would become smaller, disappearing eventually as the negative plates were wholly reduced to spongy lead. From these experiments, which were repeated many times, the conclusion is that the negative plates of an accumulator, all the remaining conditions being identical, are formed more rapidly in the light than in the dark. This point being once established, the action of light on the positive plate was investigated by connecting together two accumulators similar to those above described, so that the two external plates were positive. One of the accumulators, A′, was exposed to the action of the light, while the other, B′, was left in the dark; both being connected in series, they were charged with from two to three amperes. After about 20 hours the positive plates left in the dark showed a much darker coloration, being more strongly peroxidised than the positive plate exposed to the action of light These differences in coloration showed a similar behaviour to the one above mentioned, thus giving evidence of the fact that the positive plates of an accumulator, all else being identical, are formed more rapidly in the dark than in the light. There are, in addition, permanent differences in coloration; positive plates as formed in the dark being dark brown, and those formed in the light, reddish brown. This may be observed even after several consecutive charges, but, finally, all the positive plates would assume the coloration of the plates formed in the dark. The same is true of the negative plates, which when formed in the light are lighter, whereas the capacity of the accumulator is about the same, no matter whether they are formed in the dark or in the light.

**Research on Contact Resistance.**—In a paper recently presented to the French Academy of Sciences, M. A. Blanc records his investigation of a contact resistance in a coherer consisting of a steel plate and a steel ball, the surfaces of which were carefully polished. The steel plate was supported by a rigid rod and the ball by a thin spring, so as not to touch the vertical plate in the vertical position of the spring. The contact was established by inclining the apparatus when the spring was bent merely by the weight of the ball; the pressure could be controlled readily by altering the inclination. If the apparatus be protected against any great vibrations, a resistance as high as 10,000 ohms and more was produced in this way. On suddenly passing through the coherer a current of a given intensity, the resistance, starting from a certain value would decrease continually for some hours, first rapidly and then more slowly, seemingly tending towards a limit. This progressive fall of resistance under the action of the current is termed by Mr. Blanc cohering by the current. The fall in the resistance due to cohering is irreversible, persisting even in the case of the current ceasing to pass, and being the higher and the more rapid as the intensity of the current is higher; small shocks will accelerate the phenomenon. If the cohering be nearly completed for a certain current value, it is completed entirely for lower currents, when the resistance becomes very stable. If, however, the current be increased, further cohering is produced, the limiting value of the resistance being the same as in the case of the actual current being established suddenly. For medium intensities of this current there is a region of maximum sensitiveness. Before any cohering has been produced the contact resistance appears to depend inversely on the intensity of the current traversing it, decreasing it for increasing currents. For a slight cohering nearly com-

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pleted, the resistance is found to vary inversely as the currents. For great cohering the direction of this variation is altered, the resistance decreasing for decreasing currents. Between both regions there is a degree of cohering for which the resistance is constant—*i.e.*, for which Ohm's law is available. The same results are obtained in the case of the cohering being produced by a spark. For a given current while breaking and next completing again the current will not have any appreciable effect, each reversal will produce in the beginning of the cohering a fall of resistance, continuing with a higher speed than before the reversal. As cohering goes on, the fall of resistance due to reversals, however, becomes less. Later on the resistance will, in the case of a reversal, first augment for a certain interval to diminish afterwards much more slowly, after a maximum has been reached. For a nearly completed cohering no effect is observed. The same phenomena are observed in the case of brass, though being less marked than in the case of steel. From the above it is inferred that a contact resistance has a character quite different from that of a metallic resistance, being a reversible function of the currents whenever no variation due to the passage of the current is going on. An irreversible diminution is noted in addition, whenever the resistance is traversed for an appreciable period by a current of sufficient intensity, the latter phenomenon depending on the direction of the current.

**A Phase Meter.**—In a contribution to the *Elektrotechnische Zeitschrift* Prof. A. Grau describes what he terms a phase meter. The alternating-current effect, $E_1 J_1 \cos \phi$, may be determined from the expression C W $a$ by means of

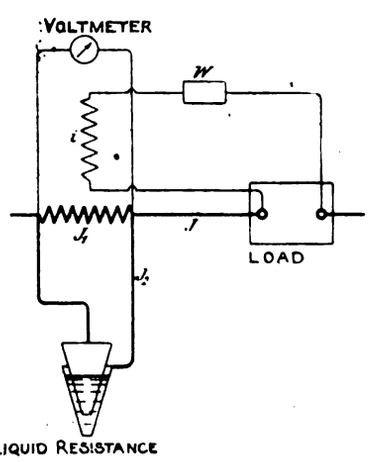


FIG. 1.

a wattmeter. Let $E_1$ represent the potential, $J_1$ the current, $\phi$ the phase distortion between current and pressure, C the constant of the instrument, W the total resistance offered by the moving coil and the non-inductive load, and $a$ the angular torque. If $i$ be the current flowing in the moving system, then since $E_1 = i$ W, we may write the equation $E_1 J_1 \cos \phi = C W a$. Thus $J_1 i \cos \phi = C a$. Now, if we could so arrange matters that the current, $i$, in the moving coil and the current, $J_1$, flowing through the fixed coil remained constant with different outputs, then the instrument would serve to give the value for $\cos \phi$ direct. To attain this end we make the fixed coil of the wattmeter of manganin, the resistance of which may be exactly determined, and connect the ends of the coil with a suitable voltmeter. Since the resistance of the coil remains constant within wide limits, the deflection of the voltmeter will serve to determine the current passing through the fixed coil. If a constant deflection is obtained, we know then that the current $J_1$ is constant. To maintain $J_1$ constant, or, in other words, to render it independent of the demand in the external circuit, a liquid resistance is connected in parallel with the fixed coil (Fig. 1). As this resistance and the fixed coil, consisting of a few turns, may be regarded as approximately non-inductive, it follows that the two currents $J_1$ and $J_2$ coincide in phase with each other and with the resultant current, J, sufficiently for our purpose. Hence, without appreciably altering the resultant current, J, required in the external circuit, we may so regulate the liquid resistance as to maintain $J_1$ constant despite a varying value for J. Similarly, in the case of the current $i$ we can maintain this constant by varying the resistance in circuit with the moving system as required. The value chosen for this resistance must be such as to render the self-induction of the moving coil a negligible quantity, the current $i$ being in phase with the potential, E, in the external circuit and $J_1$ with J, as before. Hence, assuming $J_1$ and $i$ constant values, we obtain

$$\cos \phi = \frac{C a}{J_1 i} = K a \text{ K}, \frac{C}{J_1 i} \text{ being a constant.}$$

By multiplying the reading taken from the instrument by the constant K we therefore obtain the power factor $\cos \phi$. If we add a second scale to the instrument, making one division $= k$ divisions of the original, this power factor may be read direct. A third scale may be introduced to enable the angle $\phi$ to be at once determined from the deflection obtained. The instrument is now a direct-reading phase meter. If, on the other hand, the resistance of the moving system cannot be regulated so as to keep $i$ constant for different potentials, $E_1$, then $i$ will vary with $E_1$, and, as a consequence, the constant $K = \frac{C}{J_1 i}$ will also vary. But if the variation in the pressure be known, the corresponding

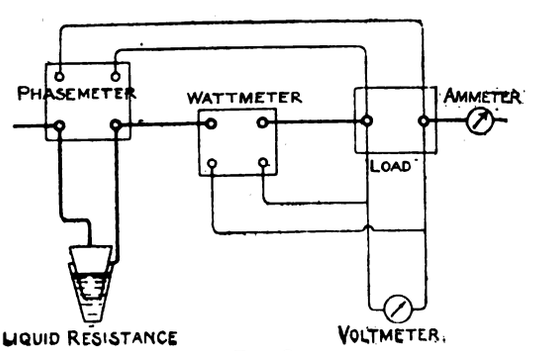


FIG. 2.

value for K may be readily determined. Hence the instrument is not only suitable for a certain normal working pressure, but may be used over a fairly wide range. Working on the above lines, an existing wattmeter was provided with a manganin coil of 0·0303 ohm resistance, and connected up to a voltmeter and a liquid resistance, the whole arrangement (shown diagrammatically in Fig. 2) being then subjected to a series of tests. The voltmeter employed must be sensitive, to enable accurate adjustment to the constant $J_1$. The liquid resistance is short-circuited before taking a measurement, and subsequently adjusted until the exact value for $J_1$ is indicated. In order to check the readings, the angular phase distortion, $\phi$, was calculated from the output in watts, current, and potential. The estimated and measured values for $\cos \phi$ are given in the following table:

| Output in watts. | Current in amperes. | Voltage. | $\cos \phi$ Estimated. | $\cos \phi$ Measured. |
|---|---|---|---|---|
| 135 | 7·3 | 107 | 0·172 | 0·179 |
| 820 | 8 | 107 | 0·958 | 0·965 |
| 528 | 12·7 | 107 | 0·389 | 0·384 |
| 860 | 14 | 107 | 0·574 | 0·568 |
| 685 | 19·7 | 107 | 0·325 | 0·302 |

With 107 volts working pressure the instrument's constant was K = 0·004088.

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## ELECTRIC LIGHTING AND TRACTION AT WEST HAM.

In our last issue we made a brief reference to the formal opening of the new electricity works at West Ham, which are supplying electrical energy for light and power and also the electric tramways within the borough. The opening of these works places West Ham on a line with quite a number of other large towns in which the original electricity works have been found to be too small and incapable of economical extension. The original works were designed by Mr J. J. Steinitz, the first borough electrical engineer of the Corporation, and supply was commenced in December, 1898. When Mr. Steinitz resigned in July, 1899, his chief assistant, Mr. Jas. K. Bock, was appointed borough electrical engineer, and he has been responsible for all work done since that date. The present electricity works will serve as a fitting monument to his energy, as Mr. Bock is now leaving the service of the Corporation to carry out some important work at Buenos Ayres for Messrs Livesay, Son, and Henderson. Mr. J. W. Bullock, who has up to the present acted as chief assistant and mains superintendent, has been appointed his successor.

When the old works were found to be too small it was at first thought they could be extended, but this would have involved the pulling down of a number of cottages and the diversion of a road. The Corporation were accordingly advised that it would be more economical to erect an entirely new generating station on the site of the old sewage pumping works at Canning Town. This has been done, and the following particulars as to the equipment will draw the attention of our readers to noteworthy points in Mr. Bock's design. The system of supply already in use for lighting was single-phase alternating with a periodicity of 50 cycles per minute, and in preparing the new scheme Mr. Bock gave special consideration to the advisability or otherwise of adopting a two or three phase system of distribution for lighting and traction, but owing to the extent to which the Corporation were already committed to the single-phase system, the advantages of the former system did not appear sufficient to justify the very heavy additional expenditure which would have been entailed in the conversion. It was consequently decided to retain the single-phase system for lighting purposes, and to instal a direct-current supply for traction purposes.

The new power station is on the banks of the River Lea, about 1½ miles from the old station, and consequently the changing over was no easy matter. After some preliminary trouble in synchronising the alternate-current machinery in the two stations, they were got to work perfectly in parallel. The plant stands on what was the site of a number of sewage settling tanks, and the remainder of these tanks are used as cooling ponds for the condensing water (as shown in Fig. 1). By means of weirs the circulation of the water through these tanks can be varied. The boiler-room plant now consists of 17 boilers, of which six have been removed from the old works. Fig. 2 shows the arrangement of the boiler-room in plan, but we have only illustrated a small portion of the same in order that the details may be more clearly seen. Fig. 3 is a section through the boiler-room and engine-room The boiler-room is designed to contain 22 boilers eventually. As will be seen, they are arranged in two rows, with the firing floor between. Over this firing floor (Fig. 4) are the overhead bunkers, capable of holding 1,600 tons of coal, from which coal is discharged into the chain grate hoppers or on to the floor, as required, by means of travelling weighing swivelling shoots. The coal used is Welsh washed peas on the hand-fired and washed nuts on the chain grates. Coal is delivered into the bunkers direct from barges in the River Lea by means of a Temperley transporter driven by a 30-h.p. continuous-current motor, the whole operation of lifting, weighing, travelling, and tipping being performed by the crane driver in the motor-house.

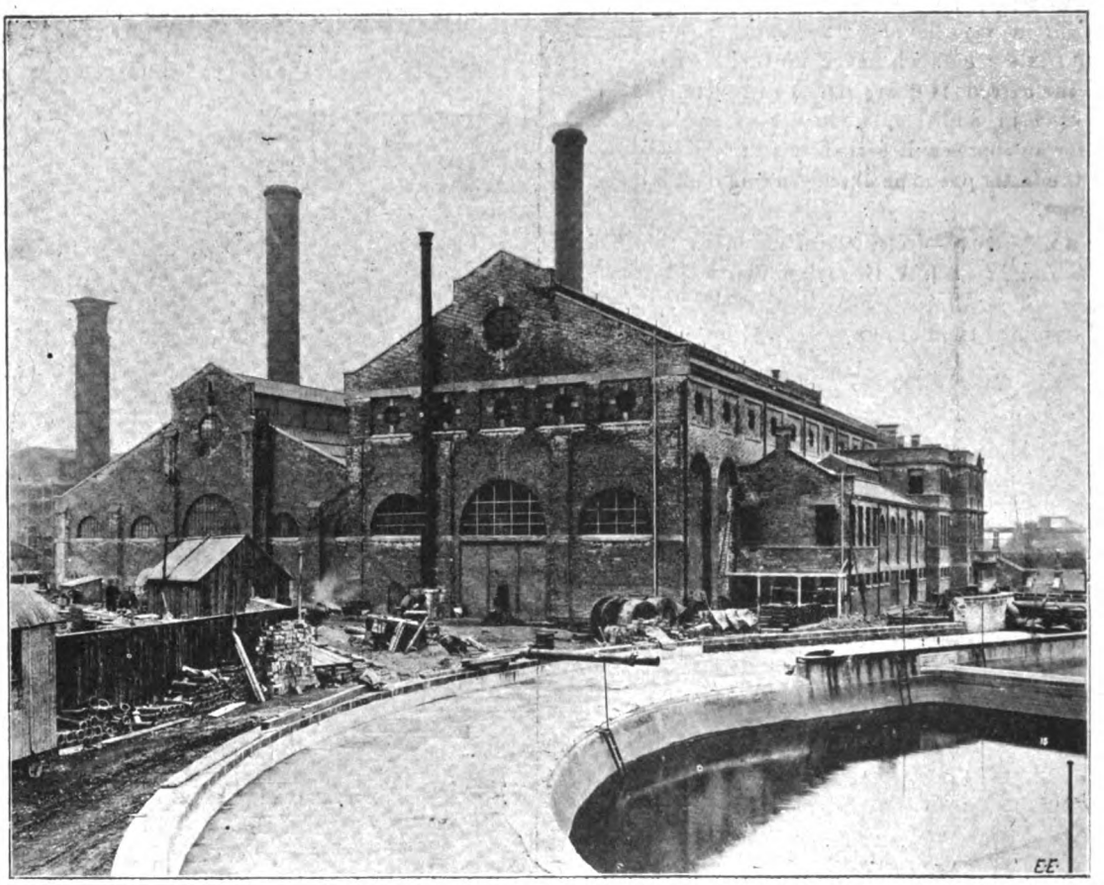

Fig. 1.—Exterior View of the Works. The old sewage tanks in the foreground have been converted into cooling ponds for the circulating water.

Only four of the boilers are fitted with mechanical stokers, as it was found in the old works that much better results can be obtained with hand firing. All the boilers are of the Babcock and Wilcox types, and they are fitted with that firm's superheaters. Purifiers are fitted to each boiler as an additional safeguard to catch any solid matter or oil which might escape. The ashes from the firebars drop into a sloping firebrick-lined chamber, from which they are discharged into trucks in the ash tunnel underneath the firing floor. The ash tunnel is open at either end, and

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the ashes may be picked up on the Temperley coal transporter and delivered into carts or barges as required.

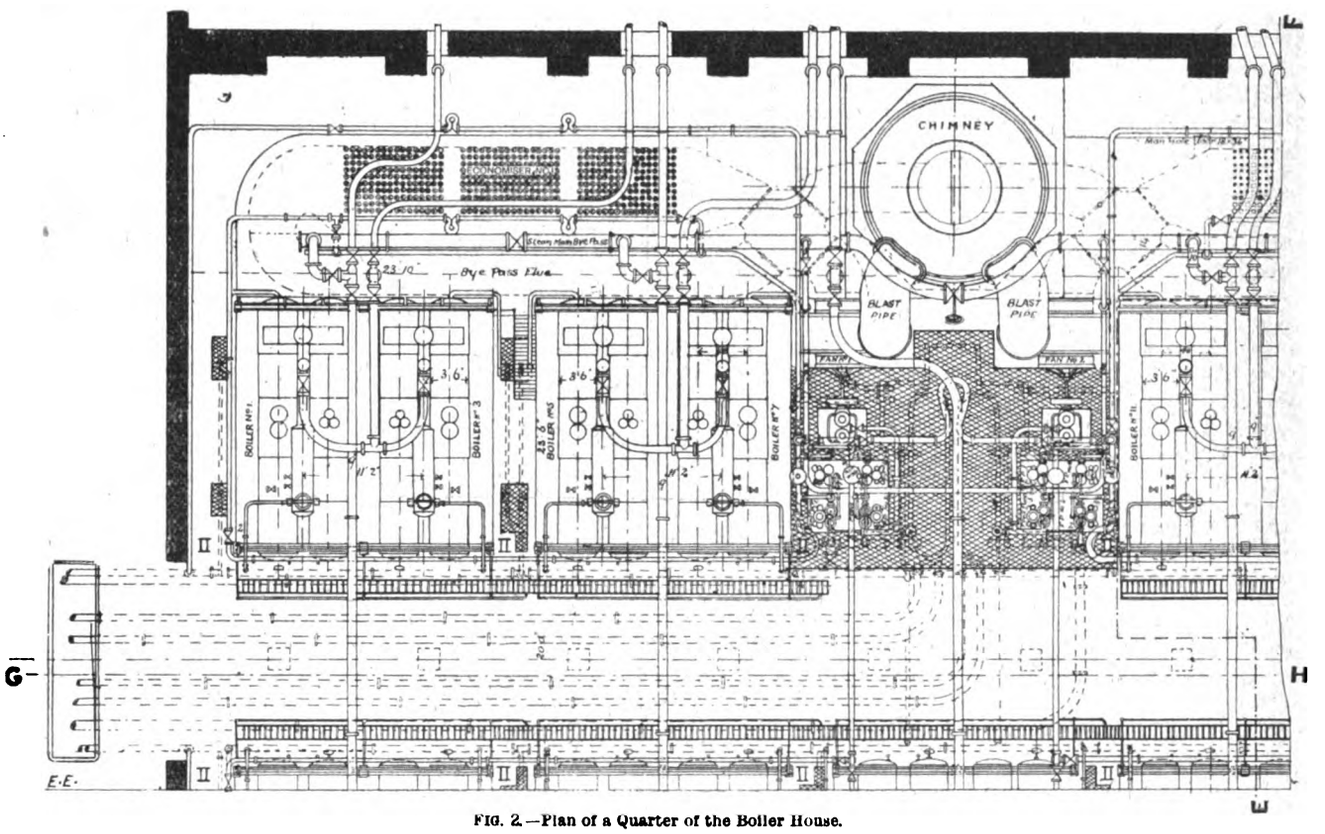


FIG. 2.—Plan of a Quarter of the Boiler House.

The boilers are arranged in four independent groups, there being two chimney shafts, one for each side of the boiler-house. The chimneys are of steel, 120ft. high. The internal diameter of the one is 10ft. and the other 8ft. 6in. Up to the present these boilers are working on natural draught, but the induced-draught apparatus seen in Fig. 5 has been provided and will be required to get the full output from the boilers. Each unit of boiler-house plant has its own economiser, and the induced-draught fan is of the "Sirocco" type, made by Messrs. Davidson and Co., of Belfast. These fans are driven by 60-h.p. compound Allen engines. The arrangement of the swivel dampers by which the economisers can be by-passed, or the change made from natural to induced draught, can be seen in Fig. 2. The boiler-house feed pumps consist of two Hall's compound tandem pumps and two Weir single pumps each capable

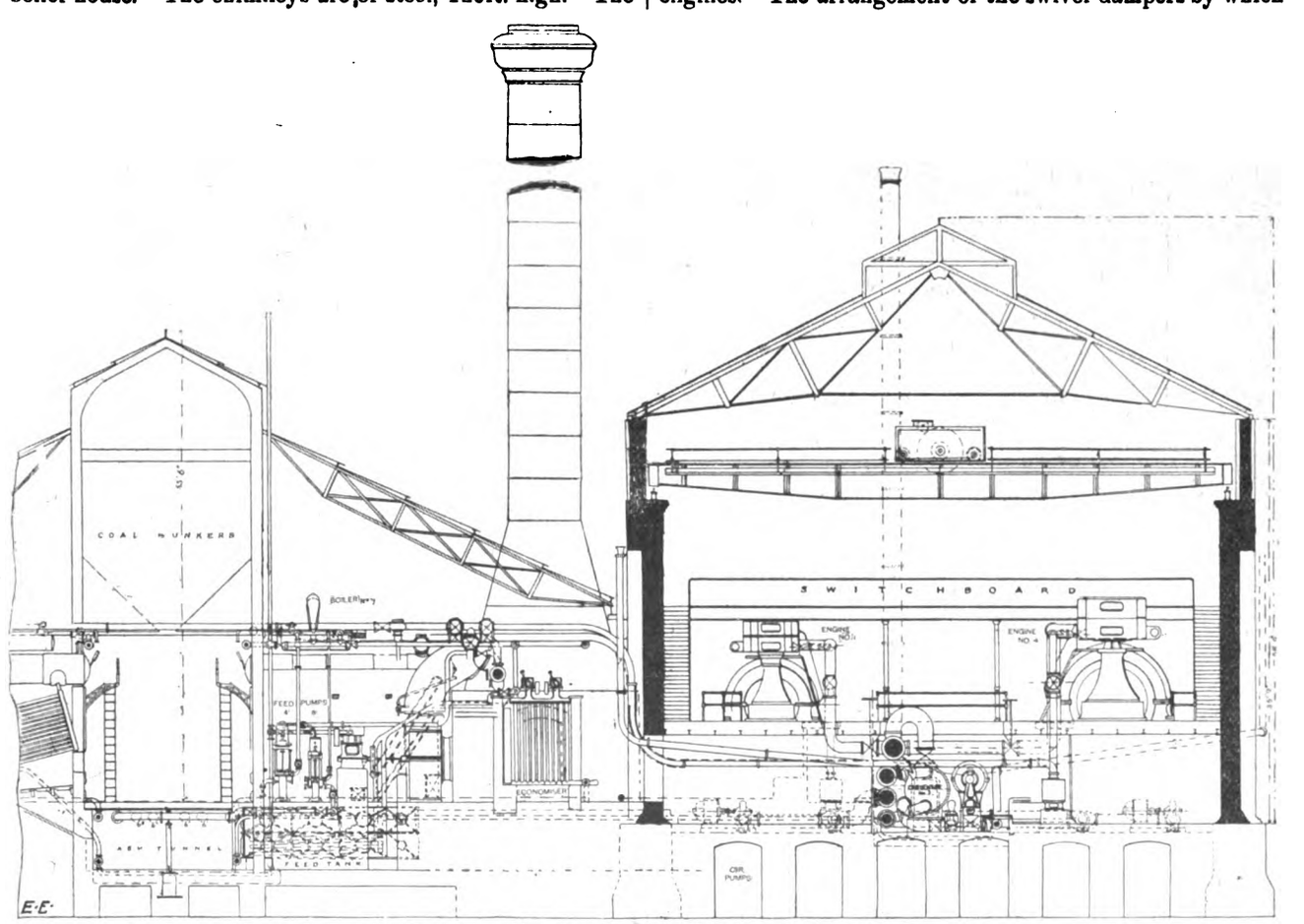


FIG. 3.—Sectional Elevation through the West Ham Electricity Works.

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of delivering 6,000lb. of water per hour, and four Weir single pumps capable of delivering 30,000lb. of water per hour each. The pumps are all fixed in a space in the centre of one side of the boiler-house round the feed tank. The feed water is discharged through a Green's economiser to the boilers. The exhaust steam from the feed pumps and fan engine discharges through two copper heating coils, composed of 4in. copper tube 90ft. long, in the feed tank.

The steam and exhaust pipe arrangements have been most carefully thought out with a view to obtaining maximum security against interruption. As will be seen from Fig. 2, the boilers are connected together in pairs by means of a common pipe, which, if desired, can be isolated and supply direct on to a certain engine. The connection from this pipe into the same main by-pass enables these boilers to supply other engines. In order to prevent any possibility of a rush of water finding its way to the engine cylinders, the pipes are arranged to drop the whole way from the boilers to a separator fixed in the basement 3ft. below each engine, from which a steam-pipe rises vertically to the engine stop valve. A main header 14in. internal diameter runs the whole length of the boiler-house, and each steam-pipe has a branch into the header, so that, if desired, the boilers can all feed into this common main. This system gives great flexibility and security with a minimum of piping. Cast-steel pockets are fitted to the header underneath each branch supply pipe. These pockets are fitted with gauge glasses and shut-off cocks, and are connected through Geipel steam-traps with by-pass pipes to a main 4in. drain running parallel to and immediately beneath the main header.

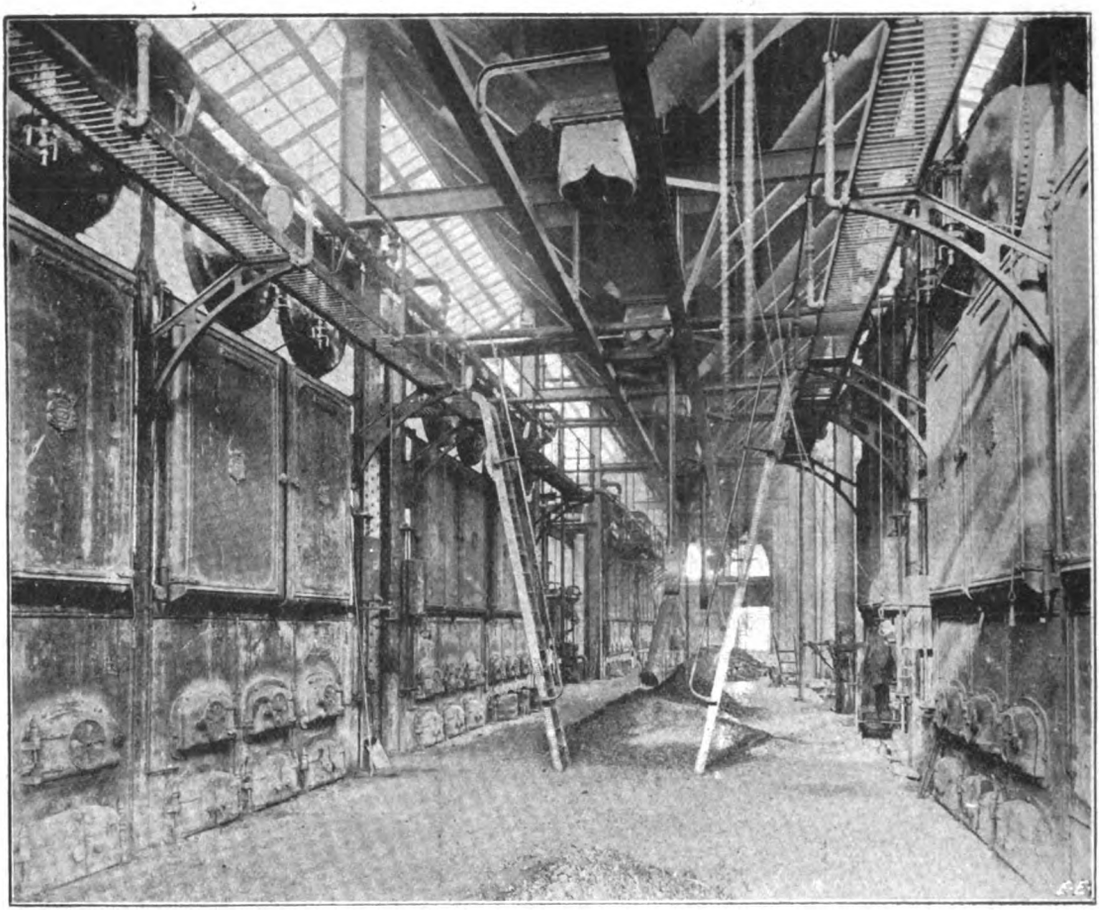

FIG. 4.—The Firing Floor in the Boiler House.

The engine-room plant, as mentioned above, consists of alternate-current machinery for lighting, and direct-current machinery for the tramway load. As will be seen from Fig. 6, the engines are arranged in two lines, one on either side of the engine-room, with the condensers and air-pumps in a capacious trench in the centre and below the floor level. The switchboard gallery is erected at one end of the room at about 15ft. above the floor level, with an office for the assistant in charge opening off one end, and an opening at the opposite end from which an iron stairway gives access to a raised platform running along the end of the boiler-house. The assistant in charge consequently has the whole system under easy supervision. Underneath the switchboard gallery and on the engine floor level is a space reserved for four Ferranti rectifiers and the traction negative and differential boosters. Beneath this space in the basement are placed four centrifugal pumps, which supply the circulating water to the condensers. A travelling crane, driven by an electric motor and capable of lifting and carrying 30 tons, spans the engine-room. Space has been left to erect three additional generators of 2,000 h.p. or more each as required. The generators at present installed consist of two 300-kw. engines and alternators, running at 250 revolutions per minute; two 600-kw. engines and alternators, running at 225 revolutions per minute; two 1,200-kw. engines and alternators, running at 250 revolutions per minute; three 500-kw. engines and alternators, running at 175 revolutions per minute. The engines have all been manufactured by Messrs. Ferranti Limited, Hollinwood, and are cross-compound, vertical, condensing, fitted with this firm's well-known patent valve gear and grid valves. The alternators are Ferranti single-phase, disc type, generating current at 2,000 volts, 50 periodicity. The continuous-current tramway generators have been manufactured by Messrs. D. Bruce Peebles and Co., Leith, and are compound-wound.

The whole of the condensing plant has been supplied and manufactured by Messrs. W. H. Allen, Son, and Co., of Bedford. The air and circulating pumps for the new plant are electrically driven by means of continuous-current 500-volt motors. No gear is used, the motor armatures being connected direct to the pump shafts. The plant consists of four surface condensers, 4,000 square feet cooling surface, fitted with Edwards type three-throw air-pump, with auxiliary force pump; four 15in. electrically-driven centrifugal circulating pumps; two surface condensers, 2,000 square feet cooling surface, fitted with combined air and circulating pump, driven direct by compound steam-engines. The air-pumps on the large condenser are driven direct by 15-h.p., shunt-wound, 500-volt, continuous-current motors. These pumps discharge into a cast-iron tank fitted to each condenser, from which an auxiliary force pump, driven off the air-pump crankshaft, discharges the greasy water to a Harris Anderson purifier situated outside the engine-room,

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This purifier, which is capable of dealing with 16,000 gallons of water per hour, is a most interesting one. Its operation may briefly be described as follows: As the condensed water enters the purifier, 1 per cent. is mechanically withdrawn and passed into a receptacle containing washing soda. After passing up through this and becoming saturated with soda, this 1 per cent. is mixed with one-half of the condensed water. In the same way another 1 per cent. of the original water is passed through a receptacle containing alum, and then mixed with the other half of the condensed water. After this has been done the two portions of the water are allowed again to mingle, and as a result the oil is thrown down in a flocculent precipitate which can be filtered. The apparatus is quite self-regulating, and converts the oil in suspension into a satisfactory state for filtering. The apparatus is regulated so as to get, if anything, an excess of soda in the effluent. The two filters are filled with wood wool, and the only attention necessary is that required to reverse the flow of water through the filter one or twice daily in order to remove the accumulation of greasy sludge from the filtering medium and to recharge the chemical tanks. The cost of treating the water is said to be about ¼d. per 1,000 gallons, and the results are extremely satisfactory, there being absolutely no perceptible trace of oil in the water after treatment.

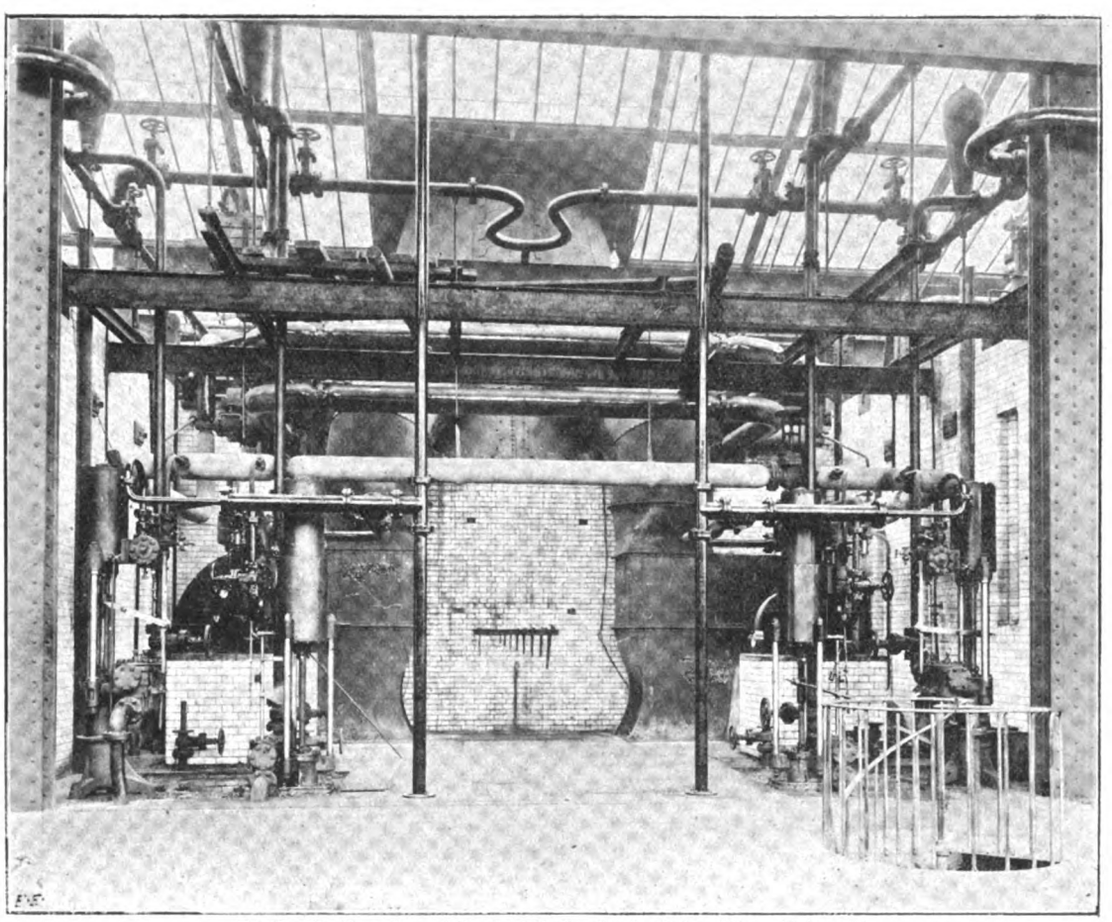

FIG. 5.—The Base of one of the Steel Shafts, showing Induced Draught Apparatus

The circulating water is taken from the cooling ponds before mentioned. A pipe, 3ft. in diameter, is laid from the channel, into which all the ponds drain, to a suction tank outside the end wall of the engine-room. Four 15in. centrifugal pumps, direct coupled to 15-b.h.p. motors, take the water from this tank, each pump having an independent suction pipe. These pumps are all below the level of the water in the suction tank, so that there is no difficulty in flooding same. The centrifugal pumps discharge into two 24in. mains, each of which supplies two of the large condensers. The steam condensers have independent suction pipes. The water-softening plant used to deal with the make-up water is of the Archbutt-Deeley type, and has been fixed by Messrs. Mather and Platt.

The electric lighting switchboard (Fig. 7) is of the Ferranti type, and needs no special mention in consequence. The old Ferranti board from the Abbey Mill station is shortly to be moved to the new works. The traction switchboard has been supplied by the British Thomson-Houston Company, and is of their standard pattern. It is equipped with a spare positive 'bus bar, and all the switches are arranged to throw over to either 'bus bar. There are four 1,000-ampere generator panels, fitted with maximum and reverse current circuit breakers, integrating wattmeters, and the necessary switches and instruments, eight feeder panels, Board of Trade, main, battery, negative, and station circuit panel. A differential booster, manufactured by the Lancashire Dynamo and Motor Company, is supplied, to be used in the battery circuit, also a 12-kw. negative booster to be used for boosting on one of the longest negative returns.

A battery of Tudor accumulators, having a capacity of 200 amperes at 500 volts, has been installed, and will be used for a great variety of purposes. Its principal function will be to ensure the supply to the station motors and the street and station lighting, which are supplied from the switchboard in such a way that any failure or fluctuation in current supply to the main board will not affect these circuits.

For distribution, sub-stations are chiefly used which are divided into two sections—one containing the transformers and the other the switchgear, with an iron door between. Ferranti high-tension switchgear is fitted, and only concentric cables are used in making connections. The chambers are as safe as it is possible to make sub-stations, and, together with the transformer tanks and switch boxes, are maintained in excellent condition. No disconnecting boxes are used in any of the high-tension cables, nor are these broken anywhere excepting in transforming chambers. The original mains were broken every quarter of a mile by plug switch disconnecting boxes, but it was found that the only breakdowns that ever occurred in the mains were caused by the very boxes which were installed with the object of localising such faults. Mr. Bock had all the old boxes removed and the cables jointed through three years ago, and no trouble has been experienced since.

There are at present 100 rectified arc lamps, 45 parallel enclosed, and 15 series enclosed lamps. The tramway routes will all be lighted by continuous-current series open-

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type lamps arranged either 6 or 11 in series according to type of lamp, and supplied by mains direct from switchboard, the rails being used for the return. The rectified lamps are supplied by the Brockie-Pell Company, and all enclosed and continuous current lamps by the British Thomson-Houston Company.

### Electric Tramways.

Mr. J. Edward Waller, of the firm of Messrs. Kincaid, Waller, Manville, and Dawson, has advised the Corporation of West Ham on their tramway system, and the whole of the track work has been carried out to his specification. Mr. Bock has been responsible for the electrical equipment, including the overhead work, tramcars, feeder cables, and generating plant. It will be remembered that at West Ham the noted Ilford decision was reversed. When the Corporation commenced to put down tramways, the gas company demanded not only that all pipes which would be under the track should be moved, but also that duplicate gas-mains should be laid on either side of the road in order to avoid the frequent crossing under the track of service pipes. They claimed all this under Section 30 of the Tramways Act. Mr. J. E. Waller advised the Corporation to dispute the gas company's reading of the clause in question. The Board of Trade appointed as arbitrator the Hon. Alfred Lyttleton, who was naturally more competent to decide as to the correct interpretation of the Act than an engineer would be. The result quite justified Mr Waller's advice, as the gas company lost their case and had to pay the cost of the reference and of the award. The full text of this award will be found in our issue for Aug. 7 last year.

As regards the feeding arrangements, all the cables have single cores and are paper insulated. They were manufactured by the British Insulated and Helsby Cables, Limited, and have been drawn into 3in. earthenware conduits with Stanford joints. The mains for lighting and tramways have been laid simultaneously, but the conduits and pulling-in boxes have in each case been kept distinct, as will be seen by the illustration (Fig. 8). The sizes of the positive feeder cables are ·75, ·6, ·4, and ·2 square inch; the two negatives ·75 and the line sub-feeders ·2 and ·15 square inch section. The negative feeder pillars are fixed, one at Canning Town station, at the point of the rails nearest to the works—*i.e.*, 860 yards distant—and the other at Church-street, a central point, 4,280 yards distant. The negative 'bus bar at the works is not "earthed," the earth connection being made at the negative pillars. The negative feeders are connected to the rails at Canning Town by twelve 0000 S.W.G. copper bonds, and at Church-street by eight No. 0000 S.W.G. copper bonds, and also at both places through recording ammeters to the water-mains.

The contractors for the overhead equipment are Messrs. Macartney, McElroy, and Co., of Westminster. Very heavy trolley wire has been used—*i.e.*, No. 0000 S.W.G.—and the fittings are proportionately heavy, and, notwithstanding the difficulties consequent on the erection of this wire, the contractors have made a very neat and satisfactory job of the work. The trolley wire is anchored on either side of each section insulator and splicing ear on the "vertical plane system," and Mr. Bock has adopted this system on curves by anchoring the bracket arm to the pull-off pole and the trolley wire to the bracket. Side-pole construction has been used throughout, except at curves, crossings, and roads, necessitating a bracket arm of over 20ft.

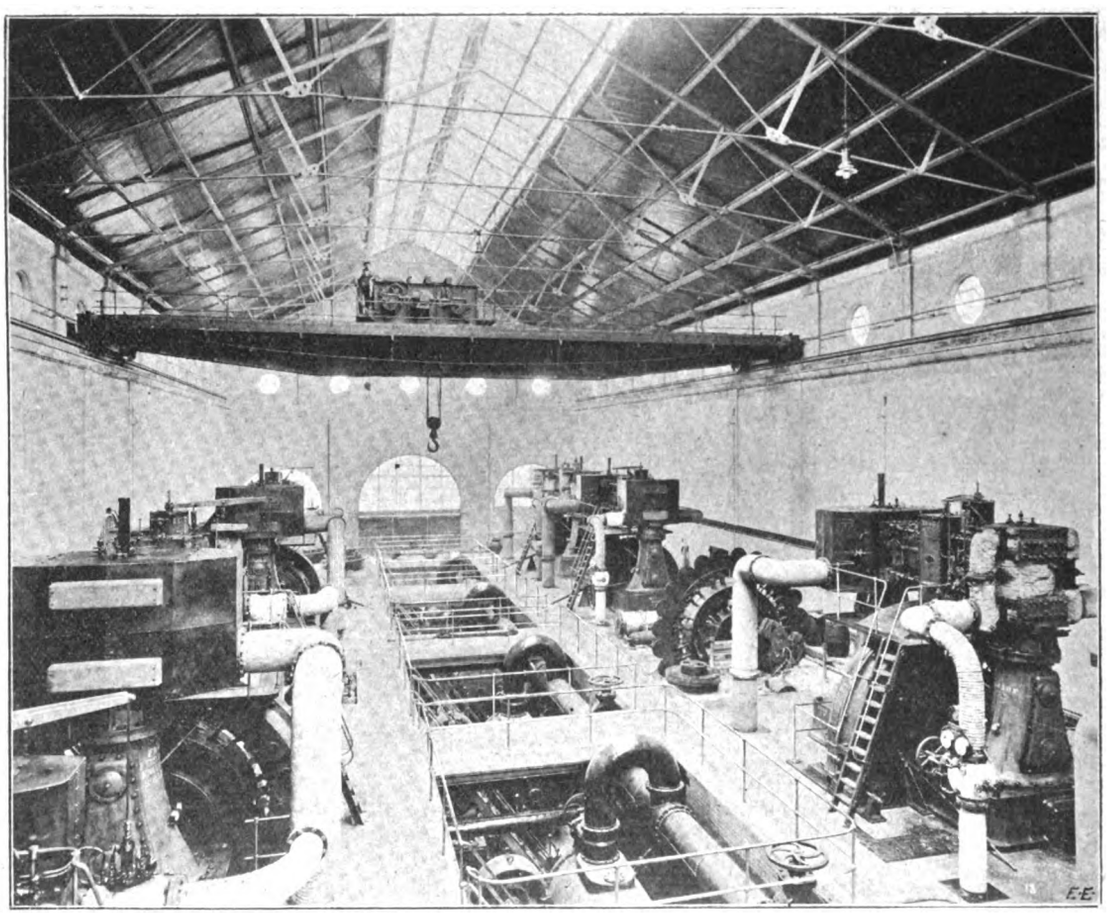

Fig. 6.—View of the Engine Room at West Ham, taken from the Switchboard Gallery.

A complete system of telephones has been installed on the General Electric Company's system, each feeder and section pillar being provided with a small door in the upper panel, which when open exposes a plug contact, to utilise which portable telephone sets are provided on each car. Pilot wires are run to the end of each route from the generating station, which register the drop of pressure between these points and the station.

A contract for 50 cars was given to Messrs. Witting, Eborall, and Co., Limited, the sub-contractors being as follows: car bodies, Messrs. G. F. Milnes and Co.; trucks, the Brush Electrical Engineering Company; controllers, etc., the British Thomson-Houston Company. The cars have a seating capacity of 56—34 outside and 22 inside. The cars are finished plainly, but at the same time in the best manner, no cushions or curtains being used. The seats are of three-ply birch veneer, perforated, and the roof of birdseye maple. The staircases are of Messrs. Milnes's

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well-known ordinary type with overhead canopy, giving the advantages without the disadvantages of the reversed staircase. The seats on the canopy have been arranged in rather a novel manner around the end of the deck, providing a roomy landing for passengers and also an additional seat. This arrangement was made to the designs of Mr. Bock. Each car is fitted with two 25-h.p. Witting series motors, specified to have a drawbar pull of 1,200lb. at the periphery of a 30in. wheel at a speed of eight miles per hour for a period of one hour with a maximum temperature rise of 75deg. C. Tidswell lifeguards, hand and rheostatic brakes, Blackwell swivelling trolley, and B.T.H. series-parallel controllers are fitted, and also Garton lightning arresters and automatic switches.

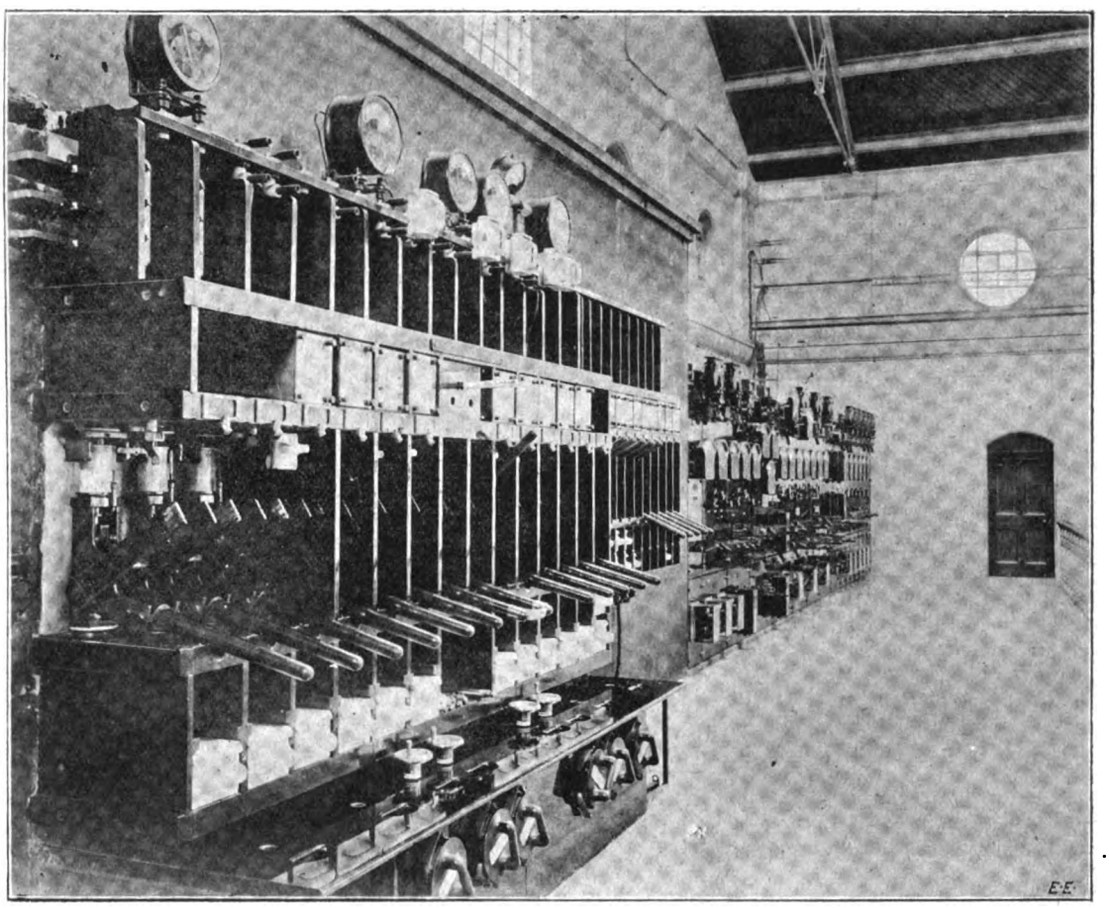

FIG. 7.—Ferranti Switchboard and Tramway Boards at West Ham.

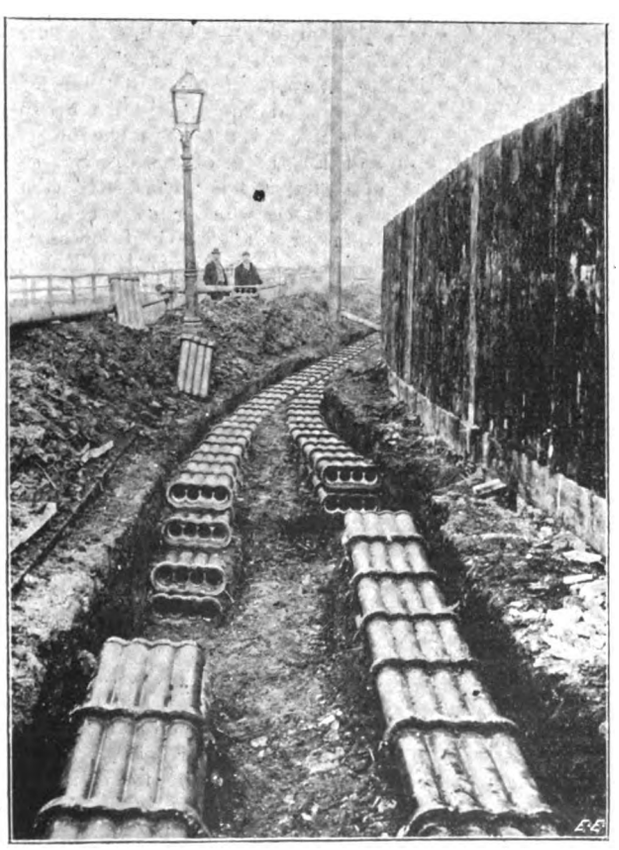

FIG. 8.—Lighting and Tramway Conduits as laid by the Electricity Department.

The track has been laid by Mr. Fred Osman, of Southampton, to the specification of Mr. J. Edward Waller, the work being superintended for Mr. Osman by Mr. William H. Davis. Mr. H. E. Blain, formerly of the Liverpool Corporation, is tramways manager, to which position he was appointed in July, 1903.

It is hoped to arrange in the future through running with the London County Council, so that there will be no need for passengers to change cars when entering the borough. The photographs from which the above blocks were prepared were taken by Messrs. W. E. Wright and Sons, of 65, Woodgrange-road. We have to thank Mr. Bock for most of the above information and for showing us over the works.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 567.)*

*Theory of the Action of the Filings Coherer.*

The action of the coherer may be briefly described as follows. Suppose a sending and receiving plate on the top of a pole, connected through a single spark-gap to the earth—this is like a Hertz vibrator with its axis vertical, and its lower plate replaced by the earth—or a pair of plates may be used, one charged and the other at zero potential. Some of the lines of force due to the one plate no doubt extend to the other. The spark passes with a sudden discharge, which is in effect like the rush of an opposite charge into the sending plate, disturbing the electric equilibrium to a great distance, and having an effect—very small, it is true—on the distant plate and conductor. If the latter plate is separated from the earth by a coherer, the minute jerk or

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sudden disturbance of electric equilibrium is felt by the coherer, it is rendered much more conducting) some investigators think that small sparks passing between the particles of filings aid in this effect), and a current passing works the relay, giving a signal. A tapper to give mechanical shocks to the coherer, so as to restore it to its original condition, is provided for instruments of the non-restorative class. Dr. Lodge suggests that the eye has a sensitiveness of the coherer order, some part of the retina maintaining an E.M.F. which is prevented from stimulating the optic nerves by an intervening badly conducting material, which in turn is made much more conducting by the ether waves of light falling upon it.

*Dr. Bose's Theory of the Coherer.*—It is only right to add that Prof. Jagadis Chunder Bose, the great Indian scientist, who has made a special study of Hertzian vibrations and coherer action, gives a different explanation of the action from that usually accepted. He says the alteration of resistance is due to a kind of allotropism, and not to cohesion or the formation of vapour arcs. The metal filings in a coherer are like a metal in a very unstable condition, which only requires a slight strain to throw it off its balance. In most cases the effect of the strain due to Hertzian waves is to *lower* the resistance of the coherer, but as Dr. Bose points out coherers can be made in which the resistance *rises* on receipt of the vibrations—this being especially the case with metals like potassium, sodium, lithium, etc. Coherers formed with these metals tend to de-cohere themselves. It is only right to add that Dr. Bose has been found to be right, as regards decrease of resistance being limited to some metals only, and his theory may be the correct one. It is very similar to that given by Prof. Minchin for his cells.

*Cell Detectors.*

These are often classed with coherers, and certainly there are many points of similarity. Some are self-restoring (as the De Forest electrolytic cell), but others, such as those now to be described, are not. Prof. Minchin, working at Cooper's Hill with his sensitive photo-electric cells, found that they behaved curiously when Mr. Gregory worked an electric Hertz radiator in the next room, and that an electrometer connected to his cells responded to the discharges of the radiator. He was able in this way to signal over considerable distances without connecting wires even at that early date (1888-9). The reason of the action of the cells is obscure—it may be a chemical one, though Dr. Lodge classes it with that of the coherer. The cells are described below under a separate heading. The sensitive photographic plate has also been used as a detector. Explosive gases may be ignited by the spark due to Hertz waves, and form another, though not practically important, chemical means of revealing the incidence of such waves. Selenium cells, which are very sensitive to light, have also been tried, but, so far as we know, without success. The reader may wish to know what a selenium cell is. Crystalline selenium has its resistance considerably reduced by the action of light. Selenium in narrow strips, arranged between broad conducting plates of brass, giving a large surface for exposure to light, form one kind of selenium cell. When in the dark a new form of this cell may have a resistance of, say, 120,000 ohms, but after exposure to light its resistance is only 1,500 ohms, and later cells have even a wider range. This curious property of selenium has been used in the *photophone*, an apparatus which transmits sounds to a distance by means of a beam of light, reflected to the distant station by a very thin mirror vibrating under the influence of the voice like the diaphragm of a telephone. The reflected beam falling with varying intensity on a selenium receiver in circuit with a small battery and a telephone, sounds are reproduced in the telephone by the variation of the current due to the variations of resistance in the selenium.

A young German scientist, Herr Ernst Ruhmer, has recently greatly improved this method of transmitting intelligence, and has invented a cell having a variation of resistance of about 1 : 200 between darkness and light, and whereas the older cells required from 10 to 12 hours to return to their original condition, the new cell is restored in a few minutes. These cells are cylindric in form, and can be placed in the focus of the receiver, which is a parabolic mirror. Thus the cell receives the light uniformly, being enclosed in an exhausted thin glass tube or globe. The transmitting light consists of an arc searchlight. Herr Ruhmer uses a telescope in combination with the transmitting reflector, and by this means, having the optical axes of the two instruments parallel, gets over the difficulty of keeping the positive crater of the arc in proper focus. He has been able to convey articulate messages over a distance of about 10 miles.

It is also worthy of note in passing that Prof. Garbasso, of Turin, has recently found the action of sunlight to be such as to greatly facilitate the passage of electric sparks. The effect of the light continues for some time after the light is cut off. Focussing the light on the negative electrode gives a nearly continuous current at a distance at which sparks would hardly pass in the dark. Screens of mica, glass, or alum solution check the action of the light, but plates of quartz or Iceland spar allow the action to take place through them.

*Prof. Minchin's Impulsion Cells.*—These constitute one of the most interesting, as they were among the earliest of the detectors of Hertzian vibrations. They were constructed of strips of pure stiff tinfoil, 1in. long and $\frac{1}{8}$in. broad, which, having been cleaned first with sodic hydrate, then with dilute hydrochloric acid, and thoroughly washed in distilled water, were then coated with a solution containing 500 cubic centimetres of distilled water, three cubic centimetres of pure nitric acid, and 15 grm. of nitrate of ammonia. When the plate is covered with the solution, a whitish deposit is thrown down on its surface, the deposit being allowed to form for about four minutes. The glass plate on which the tinfoil rests is uniformly heated with a spirit lamp until the liquid on the tinfoil is evaporated. Continuing the heating process, the surface of the tin on which the deposit is assumes first a dull slaty look, then a whitish aspect, rapidly changing to a dark colour with a tinge of green as the heating goes on, until finally the green shade having passed over the foil, the dark surface changes to a strong white, when the plate should be plunged into alcohol. It is now in a very sensitive condition. If suspended from a platinum wire, and placed in an alcohol cell in front of a similarly suspended clean tin plate—the plates being connected to the poles of an electrometer, whilst the cell is screened from light—a small difference of potential is observed, the sensitised plates being positive to the unsensitised, but this difference of potential disappears in a short time. The plates and liquid, if sealed up in a glass tube, form a cell, and if connected with the poles of an electrometer, a rise of E.M.F. is observed. Six such cells were connected in series, and a "standard" candle placed in front of them, the cells being connected to a Thomson quadrant electrometer. The curve of increase of E.M.F. with time was shown, the maximum E.M.F. being ·566 of that of a Minotto cell. The E.M.F. curve followed a logarithmic law, $E = A + B E^{-K t}$, where A and B are constants, E the E.M.F. at time $t$. It sometimes happens that a few days after the cell is mounted an exposure produces no E.M.F. at all, but a slight tap (even if scarcely audible) given either to the support of the cell or the table on which it rests makes the cell sensitive to light once more, whilst another tap makes it insensitive again, and so on. This action is not due to any gas formed in the cell, but probably (as Prof. Minchin states) to some molecular alteration either in the sensitive surface, or the liquid, or in their layer of contact.

Prof. Minchin found that when a Voss machine was worked some distance off, the cell being in its insensitive state, *the moment a spark passed between the poles of the Voss the insensitive state altered to the sensitive.* The same effect was produced at a much greater distance when the spark was from an induction coil. In fact, when a Hertz oscillator was taken into the grounds of the college, the cell being inside at a distance of 60 yards, the insensitive cell was at once rendered sensitive by the discharge of the oscillator. The opposite change, that from the sensitive to the insensitive state, was readily accomplished by taps administered to the base of the cell, or was even produced by dropping small pieces of cork on the base of the stand on which the cell was mounted. It seems as if the change we call de-cohering is readily produced by slow vibrations,

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whilst the opposite change (cohering) is due to rapid vibrations. The length of the waves has also something to do with the matter, for when capacity was added, and so as to lengthen the waves sufficiently, they ceased to effect the change. To show that the changes *were* due to electromagnetic disturbances, the cell with its connecting wires was shut up in a metal box, when it was found to be unaffected by any electrical discharge When the wires projected outside the box, but were not connected to anything except the cell, it was affected as if exposed in the open, immediately becoming sensitive on discharge. Here we have the use of embryo antennæ demonstrated.

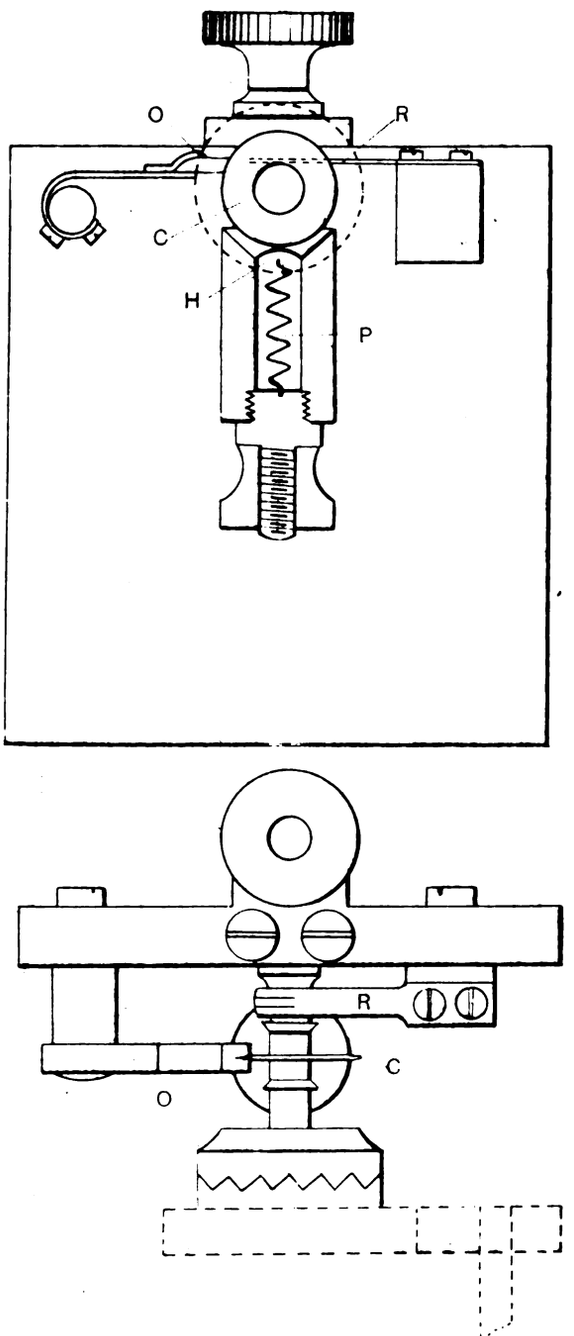


FIG. 24.—New Lodge-Muirhead Coherer (Elevation and Plan).

Remember this was in 1888. Branly's coherer was not discovered or at any rate not described till 1890 or 1891. If Prof. Minchin had attached a long vertical wire to one pole of his cells and connected the other to earth, with an automatic tapping arrangement, he might have signalled "wirelessly" to considerable distances even at that early date. The action of the filings coherer is very similar to that of the impulsion cell, and it is worthy of note that the explanation of the action of the latter given by Prof. Minchin is very like that given by Dr. Bose for the former. Prof. Minchin also constructed sensitive films somewhat similar to his cells.

*Self-Restoring Coherers.*

The foregoing all require some "de-cohering" device. The following coherers do not require such an addition, but are self-restoring. The *microphone* of Prof. Hughes is one of the earliest of this class.

*Mercury Coherer.*—Dr. Bose and Mr. Rollo Appleyard proposed the use of mercury long ago, but it is said a signalman in the Italian navy was the first to construct a practically successful mercury coherer. It consists (according to Mr. Marconi) of a globule of mercury between an iron and a carbon plug. The mercury wets the iron, or adheres to it, only when under the influence of Hertzian vibrations. It is far more sensitive than a filings coherer, and has the valuable property that it is self-recovering. It was used by Mr. Marconi when receiving signals at Newfoundland from Cornwall, 1,800 miles away. A balloon or kite was used to carry the aerial wire, but, owing to the varying capacity, an ordinary coherer was found unsuitable. Mr. Marconi says it was shown to him by Lieutenant Solari, of the Italian navy, and was baptised with the name "Italian navy coherer," as it was the fruit of the work of several individuals, and not of one.

*Lodge's New Coherer.*—A new coherer has recently been perfected by Drs. Lodge and Muirhead, in conjunction with Mr. E. E. Robinson. It is said to be by far the best yet constructed. It is not disturbed by shaking, requires no tapping back, and is extremely sensitive and dependable. Dr. Muirhead recently picked up signals with it (not

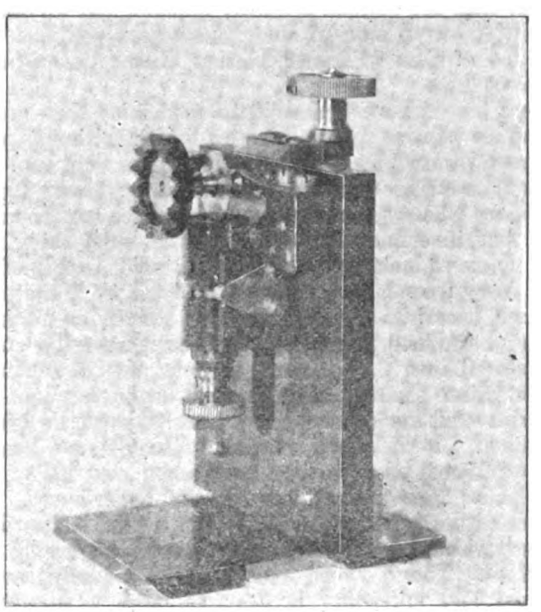

FIG. 25.—Lodge-Muirhead Coherer. (The sharp steel disc is well shown, its lower edge running in mercury held in an ebonite cup. The clockwork for driving the coherer disc acts through the serrated wheel.

intended for him, however) when on the Atlantic 800 miles from land. It consists of a little disc, or wheel, with sharpened edge, running in mercury. This wheel is turned at a medium speed by clockwork, and a small pad with a supply of oil keeps the little wheels' sharp edge always oiled. Thus there is a slight film of oil between the wheel and mercury where the former dips into the latter. The wheel is connected to one terminal of the apparatus and the mercury to the other. The incidence of ether waves breaks down the insulating properties of the thin film of oil, making the coherer conductive, but the continued motion of the wheel immediately brings another portion of its surface with its film into action, so that no decohering device is necessary. This coherer requires no relay and no tapper, but operates a siphon recorder direct. It is said to be so sensitive that in the long stroke or dash which the recorder prints can be detected the oscillations showing the frequency of the sparking apparatus. The record given is strong and clear, indeed equal, it is said, to the best cable records. The coherer is shown in elevation and in plan in Fig. 24 C is the steel disc, H the mercury, P a platinum spiral connecting the mercury to one terminal, O is the pad which keeps the coherer clean and supplies the oil, R a spring to hold the coherer in place. Should any injury happen to the coherer disc—the only likely one is mechanical injury to its sharpened edge—it is easily removed and another disc substituted. The oil film breaks

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down in resistance at a very low pressure (probably under 0·4 volt), but if not acted on by ether waves the resistance is high. A photograph of the actual apparatus is shown in Fig. 25.

*(To be continued.)*

## CENTRAL-STATION ECONOMY.

BY F. H. DAVIES.

When one considers that in the average well-managed electricity works only about one-twentieth of the heat energy liberated by the combustion of coal is delivered in the shape of electrical energy at the dynamo terminals, it is obvious that there is plenty of room for improvement in methods of generation. But practical experience shows that if this tremendous loss is to be reduced to any appreciable extent, these methods must be of an entirely new character, and must not require the present numerous transformations of energy that necessarily produce uneconomical results. This fact has been recognised for some time, and many efforts have been made to bring about a more satisfactory state of affairs by the production of electricity direct from coal, thus eliminating those factors that are responsible for the waste—viz, boilers, steam-pipes, engines, and dynamos. Whether this Utopian idea will ever take practical shape remains to be seen; at the present time the outlook is hardly hopeful, and we have no alternative but to proceed along the stereotyped, and from the point of view of transformation of energy, extremely inefficient lines.

There are, however, many little economies that may be effected in central-station practice, which, although small in themselves, mount up considerably in the long run. The means of securing these economies will generally suggest themselves when it is ascertained where the loss is taking place, but in connection with this the chief thing is to know where to look for it. A case in point is that of wet coal. Very frequently, when coal is brought to the works by barge, it arrives in a more or less sodden state at the bottom of the load, and as this portion is naturally on top when stored into the bunkers, a great part of the water percolates into the heap and damps it right through, with the result that its efficiency as a heat producer is greatly diminished. It is astonishing what a long time a heap of damp small coal takes to dry even when exposed to sunshine or a high temperature in the boiler-house. The surface naturally dries quickly, but a few inches down moisture will be found even after weeks of storing in a dry place. The obvious remedy is continually turning the coal and spreading it over as large a surface as possible, but this necessitates bunkers of very ample proportions, such as are not usually found. The prevailing impression seems to be that coal can be stored anywhere and anyhow, and many do not appear to be alive to the fact that "weather" has a very bad effect on its calorific properties. The ideal coal bunker should be spacious and well ventilated, and, if possible, placed in such a position as to allow of a glass roof, and the consequent drying action of the sun. The coal stores at the Bankside station of the City of London Company and the City-road station of the County of London and Brush Provincial Company are of this type, being placed at the top of the building over the boiler-house. Coal stored in such bunkers has a fair chance of drying, that in the usual gloomy dungeon of the domestic coal-cellar variety it does not get. This seems but a small point, but it is one that should not be neglected, as those who have gone into the question practically will know. Of course, where coal is very small and dusty, the addition of a little water is necessary, in order to keep it from being carried into the flues, unconsumed, by the draught.

Bad stoking is a very prolific source of waste, and whether it is performed by hand or machinery, there are few engineers who can be certain that they are getting the full value out of the coal consumed. It is well known, of course, that the grate should be uniformly covered, and only sufficient air admitted to ensure perfect combustion and the minimum amount of smoke. It is, however, only too common to find bare patches on the bars, especially where mechanical stokers are used, or, rather, misused. With those of the coking type with movable grates, a common mistake in working is that of allowing the fuel to burn completely away before it reaches the back of the furnace, the consequence of which is that the hinder part of the bars are only covered with clinker, and so let through air in large quantities, thereby reducing the efficiency considerably. It is by far better practice to so adjust the speed of the bars that the fuel falls over the back partially consumed; it can always be burnt over again mixed with fresh coal, or if allowed to remain in the ashpit, will efficiently finish its combustion there. Another alternative is to work with a thicker fire, which naturally takes longer to burn away, but this course is not always possible, as the thickness of fire must to a certain extent depend upon the nature of the coal and conditions of load and draught. Good stoking is naturally the outcome of experience that dictates what must be done under varying conditions, and it must not be thought that even the best mechanical stoker can be efficiently worked by an unskilled man; if anything, the reverse is the case.

The banking of fires in standing boilers is another operation that frequently gives rise to loss, and in connection with this it is most essential that the coal should be well damped and heaped, and that the dampers should be efficient—that is to say, not leaky.

The brickwork settings of water-tube boilers need most careful erection and watching, as the air leakage that is continually taking place through the pores of the bricks and their joints is very deleterious to efficiency. The layers of fireclay mortar between the courses should be as thin as possible, and the bricks should always be of the glazed variety. Cracks, which are bound to occur in time, should be thoroughly stopped up directly they appear, and holes in the brickwork through which blow-down and other pipes emerge should be carefully filled up or covered, not with cement, as this is liable to cause damage to the pipes, but with a dab of boiler lagging or a wooden or iron cover. This trouble of air leakage is so serious and difficult to overcome, that in places it has been found necessary to completely cover in the boiler and brickwork with a thin sheet-iron casing. Well-built glazed brickwork will, however, generally solve the problem, or where ordinary bricks are used, a good coating of tar will considerably reduce the leakage.

Perhaps the greatest source of waste in boiler-house plant is the old-fashioned steam feed pump that carries steam along the full length of the stroke. This fact has long been recognised, but, strange to say, this type of pump is still installed on the score of its supposed cheapness, which is an utter fallacy. The modern expansive steam-pump is very little, if any, dearer in first cost, and will certainly save the extra amount, if it exists, in a few months in steam consumption alone, putting aside repairs and renewals, which are comparatively low in this type of pump. The so-called cheap pump is also frequently very wasteful on the water side, owing to its plunger letting by, thus producing a churning motion that absorbs a great deal of power. The water pistons of these pumps should be frequently examined, and if it is noticed that a higher speed than usual is necessary to perform the same work, they should be repacked at once, as this is a sure sign of letting by. Apropos of this, it is always advisable to thoroughly overhaul pumps of this kind before setting to work for the first time. In a station with which the writer was connected some cheap American feed pumps were installed. They were sent down as ready for running, and were started up hurriedly without examination. One of them answered satisfactorily for a year, and then gave signs of being unable to do its work. Upon overhauling it was found that the water piston had never been packed; the space for the fibrous packing was empty, and the pump had been running, strange to say, satisfactorily on the two gunmetal ends of the plunger. This was doubtless due to a very exceptional piece of American workmanship, as at the start the piston itself had evidently been a perfect fit. The above is given as an instance of the care that must be exercised in the installation of plant of this class, and that in the interests of efficiency it does not do to take anything upon trust when dealing with it.

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Feed water in many installations accounts for a good portion of the works' costs, and is frequently the source of waste. In most cases, if a boiler has to be repaired or cleaned, it is blown right down into the sump and all the water thus lost, but this is not at all necessary if the blowing-down arrangements are properly designed and used. There should be a main blow-down pipe, into which all the boiler branches lead, having a valve in it between the *last* boiler and the sump. When a boiler is to be emptied the main valve should first be shut, the valve in the blow-down pipe of an empty boiler and its safety valve opened, and the boiler then blown down. This will result in the saving of practically 50 per cent. of the water, as this amount will naturally flow into the empty boiler before the water-levels become even. The other 50 per cent. must be lost, but the saving is considerable, especially when large boilers are used.

The losses that occur in steam-pipe work account for a large proportion of the total. They are due to four causes—leaky joints, long runs, bad covering, and inefficient steam traps. Persistently leaky joints cannot be cured except by some structural alteration in the piping. Practical experience proves that, although some jointing materials are better than others, the best will not cure a defect arising from bad workmanship, and for this reason it is imperative that pipework should be of the best quality and erected in the most careful manner possible, with due provision for staying and expansion. The causes of leaky joints are badly-faced flanges, pipework that being too short has had to be pulled together on the last joint, inefficient expansion and draining apparatus. If flanges are badly faced, or do not meet truly all round, the cure is obvious—they must be faced up properly; experiments with jointing materials are waste of time and money. If the work has been pulled together in a straight length where there is no allowance for expansion, there are two remedies open—either to provide an expansion bend or joint, which is costly, or, preferably, to insert a carefully shaped and faced distance piece between the two open flanges. Should a certain length of pipe persistently give trouble with all or several of its joints, this points generally to expansion or water troubles, and should be carefully investigated; it may be that the staying is too tight and does not allow the contraction and expansion to be taken up on bends, as is generally the case. If this is so, an expansion piece must be inserted, preferably a U-shaped piece, not a joint, as the latter always leak. This will be found, in the long run, the cheapest remedy.

Should the trouble be located as due to water, it means that the draining arrangements are inefficient or not properly used, and the best way to set about a cure will probably be to instal an extra drain pipe at some low part of the range, or to overhaul the steam traps. These latter are often very troublesome, chiefly owing to inattention. They are too frequently stowed away in practically inaccessible places, and there left to chance their luck, year in and year out, with little or no inspection. If such is the case, they are bound to become in time either useless or wasteful—that is to say, they will either not let anything through them or will go too much the other way and pass steam and water indiscriminately. Traps should be in sight, above the floor level, and under constant observation; if placed like this, leaking and waste or refusal to work is bound to be noticed at once.

Condensation losses through long runs of pipe can only be minimised by judicious manipulation of the section valves, allowing only just as much pipe to be alive as is commensurate with convenience and safety. This in some large stations has been reduced almost to a fine art, and there is no getting away from the fact that the amount of thought and organisation necessary is amply repaid by the increase in efficiency. In a large station with a dozen or more boilers, and perhaps as many steam sets, the efficient working of the pipe range is by no means a simple matter, the economic possibilities, of course, depending greatly upon the style of arrangement. The only way to secure maximum economy is to work upon a system—that is to say, as far as practicable, certain engines should be run when certain boilers are in service, taking care that the steam way is the shortest possible between the two. In a small station, or with a simple straightforward arrangement of piping, there is not much in it, but with some of the old-fashioned elaborate ring or duplicate systems that are fortunately dying out, the possibilities are immense.

Much has been said about pipe and boiler coverings, particularly by manufacturers. It is therefore only necessary to reiterate that to allow even the smallest portion of steam-piping to go inefficiently covered or entirely bare, is simply throwing money away. Condensation tests on covered and uncovered pipe are frequently quoted, and the writer would commend their perusal to engineers who do not appreciate the enormous losses entailed by bad lagging.

In all well-managed stations the engines are indicated at frequent intervals—a very necessary precaution, from the neglect of which inefficiency often arises. The comparative economy of engines, of course, depends chiefly upon their design and building, and cannot be improved unless drastic structural alterations are made, but it is necessary to guard against the minor losses that occur through wrongly set valves, leaky joints, glands, etc., and the frequent use of the indicator is the only way to check the first and most important of these. It is not sufficient to take cards and so get an indication of the general action of the steam in the cylinders—they should be worked out in order to ascertain whether the work is evenly distributed; if it is not, an uneven turning moment is the result, and unequal wearing of the brasses. This, when very bad, has often been the cause of persistent hot bearings on one side of the engine, and consequent expense and trouble in repairs, that by an intelligent use of the indicator might have been entirely obviated. The glands of enclosed engines when covered in naturally do not, as a rule, receive as much attention as those of the open type; they are, however, apt to be just as troublesome. The surest indication of their leaking is excess of water in the crank chamber, and if the amount of this is systematically observed, a certain check can be kept upon their condition.

In all stations during the heavy load it is necessary to keep a certain amount of plant in a condition to be put to work at the shortest notice. From the point of view of economy this is a very important point, indeed, and a great deal of experience is necessary to say when the expense of keeping spare plant turning over or warmed up is exactly counterbalanced by the increased safety. The primary considerations are, of course, the condition of all or any one of the running sets or boilers, as regards freedom from breakdown, the amount and nature of the load, and whether rising or falling; upon these, again, is imposed what may be termed the component of local conditions, and the whole makes a very pretty problem for each individual station engineer.

To tackle the question from the commencement: boiler stand-bys, in anything but the very largest stations, are practically unnecessary—that is to say, if the boilers are well looked after; there may be a little risk in this, but the expense of getting up steam in a spare boiler every day, only to let it down again, is in most cases prohibitive. In a small station, therefore, there is but little choice in the matter—so many boilers will be required for the peak of the load, and so many must be steamed. Until the maximum is reached, and after it, there is plenty of stand-by, the only risk taken is at the peak, and as this is not as a rule on for long, it is worth running. In a large station, however, things may be rather different; the expense of steaming up a spare boiler or two is proportionately small, and the usual, procedure, therefore, is to use more than enough boilers for the work, thus having something in hand in the event of breakdown. As it does not pay to force boilers, this method, besides being safe, is perhaps economical, and its use in small installations is only debarred by the proportionately large cost of raising steam and banking fires

It is on a rising load that stand-by engines are chiefly required; when the load is falling, this precaution is, in most cases, not so necessary. It all, however, depends upon conditions, such as the size of the sets, and whether they can be run up to speed quickly. If they are small, and of the high-speed enclosed type, warming up is generally sufficient to meet all the requirements of safety, as such engines can be got up to full speed from standing in a few seconds; but with heavy plant the case is different, and

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unless the spare set can be run up to speed and ready for taking load, say, in about 30 seconds, it is necessary to keep it turning over. This, of course, entails unprofitable use of steam—that is to say, unprofitable, inasmuch as it does not go towards the generation of current—but it is a highly necessary precaution, and on a rising load the loss is scarcely to be begrudged, seeing that the spare set will probably go into parallel very shortly. In the case of a fog load, questions of economy in this direction must, of course, be thrown to the winds; but in dealing with the ordinary evening load, with its predeterminated value at certain times, a system based upon observations and energetically carried out will do much to reduce what is sometimes the very considerable loss entailed by the keeping ready of stand-by plant.

## MUNICIPAL TELEPHONE CONFERENCE.

On Monday last a conference was held at the Westminster Palace Hotel, at which representatives from Glasgow, Guernsey, Hull, Portsmouth, Brighton, and Swansea attended. The Lord Provost of Glasgow (Sir John Ure Primrose, Bart.) having been asked to take the chair, explained that the conference had been convened to consider (1) what will be the effect on municipal corporation telephone undertakings if the Government purchase the undertaking of the National Telephone Company; and (2) whether any, and, if so, what representations should be made to the Postmaster-General on the subject prior to the completion of any agreement between him and the National Telephone Company. He further explained that the representatives present were not all in a position to bind their corporations, but had been appointed to attend the conference, and thereafter report to their respective corporations and receive from them further instructions. After a full interchange of views the meeting resolved as follows:

1. That the corporations here represented should not object to the Postmaster-General acquiring the National Telephone Company's undertaking if it can be purchased on such fair and reasonable terms as will bring telephonic communication within the reach of the general community.
2. That all town and county authorities should, if they so desire, be allowed and encouraged to own and work telephones within their districts.
3. That the Government should continue to own and work, and should greatly develop, the trunk system of telephones, and should also own and work local telephones in places where the district authority does not desire to do so.
4. That an interview should be asked at once with the secretary of the Post Office to secure that, before any agreement is entered into with the National Telephone Company, an opportunity be afforded the municipal corporations of stating their views to the Postmaster-General.
5. That steps should be taken to secure that, in the event of Parliament appointing a committee to consider the negotiations between the Postmaster-General and the National Telephone Company, the municipal corporations should be enabled to lead evidence before that committee.

Thereafter it was unanimously agreed (1) that this meeting be adjourned until the representatives present have been able to report to their corporations; and (2) that meantime an executive committee be appointed, consisting of two representatives of each of the corporations, to be appointed by them, to watch over the interests of the municipalities in the light of the discussion of to-day, with power to arrange for the interview with the Postmaster-General.

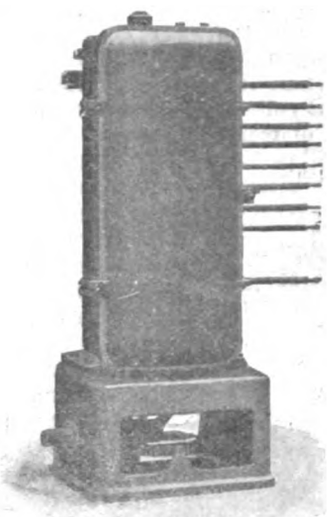
Before the meeting terminated it was reported by Councillor D. M. Stevenson, of Glasgow, that he had been able to arrange for an interview on Tuesday last with the secretary of the Post Office. The meeting approved, and many of the representatives attended the interview. They were assured that an opportunity would be given them of placing their view before the Postmaster-General.

It was agreed at a subsequent meeting to ask the Lord Provost and the town clerk of Glasgow to act as convener and secretary respectively of the Executive Committee.

## TRADE NOTICES AND NOVELTIES.

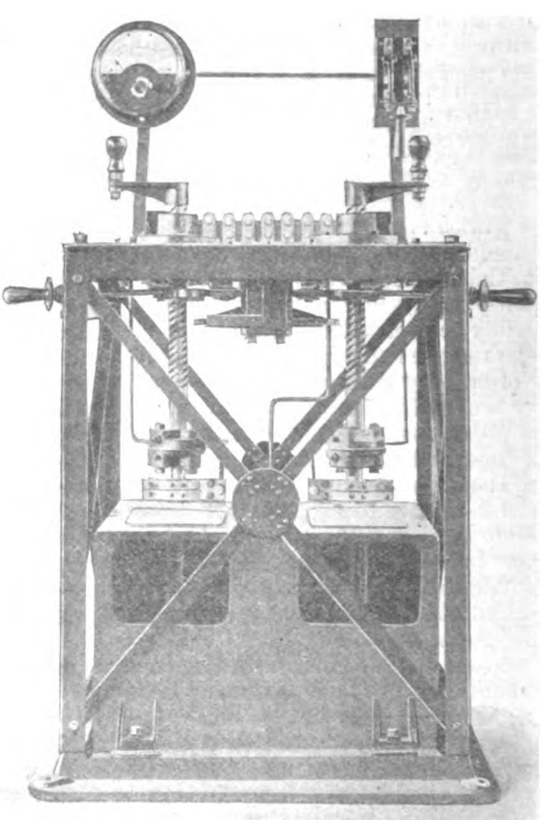
### Controllers and Other Apparatus for Cranes, etc.

The Lahmeyer Electrical Company, Limited, Bank-buildings, 109-111, New Oxford-street, London, W.C., have long given special attention to the design of controllers and accessory apparatus for electrically-driven cranes, hoists, lifts, and other variable-speed machines. If proof were needed, it could be found abundantly in the voluminous list No. 13 B, recently issued by the firm. This list contains some instructive reading matter relative to the driving of cranes generally, besides full particulars of the various types of controller, etc., introduced by the firm for the purposes in question. The range covered is a wide one, including as it does a variety of simple controllers suitable for use with continuous and multiphase current motors



Controller for Starting Series-Wound Motor, combined with Reversible Switch

of different types, controllers combined with reversible and starting switches, controllers for reducing and increasing the speed of shunt-wound motors, or for the series-parallel control of two motors, double controllers for direct and multiphase current working; resistances, brake magnets, and switches, etc. The accompanying illustrations are borrowed from the list. The first of them represents a type of controller which is especially suitable for saws, shears, rolling-mills, high-speed cranes,



Liquid Starter for Two Motors.

coke extractors, etc.—*i.e.*, for all cases where variable speed is required without mechanical braking. This controller is provided with eight starting and regulating steps, as also with four brake positions. The starting is effected by moving the lever forwards, while the direction of rotation may be reversed by moving the lever sideways, either to the left or to the right. It is impossible with the arrangement adopted to reverse the

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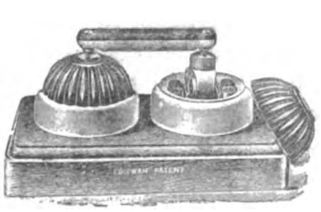
motor when under current. Now we come to the second illustration, which is of a liquid starter for two motors. Starters of this type may be used with advantage for controlling the lifting and traversing motors of foundry cranes from the ground-level, as there is not the slightest sparking at same, and they will take heavy overloads; also in places where it would be difficult to employ metal controllers on account of dust and dirt. The motors are started up by means of two handles, and reversed by the levers fixed on each side. For the rest we must refer the reader to the list itself.

### "Ediswan" Electrical Supplies.

We have received another budget of leaflets from the Edison and Swan United Electric Light Company, Limited, 36 and 37,

"Ediswan" Queen of Lamps.

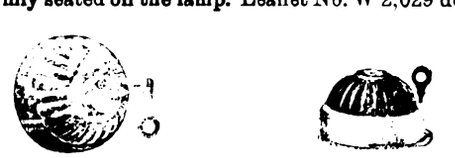
Queen-street, London, E.C. These leaflets are enclosed in a new and ingenious binder, bearing on the front cover the legend "'Ediswan' Electrical Supplies." This binder is intended to hold the new series of catalogue sections and leaflets now being issued by the company, and customers are asked to file therein those publications already received, as well as those which are yet to come. Later on, when the series is complete, it is hoped to issue a bound catalogue. Of the leaflets to hand, No. L 2,024 describes the firm's new pattern "Queen of Lamps," with loose



"Ediswan" Coupled Switch.

"Ediswan" Ceiling-Pull Switch.

opal reflector and patent adjustable sleeve. The new shape of this lamp (see the accompanying illustration), together with the fact that the reflector completely covers the filaments, gives it enhanced reflecting powers; a lamp rated at 16 c.p. and taking ·58 ampere being capable of concentrating 32 c.p. in a vertical direction with an efficiency of 1·8 watts per candle-power. The patent adjustable sleeve makes a neat finish by covering the usual gap between the lamp cap and the holder; it also keeps the reflector firmly seated on the lamp. Leaflet No. W 2,029 describes



"Ediswan" Loose-Key Switches.

"Ediswan" pure rubber flexible cords, and No. G 2,030 shows the "Fountain" shade, a device constructed of glass tubes and beads, which gives a beautiful lighting effect. Leaflet No. A 2,031 describes and illustrates a complete range of the well-known "Wedge" tumler switch, an entirely novel improved type of point switch, which does away with all the usual gear under the lever, so that the china bridging piece has a free and recessed travel right across the china base. The patent spring is inside the screw collar, and high insulating qualities are combined with quick positive snap-off action, small dimensions, substantial terminals, wide break, and good contact. The "Wedge" switch, we are told, has met with a success never before attained, and has established quite a revolution in tumler switches. A few of the patterns of this switch are illustrated herewith.

## HASTINGS ELECTRICITY ACCOUNTS.

The accounts of the Hastings Corporation electricity department for the year ended Dec. 31, 1903, show a total expenditure on capital account to that date of £131,832. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc, are appended.

| Dr. Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 6,990 | 6 | 8 |
| Distribution of electricity | 359 | 12 | 4 |
| Repairs and renewals of public lamps | 825 | 12 | 11 |
| Rents, rates, and taxes | 204 | 16 | 6 |
| Salaries of engineer and clerical staff | 881 | 8 | 6 |
| Stationery and printing | 56 | 13 | 1 |
| General establishment charges | 557 | 15 | 8 |
| Special charges, insurance, etc. | 218 | 2 | 0 |
| | 10,104 | 7 | 8 |
| Balance carried to net revenue account | 7,873 | 6 | 10 |
| | £17,977 | 14 | 6 |

| Cr. | £ | s. | d |
|---|---|---|---|
| Sales of current per meter | 13,020 | 1 | 7 |
| Sales under contract | 47 | 0 | 0 |
| Public lighting, repairs, etc. | 4,028 | 19 | 10 |
| Rental of meters and other apparatus | 653 | 5 | 7 |
| Rents receivable | 152 | 0 | 0 |
| Miscellaneous receipts | 76 | 7 | 6 |
| | £17,977 | 14 | 6 |

General Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 126,517 | 0 | 0 |
| Temporary loan from bankers | 11,378 | 0 | 0 |
| Sundry creditors | 3,956 | 11 | 0 |
| Consumers' deposits, including interest | 204 | 14 | 1 |
| Insurance fund | 50 | 0 | 0 |
| | £142,106 | 5 | 1 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended on works | £113,201 | 3 | 8 |
| Redemption of stock and loans account | 8,630 | 15 | 7 |
| Stores on hand | 1,378 | 15 | 8 |
| Sundry debtors for current supplied | 6,870 | 1 | 10 |
| Unexpired rates, insurance, etc. | 111 | 15 | 7 |
| Balance at debit of net revenue account | 4,468 | 8 | 11 |
| Amount in hands of borough treasurer | 7,445 | 3 | 10 |
| | £142,105 | 5 | 1 |

Statement of Electricity Generated, Sold, etc.

| | | |
|---|---|---|
| Quantity generated in B.T. units | | 989,562 |
| Quantity sold { Public lamps | 228,432 | 852,094 |
| Quantity sold { Private consumers by meter | 623,662 | |
| Quantity used on works | | 19,490 |
| Total quantity accounted for | | 871,584 |
| Quanttiy not accounted for | | 117,978 |
| Number of public lamps | | 104 |
| Total maximum supply demanded (kw.) | | 610·4 |

## PERSONAL.

The Brighton Town Council have ratified the appointment of Mr. W. C. Gardner as assistant manager to the telephone system.

Mr. Geo. J. Edwards has been presented with a gold watch and silver-mounted walking stick on the occasion of his leaving Liverpool to take up the position of chief clerk to the Ashton-under-Lyne Corporation tramways.

Mr. Percy Longmuir, of University College, Sheffield, has been appointed junior assistant in the metallurgical department of the National Physical Laboratory. Mr. Longmuir is a pupil of Prof. Arnold, and has for two years been engaged in research as a Carnegie Scholar of the Iron and Steel Institute. He will at present assist Dr. Carpenter in carrying on the work undertaken by the laboratory for the Alloys Research Committee of the Institution of Mechanical Engineers.

The Radcliffe District Council have appointed Mr. M. B. Henry, of Nelson, electrical engineer, at a salary of £150. There were 100 applications for the position.

Mr. E. Lafferty, an inspector on the Bradford city tramways, has been appointed traffic manager of the Preston Corporation tramways.

The Sheffield tramways officials recently presented a gold-mounted umbrella and a silver-mounted walking stick to Mr. T. E. Barnes, of the tramways department, on his leaving Sheffield to take up a more responsible position on the London County Council tramways. Mr. H. E. Yerbury presided.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## WIRELESS TELEGRAPHY IN PRACTICAL USE.

It is not our intention to discuss the merits of any particular apparatus connected with wireless telegraphy, but simply to refer to the excellent work being done by the *Times* correspondent in the Far East. For weeks past expectation has been rife as to the exactitude of the events happening off Port Arthur and in Korea. Imagination has played the most important part in the various statements that have appeared in the daily papers, but of authoritative news there has been very little, for no correspondent had reached the front. Western enterprise seemed to be at fault—and the world wondered It remained for the *Times* to solve a difficult problem by the installation of a wireless system upon a steamer and on shore, by means of which the information gained by the correspondent on board the steamer was conveyed to the shore station and then by ordinary cable to this country. The present range of effective signalling is given in the telegram to the *Times* of April 14, which says: "Yesterday's messages established a record for wireless telegraphy in consideration of the length of wire exposed. Our receiving station heard us at a distance of one hundred and seventy sea miles, and acknowledged messages as received at a distance of one hundred and fifty sea miles." It was by this means that the *Times* was able to give information as to the position of the Japanese fleet on April 13 and 14 and its action at Port Arthur. Really, the possibilities of electricity seem inexhaustible, and even those most familiar with the subject wonders what next. The conditions under which this signalling is carried on are probably favourable, in that there is no chance of interference, so that the system is seen to the greatest advantage. Whatever be the exact truth with regard to the loss of the Russian flagship, it was only because of the *Times* enterprise that the outside world knew at an early moment that the Japanese fleet was in the vicinity of the Russian fleet, and actually attacking either that fleet or the forts at the time the disaster occurred. The value of wireless telegraphy was not proved during the late South African War, but we may be sure that developments may be expected during the present Russian-Japanese embroglio. The former are said to have destroyed the telegraphs in Northern Korea, so that possibly more will be heard of wireless telegraphy in this direction during the Japanese advance. However it may be, the electrical engineer will watch with great interest the practical use in war of this new system of intercommunication.

## THE MOSELY EDUCATIONAL COMMISSION.

The reports of the members of the Mosely Educational Commission are now to hand, and occupy no less than four hundred pages of printed matter. Their value is very great, and is enhanced by the fact that the members of the commission are by no means unanimous in their conclusions on certain points at issue. Mr. Alfred Mosely, who both inaugurated the commission and has himself borne the expense of the same, calls attention in an introductory note to the objection which conservative school teachers have to fundamental improvements in educational matters. An American idea is that such obstructions to progress must be removed, and that we cannot really afford to wait for the older teachers to die out. Mr. Mosely has himself inaugurated an alternative method, by which those responsible for the lead in educational matters shall have every facility for determining which fundamental changes in our educational methods are imperative. Thus, his committee included not only leaders on the teaching side of educational reform, but also a number of men who are concerned

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in the control of our schools—such as chairmen of educational committees and of Government departments dealing with education. In a casual glance through a number of these reports, one quickly sees that certain of the members of the commission are critical in their remarks as to what they have seen. Thus, Prof. Henry E. Armstrong remarks that "It is quite clear that the right spirit is at work in the United States, but the lack of the critical faculty and of depth of purpose, combined with an excessive development of the utilitarian spirit, are serious drawbacks at present and militate against progress in education. Until higher ideals prevail and sober calculation takes the place of a somewhat emotional and superficial consideration of its problems, it will be difficult to introduce reforms." Earlier in the same report it is remarked that we have sinned in the same way, but that there are clear indications that we in this country have recognised our mistake, and that we may shortly enter upon a new educational era in which commonsense will prevail. Prof. Armstrong adds that he saw no such signs in America The report of Prof. W. E. Ayrton deals entirely with the education of the electrical engineer, and we hope to give this report full notice in an approaching issue. Prof. Ayrton's opinion is that the closer bond between the manufacturing works and the technical colleges in the United States is responsible for these colleges being in advance of those in Great Britain. This connection between the works and the colleges tends to make the American student more practical, and he usually has his knowledge in such a form that it can be quickly applied. In conclusion, the reports of the Mosely Commission are the more valuable because of the variety of opinions expressed, and because they tend to show not only what is good in the American educational methods, but also what should be avoided in the evolution of a more practical system of education in this country. Any such change is bound to be a gradual one, and it is, therefore, of the utmost importance that the steps taken to this end should be in the right direction.

## TELEPHONY IN AMERICA.

We have just received the annual report of the Bell telephone system for the year 1903, which gives information clearly showing the magnitude of the public service rendered by this company. Thus, in the year in question, the gross revenue of the company reached the large figure of £3,309,126. The expenses, including interest on debenture loans and taxes, was £1,196,193, leaving a net revenue of £2,112,933, out of which no less than £1,723,830 was paid in dividends. The balance was carried to reserve or brought forward to next year's account. At the end of the year 1903 there were no less than 3,779,517 instruments issued by the company to their subscribers, while the number of exchange stations, which we presume is equivalent to our subscribers' lines, was slightly over 1½ millions. The total mileage of wire for exchange and toll service was nearly 4,000,000 miles, of which 677,229 miles were added during the year. The average number of connections per day reached the enormous total of 10,000,000, which is on the average between six and seven messages a day per subscriber. The capital expended by the company during the year was slightly over seven millions. On the vexed question of maintenance and depreciation, the report includes the following interesting paragraph: "This matter of maintenance and depreciation is constantly before the eyes of our companies. The system of accounts, which is practically uniform for all the Bell organisations, forces them fairly to face this expense from month to month and from year to year. Before there is any question of profits, each company recognises the necessity of reserving from its earnings such amounts as experience has shown to be adequate to keep its property in repair and replace it when worn out or destroyed. The sum properly to be charged varied to some extent in different parts of the country, on account of climatic conditions and the character of the plant employed, but the average allowance for maintenance of the Bell companies for the year 1903 was over 30 per cent. of their gross revenue. In this respect the company claims that the independent telephone undertakings who are competing with them have not allowed sufficiently for depreciation when fixing their scales of charges.

## THE INSTITUTION SECRETARYSHIP.

We are officially informed that Mr. George C. Lloyd, chief assistant to the secretary of the Iron and Steel Institute, has been appointed to the secretaryship of the Institution of Electrical Engineers, with Mr. Percy F. Rowell, chief assistant to the late Mr. McMillan, as assistant-secretary. It affords us great pleasure to tender our congratulations to these gentlemen on their election.

The new secretary, who is the son of the Rev. Charles A. Lloyd, was born at Rand, Lincolnshire, in 1862. At the age of 15 he proceeded to Germany, where he spent 2½ years at one of the gymnasia. On his return he entered the service of Messrs. Robert Stephenson and Co., the Newcastle firm of locomotive and marine engine builders. Five years later Mr. Lloyd joined Messrs. Lamport and Holt, of Liverpool, in the capacity of marine engineer, subsequently entering the service of the Spanish Royal Mail Steamship Company. He is acquainted with many parts of the globe, having visited the Philippines on five occasions, and spent some time in India, South America, and the West Indies. It is not surprising to learn, therefore, that Mr. Lloyd, who is the holder of an extra first-class Board of Trade certificate, possesses considerable linguistic attainments. Returning to England in 1891, he engaged in engineering work at Glasgow and London until 1900, when he entered the service of the Iron and Steel Institute. Consequently it is with an extensive and varied experience both at home and abroad that Mr. Lloyd now succeeds the late Mr. McMillan.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

679. With £100 to spend, and having access to a direct-current 230-volt supply, say what machinery and instruments you would buy in order to illustrate the principles of alternating currents.—M. F.

680. When a battery has dropped in capacity is it correct to charge at the original rate—viz., a 600 ampere-hour battery has dropped down to a maximum 200 ampere-hours. Original charging rate 100 amperes. Should this rate be lowered? Give reasons for and against.—C. G.

### ANSWERS.

*Question No.* 671.—Describe in detail, with sketches, any system for the sterilisation of water by ozone on a large scale, particularly where connected to a town's water supply.

*Best Answer to No.* 671 (*awarded* 10*s.*).—The first plant for the commercial purification of water by means of ozone was erected in Berlin about 1897-8. This plant was designed to deal with 2,200 gallons of water per hour, which is equal to the demand of a town with 5,000 inhabitants approximately. The apparatus used to effect the absorption of

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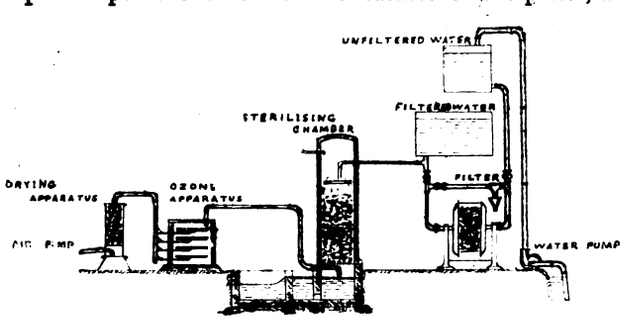
ozone is somewhat similar to a scrubber having a small brick chamber filled with fine gravel, through which the water percolates after being previously cleansed of suspended matter by passing through a rapid filter. The water on its passage through the gravel passes through an atmosphere of ozone. The ozone generators used in the plant referred to were of both the tube and plate type, the E.M.F. employed being 12,000 volts, which is sufficient with proper proportions of plate surface to generate 25 grm. of ozone per horse-power hour with a concentration of 2·5 grm. to 2 9 grm. per cubic metre of ozonised air.

The arrangement of apparatus and method adopted is shown in the accompanying diagram, which is an outline of the experimental apparatus of Dr. George Erlwein, and consists of four parts—namely, a rapid filter through which the river or other water to be cleansed of suspended matter flows; the sterilising chamber, which is filled with fine gravel, through which the filtered water percolates, becoming sterilised by its passage through the ascending ozone; the ozone generator, which is an hermetically sealed box containing pairs of insulated plates similar to a condenser. In the generator the discharging space is formed by superimposed plates. The upper plate of a pair is of glass partly covered with foil, while the lower plate—insulated from the upper by means of glass strips—is an ozone-resisting metal plate. The introduction of the air into the discharging space is effected either in the longitudinal direction of the plates, or centrally through the lower plate of each pair, which is the method shown in the figure herewith. These plates are connected to the high-tension mains; at the same time a current of dry air is forced through the generator after passing through a drying tower. The power required depends upon the extent of the surface of the plates, and




is absorbed at the rate of 1 h.p. for every 22 square feet of plate surface.

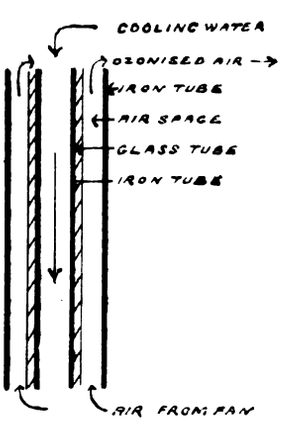
In regard to cost, in the particular plant designed by Messrs. Siemens and Halske, for an output of 26,000 to 33,000 gallons per hour, the cost of treating 1,000 gallons of water was calculated to be ·65d., the cost of power being ·6d. per horse-power hour. Of this amount the cost of energy represents ·41d.; wages, repairs, and filtering, ·086d.; interest on loan and depreciation, ·165d The total cost of 1,000 gallons of sterilised water, delivered at the point of consumption, including filtration, pumping, etc., comes out at 1 8d.

In the latest type of such apparatus, the ozone generator consists of concentric metal tubes, both cooled by means of water. Between the two tubes is inserted an insulator in the form of a mica cylinder attached to the inner side of the outer tube; a combination of seven such tubes forms one complete apparatus. The individual tubes are contained in a cylinder similar to fire-tubes in a locomotive boiler, the water for cooling the tubes circulating between them, thus the outer tubes are earthed by means of the circulating water.

Whatever method be adopted the principle remains the same—that is, the successful work depends upon the amount of plate surface relative to the power, and the proper regulation of the flow of dry air through the ozone generator.—K.

*Answer to No.* 671 (*awarded* 7*s.* 6*d.*).—Owing mainly to the bacteriological researches of late years, sanitarians have endeavoured to find a more satisfactory method of sterilising water than by the ordinary way of filtration. Heat has been tried, but, in the opinion of many who are qualified to judge, practical difficulties are very much against its adoption. To ensure destruction of all pathological germs, the temperature of the water has to be so raised that the deposit of calcium salts becomes a serious trouble. This might be obviated to a great extent by softening the water before sterilisation, but many would object to the complete removal of these salts from a water intended for drinking purposes. There are many chemical processes for water sterilisation, but these are at best very expensive.

To meet difficulties met with in the employment of these various processes, the sterilisation of water by means of ozonised air was introduced. In the Siemens method a modification of the well-known "Siemens ozone tube" is employed. The figure is a sectional sketch of one of these ozonisers. The inner and outer iron tubes form terminals, to which are attached leads from a supply of electrical energy at a potential of 8,000 volts. These two concentric iron tubes are separated by a glass tube and an air space; when energised a "silent" discharge takes place across this air space, and the contained air becomes more or less ozonised. A proportion of oxygen ($O_2$) in the air takes the form of ozone ($O_3$). A stream of water is kept up through the inner tube for cooling purposes; atmospheric air for ozonisation is forced through by means of fans. The ozonised air is taken to a receptacle similar to a "scrubber" as used in gas manufacture. The bottom of this apparatus is filled with a quantity of broken flints; the water to be sterilised flows over these and meets the ozonised air which enters from the opposite direction. The cost of sterilising water in this manner is said to be about 1d. per 1,000 gallons. As the ozone is obtained from the




atmosphere, its source is available everywhere. Given a cheap and reliable method of sterilising water, great advantages would at once follow; many doubtful supplies could be turned into pure potable water. Is it too chimerical to suggest that in the supply of electrical energy for water sterilisation station engineers may find a paying day load?—M. M.

*Answer to No.* 671 (*awarded* 5*s.*).—There are two or three methods for making ozone for sterilising water which I will endeavour to describe. First, there is the apparatus developed by Marmier and Abraham, which consists of a closed chamber containing two large cast-iron plates placed parallel to one another which have their opposing surfaces covered over with two glass plates. These two iron plates are connected to the secondary of a transformer supplying current at about 40,000 volts. Through the centre of one of these plates a pipe passes to the outside of the chamber which is for the outlet of the air after it has been ozonised. Air enters the chamber at one end and passes between the two glass plates covering the iron plates, and then out through the pipe just mentioned. A spark gap is put in parallel with the cast-iron plates, but is not within the ozone chamber; this limits the applied voltage at the plates so as to prevent arcing between them, as the spark gap being shorter than the distance between the plates, a spark will cross the gap before one will pass between the plates. The gap is also useful in another way, as it causes oscillations to be set up in the circuit which are considered to be beneficial to the operation of making the ozone. Brush discharges take place around the glass plates, and thus the air passing through the chamber is acted upon and a certain amount of ozone is made, which passes out of the chamber with the remaining air through the outlet pipe. I will now endeavour to describe the method of Otto, a Frenchman,

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who uses the same principle of brush discharges, but his apparatus is different. The nearer the potential approaches the sparking point it is found the brush discharge formed is more effective in producing ozone, and so this apparatus is constructed to use higher potentials, but as nitric acid would be formed if continuous arcing occurred, it is also designed to prevent this. Like the one before mentioned, this consists of a chamber with an inlet at one end and an outlet at the other. The chamber is of iron this time, and in it is a shaft capable of revolving, with iron discs keyed on it. Each disc has a portion of its circumference cut away, and the discs are arranged on the shaft so that the portions cut away form a spiral round the shaft. In the wall of the chamber a duct is cut away parallel to the shaft. When the apparatus is in operation one terminal of the high-potential circuit is connected on to the shaft with the discs on, and the other terminal is connected to the wall of the chamber. The brush discharge, therefore, takes place between them. If an arc should occur between a disc and the wall, it is immediately broken when the space cut out in the disc comes opposite the duct in the wall whilst rotating, and so an arc cannot burn continuously. Unlike the former system, a spark-gap does not seem to be used with this method. Now the water which is to be sterilised must be put in contact with the ozonised air, and the best method seems to be to pass the water down a tower filled with lumps of some non-absorbent material, and at the same time pass the air up the tower. A good construction would be to pump the water to be treated up to the top of the tower, and then let it trickle down the inside and be collected in a large tank or cistern at the bottom, preparatory to being run off to other reservoirs, etc. The ozonised air could then be bubbled up through the collecting tank at the bottom of the tower, and then escape to the atmosphere again by way of the tower, encountering on its path upwards the down-coming trickling water, and so sterilising it. I think "Ozone" should from the above get an idea of how water may be sterilised by ozonised air.—E. R. ALEXANDER.

*Question No.* 672.—Describe the "Heyland" system of winding alternators so that they are self-exciting.

*Best Answer to No.* 672 (*awarded* 10*s.*).—The very ingenious system devised by Mr. A. Heyland for winding alternators so that they are not only self-exciting but compounding, is an elaborate development of his method of compensating induction motors with regard to their wattless currents, first brought out in 1901. The arrangement devised by Heyland has been applied successfully to asynchronous and synchronous generators, and will probably be the means of bringing the former type of generator into more general use, since, with the compensated arrangement, this machine becomes commercially practical, for it is self-exciting and can be loaded inductively, only a relatively small synchronous machine being required to fix the frequency. With the *compounded* asynchronous generator, however, this synchronous machine can be dispensed with, as the compounded machine, on account of its peculiar features, operates at practically synchronous speed, and can be used to fix the frequency for a number of compensated machines.

The ordinary type of asynchronous generators are simply induction motors mechanically driven above synchronism;* when running in parallel with a synchronous machine they can supply the external circuit with energy currents. The synchronous machine fixes the frequency, and has to supply not only the magnetising currents of the induction generators, but also the wattless currents required by the external circuit. It should be noted that the output of the ordinary induction generator depends only on the speed, its maximum output being developed at a speed approximately equal to synchronous speed, increased by an amount approximately equal to the slip at maximum load when running as an induction motor. The magnetising currents of the induction machines are nearly the same whether they are running as motors or generators, and are consequently relatively large, being of the order of about 20 to 25 per cent. of the full-load current. The excessive amount of apparent energy required for excitation is due to the flux being generated by a current circulating in the stator windings, which current has a frequency equal to that of supply, and whereas a few volts would get this current through the stator windings if it were a direct current, it requires the full supply pressure to get it through on account of the frequency being equal to that of the supply.

Now, in an induction motor the frequency of the rotor currents is given by the slip, and in consequence is very low even at maximum load; at no load, when the rotor runs at practically synchronous speed, these rotor currents are practically direct currents. In the Heyland machines, both induction motors and generators, this fact is made use of, and the magnetic flux is produced by magnetising currents in the *rotor*, which currents, due to their very low frequency, require only a few volts for their production. These rotor magnetising currents are led into the short-circuited rotor winding from the supply by means of a special commutator, which serves to convert the high-frequency supply current into one of very low frequency, according to the slip of the rotor. The low-frequency current circulating in the short-circuited rotor bars furnishes the ampere-turns required for the production of the flux, and this current must be led into the rotor in such a way that it will have the same direction and phase as the magnetising currents in the stator which it replaces.

In Fig. 1 is shown a diagram of the compensating and compounding arrangements for a self-exciting compounded asynchronous generator, where S W represents the stator winding, R W the rotor winding, C the commutator, B the

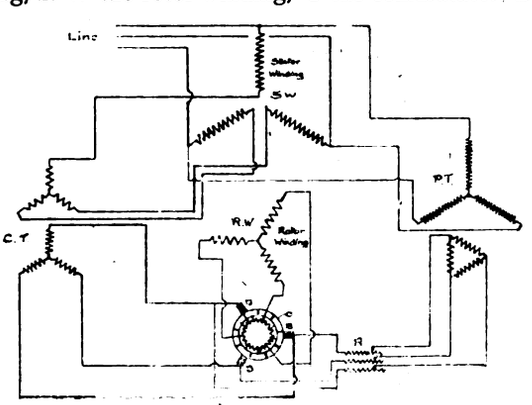


FIG. 1.

brushes, and C T, P T current and potential transformers respectively. The potential transformer is for converting the high pressure of the stator into one of six to ten volts pressure, which is led to the three brushes and forms the exciting current. The segments of the commutator are connected together by V-shaped connectors of low-resistance material, thus short-circuiting the rotor winding. With the help of this special commutator—which rotates under all conditions nearly synchronously — currents from the secondary of the potential transformer are led into the short-circuited rotor winding, appearing there as magnetising currents and having a frequency given by the slip of the rotor. The low-resistance commutator connections fulfil three functions—viz.: (1) short-circuit the rotor winding; (2) reduce the amount of current under the brushes; and (3) take up the pulsations in the rotor current, and hence in the flux due to conversion of the current from high to low frequency. The brushes are so placed relatively to the stator that the magnetising currents in the rotor bars have exactly the same direction as the corresponding stator currents which the rotor currents replace, the position and rotation of the magnetic flux produced by them being determined by the position of the brushes. The primary of the potential transformer in Fig. 1 is Y connected and the secondary Δ connected, in order that the pressure on the commutator brushes may differ 90deg. in phase from the pressure of the line conductors, being thus in phase with the flux. The compounding is effected by the current transformer, but in the case of low-pressure machines is furnished directly by the main current, the excitation in this case being carried out by a separate winding on the stator, thus dispensing with transformers. The resistance in the exciting circuit

* See the *Electrical Engineer* for Feb. 19, 1904, pp. 297-8.

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TABLE I.

| Main circuit — Terminal volts of stator winding. | Load in amperes. | Kilovolt-amp ere output. | Output in true kilowatts | Power factor of load. | Commutator circuit. — Voltage between brushes. | Current into brushes. | True watts in commutator circuit. | Power factor of commutator current. | Excitation winding. — Voltage at terminals of exciter winding. | Current in exciter winding | Current in diverter rheostat. | — |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 247 | 0 | 0 | 0 | — | 12·3 | 24 | 416 | 0 81 | — | 24 | — | First series of tests. |
| 270 | 39 | 18·2 | 2 1 | 0·11 | 21 5 | 46 | 1,620 | 0·94 | — | — | — | No diverting resistance used. |
| 255 | 30 | 13·2 | 13·2 | 1·0 | 15 5 | 35 | 950 | 1·0 | — | — | — | |
| 204 | 0 | 0 | 0 | — | 9·3 | 18 | — | — | 19·0 | 37·5 | 18·1 | Second series of tests. |
| 212 | 51 | 18 7 | 4 5 | 0·24 | 15 | 31 | 600 | 0 74 | 20·5 | 18·0 | 31·0 | Diverter rheostat |
| 220 | 52·5 | 20 | 20 | 1·0 | 13 4 | 28 | — | — | 22 | 43 4 | 27·4 | across brushes. |
| 223 | 41·5 | 16 | 5 6 | 0 35 | 12 7 | 32 | 625 | 1·0 | — | 31 | — | Third series of tests. |
| 205 | 57 | 20 2 | 9·3 | 0 46 | 13·5 | 33 | 674 | 0·88 | — | 38 | — | Diverting reactance |
| 225 | 21 | 8 2 | 8 2 | 1·0 | — | 25 | — | — | — | 40 | — | coil across brushes. |
| 220 | 48 | 18 2 | 16·9 | 0 93 | 12 | 31 | 565 | 0·88 | — | 40 | — | |
| 208 | 0 | 0 | 0 | — | 7·3 | 17·2 | — | — | — | 39 5 | — | |

is for adjusting purposes only, the compounding being adjusted by a diverting resistance in parallel with the brushes, or by altering the turns on the current transformer. With the arrangement shown in Fig. 1, where the compounding and compensating are carried out with the same brushes, the current transformer must be large enough to supply both compounding and compensating currents when the generator is loaded with a full load of *wattless* current, so that under these conditions the potential transformer supplies no current to the brushes, its ratio of transformation being adjusted and fixed by this requirement. The no-load adjustment of the terminal pressure is done by the resistance in the exciting circuit, which is fixed permanently after the test The resistance in the compensating circuit can be dispensed with by using a separate set of brushes for compounding, but this results in a more complicated arrangement.

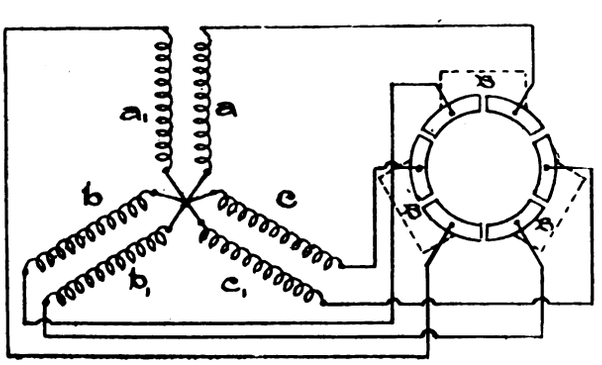


FIG. 2.

The connection of the rotor winding to the commutator, which is adopted in present machines, is slightly different to that shown in Fig. 1, although the principle is the same. It is now the practice to wind the rotor with a double star winding, each phase consisting of two separate windings, arranged side by side in the same slots. The phases are then connected up to form a six-branched star, with six ends to the commutator, as shown in Fig. 2. By this arrangement the two groups of Y connections ($a$, $b$, $c$; $a_1$, $b_1$, $c_1$) are always either together in circuit or alternately in circuit with the brushes. As a segment of the commutator leaves a brush (thus changing the circuit from one Y to the other) there can be no sparking, on account of the self-induction of one Y completely balancing the mutual induction of the other, owing to the opposite branches of the six-branched star being side by side in the same slots. By this ingenious arrangement all sparking at the commutator has been eliminated. In order to avoid the complication of more than three brushes on the commutator of multipolar three-phase machines, the segments are cross-connected by internal connectors. The number of commutator segments is not less than three per pole for compensated and six per pole for compounded machines, and the number of rotor slots is not less than two per pole per phase.

The most important portion of Mr. Heyland's work, however, relates to synchronous machines of the revolving-field type, and on this point attention should be called to an article by Mr. E Kolben on "A New Compounded Three-Phase Generator," which appeared in the *Electrical Engineer* for Nov. 27 and Dec. 4, 1903, vol. xxxii., pp. 831, 832, and 846 to 849. This new type of alternator may be said to form a complete solution to the problem of making the standard type of synchronous machine self-exciting and compounding. The remarks made with regard to the asynchronous machines are applicable to the synchronous type, the working of which will be readily understood, as the speed is always synchronous. The current in the field windings is always a direct current, and the increase of excitation required for the load is provided by the compounding current led into the commutator from the main armature circuit. The remarks below refer to a 20 kw., six-pole, 50 ⁓, three-phase machine, to

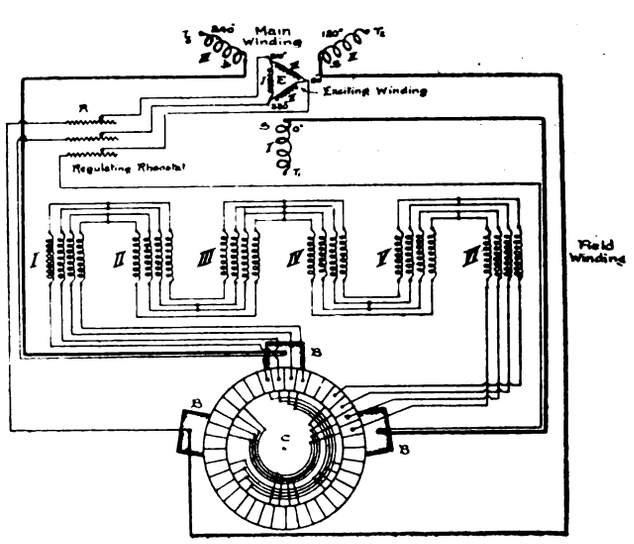


FIG. 3.

which reference is made in the article referred to above. The machine was provided with the standard stator winding for 52 amperes 220 volts, with the addition of a small separate winding for the excitation, transformers not being used in this case as the machine is a low-voltage one. This exciting winding is Δ connected, and located in the slots so that the voltage at its terminals is 90deg. out of phase with the terminal voltage of the main winding. The frame of an ordinary machine of the same size was used without alteration, as well as the stator punchings and six-pole field magnet. The exciter gives place, however, to a 36 part commutator,* while the field winding is carried out in a special manner.

The field winding of the new type of machine consists of a four-circuit winding on each spool, connected together at certain joints and also to a commutator. Fig. 3 is a diagram of the arrangement, in which the poles are numbered I. to VI., the main winding being designated by S and the exciting winding by E; R is the resistance in circuit between the exciting winding and brushes for adjusting purposes. It will be noticed that the commutator

* See the *Electrical Engineer*, vol. xxxii., p. 848, Fig. 9.

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has only four segments per pole, and that the circuits of the field windings are interconnected at symmetrical points starting from the centre. These interconnections, together with the winding, constitute a type of three-phase winding similar to the arrangement in the asynchronous machines shown in Fig. 2, and serve the same purpose—*i.e*, prevent an interruption of the circuit as the segments leave the brushes and eliminate sparking, on account of the self-induction of the circuit leaving the brush being cancelled by the mutual induction of the parallel circuit, as was the case with the arrangement of Fig. 2.

In Table I. is given some compounding tests carried out on this machine, the connections being as shown in Fig. 12, p. 848, vol. xxxii., of the *Electrical Engineer*. It will be seen from this table that these machines can be made self-regulating for constant terminal pressure, or can be over-compounded, as shown by the first series of tests, from which it will be noticed that the machine over-compounds to the extent of 10 per cent. on a load with a power factor of 11 per cent. and about 4 per cent. on non-inductive load, with a fixed adjustment of the field rheostat. In the second series of tests the amount of compounding was varied by a diverter resistance, while in the third series a diverting *reactance coil* was used instead. The employment of the latter (the idea of which is credited to Mr. Kolben) is rendered possible by the nature of the excitation, and is extremely ingenious and novel in its application. It should be noted that this new type of alternator, besides possessing advantages by being self-exciting and compounding, lends itself to a better electrical design, for the air-gap is limited by mechanical considerations, and a saving of 25 to 30 per cent in field copper over the ordinary type of alternator can be effected. The synchronous machine also requires much less copper than the corresponding type of asynchronous machine mentioned above, the saving being about 30 per cent. in favour of the former type.—MONOPHASE.

*Answer to No.* 672 (*awarded 7s. 6d.*).—When an ordinary asynchronous machine is run, either as motor or generator, it takes magnetising currents from the supply mains. These currents are in quadrature with the supply voltage. In the stator windings they produce the rotary field common to both stator and rotor. In the Heyland system of excitation the exciting currents are led through brushes and a commutator to windings on the rotor. The rotary field is produced in the rotor and not in the stator.

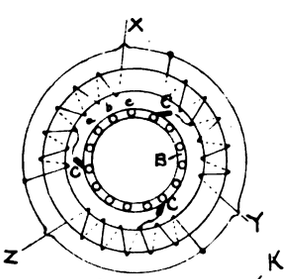

FIG. 1.

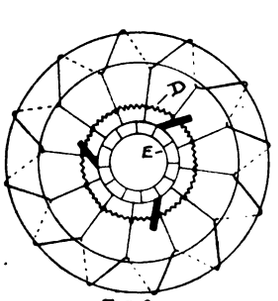

FIG. 2.

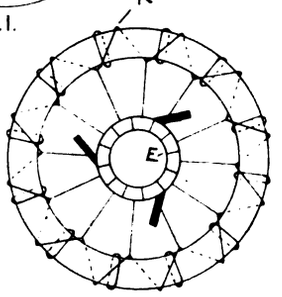

FIG. 3.

Let X, Y, Z (Fig. 1) represent the stator windings of a three-phase induction machine, and the conductors, *a*, *b*, *c*, etc., short-circuited at each end by conducting rings, B, form the squirrel-cage armature of the rotor. If currents be led through brushes, C, C, C, to the rotor armature to produce the rotary field in such a way that they have the same phase and direction as the stator magnetising currents would have, a rotary field would be produced coinciding in phase with that which would be produced by the stator magnetising currents, and this independent of the speed of the rotor. If the rotor revolves at synchronous speed—that is, speed corresponding to the frequency of supply—the field relative to the rotor will be constant, and the magnetising currents in the rotor windings will be continuous currents. Should the speed be greater or less than synchronous speed—that is, when working as generator or motor—the magnetising currents will be alternating, their frequency depending upon relative velocity (slip) of rotor and field. Supposing the rotor were stationary, the frequency and back E.M.F. would be the same as those in the stator windings, the number of coils on rotor and stator being equal. Therefore, when working, the frequency of rotor magnetising currents will be low, and the E.M.F. required to drive these through the rotor windings will be little more than what is necessary to overcome the ohmic resistance of the winding. Hence these are almost entirely wattless currents, and may be generated in a few of the stator coils, as shown in Fig. 1, or taken from a small transformer whose primary is connected to the main terminals. This current supplied to the rotor winding has nothing to do with the actual work of the machine, for the same result would be obtained by revolving an ordinary two-pole field produced by a continuous current from an external source at the proper speed. When working, the induced currents in the rotor do not flow through the brushes. The application of the above principle is shown diagrammatically in Figs. 2 and 3. The commutator, E, is substituted for the ring, C (Fig. 2). The segments (Fig. 2) are connected by non-inductive conductors, D, of small resistance, which form a damping arrangement against sparking and field pulsations. In Fig. 3, a secondary exciting winding, K, connected to commutator, E, is put on in addition to the squirrel-cage rotor winding. The latter eliminates the self-induction of winding, K. When working, currents are induced in the short-circuited rotor winding, and currents of the same magnitude flow in the opposite direction in the stator winding; the direction of the former depends on whether the machine works as a motor or as a generator. The internal wattless current being compensated for, these currents are watt-currents on non-inductive load. By strengthening the compensating current effect, the machine may be compounded against external wattless currents caused by inductive loads, as well as internal wattless currents.

When driven as a generator, the compensated asynchronous machine is not self-exciting at all speeds. Like the shunt-wound continuous-current dynamo, there is a critical speed, below which it is not self-exciting. The pressure at the terminals of the latter increases with the speed, at first due to residual magnetism, and afterwards to self-excitation, the increase during this stage being proportional to the speed. In the case of the asynchronous machine, it has no fixed polarity, and therefore no residual magnetism, and when running above critical speed must be separately excited, momentarily at least, from an external source. An E.M.F. will thus be generated in the stator and, at the same time, at the brush terminals. Thus a magnetising current will begin to flow in the rotor, and the initial field will be maintained.—H. J. W.

## WORCESTER ELECTRICITY WORKS.

In his report on the work of the Worcester Electricity Department during 1903, Mr. C. J. Sutherland, M.I.E.E, the city electrical engineer, states that a substantial profit, amounting to £1,693. 18s. 1d., had again been made, being the largest yet made, and very much more than anticipated. That result had been achieved in spite of an additional sum of £1,280. 12s. 9d. in interest and sinking fund and a contribution of £200 towards the salaries of Corporation officials having been paid. The gross profit for the year was equal to 6½ per cent. on the capital expended. The revenue from private lighting had increased in a very encouraging manner, the total being £801. 11s. 2d. higher than the previous year, and there was also an increase of £45. 3s. 6d. in the revenue derived from private motors. There had been a further large falling-off in the waterworks motors account, which was £225. 7s. 3d. lower than last year, and was a serious loss to the department. The costs showed an upward tendency, partly owing to want of water power, and partly to the running of the new station under uneconomical conditions for which it was not intended, due to the failure of the tramway company to take current on the date fixed. The cost of coal per unit had increased from ·63d. to ·75d., the other increases being small ones in stores, etc., and wages. The works

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costs had increased from 1·293d. to 1·46d., chiefly owing to increased coal consumption, and the total costs had risen from 1·59d. to 1·86d., but this included for the first time, under the heading of salaries, the sum of £200 previously mentioned as the contribution of the department towards the salaries of other officials. After commenting on the fact that, owing to the floods, very little could be done with the turbine, Mr. Sutherland says that another result of the wet season was that they were only able to run the waterworks motors for a comparatively short time, and owing to the large drop in the number of units supplied for that purpose, their net increase in units sold was only 12,932, or very little better than in 1902. At first sight that looked very poor, but when the output was analysed it was found that they sold 41,158 units more for private lighting, or an increase of 10 per cent., against only 5 per cent. in the previous year, which was an encouraging sign. Another very good sign was the increase in units sold for private motors, which had risen by 4,149, being equal to an increase of 120 per cent. Continuous-current motors were continually making progress in public favour, and already some 40 h.p. had been or were about to be connected. They had also connected 3,988 additional lamps, and obtained 56 new customers during the year. In conclusion, the engineer states that the whole of the new plant had ran admirably during the year, and there had been scarcely any attention at all required. The dynamos ran without sparking, and the engines are almost noiseless, and had ran without trouble since they were first started. The battery, which had done a large amount of work during the year, was in very good condition, which was a good report at the end of a year, as a battery often gave more trouble than any other part of the plant. The supply to the tramway company was started on Jan. 25 of this year, and there had not been any hitch whatever in the supply.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 15.

**Institution of Mechanical Engineers.**—At 8 p.m., ordinary general meeting.

**Royal Institution.**—At 9 p.m., "Korea and the Koreans," by Monsignor the Count Vay de Vaya and Luskod.

TUESDAY, APRIL 19.

**Society of Arts.**—At 8 p.m., "The Sentiment of Decoration," by Mr. Alfred East.

**Royal Institution.**—At 5 p.m., Prof. L. C. Miall on "The Transformation of Animals" (Lecture II.).

WEDNESDAY, APRIL 20.

**Institution of Electrical Engineers.**—At 7.30 p.m., students' meeting, "Armature Reactions in Alternators, with some Notes on the Running of Synchronous Motors," by Mr. H. W. Taylor. Birmingham Local Section: At 7.30 p.m., ordinary general meeting. "Some Properties of Alternators under Various Conditions of Load," by Mr. Arthur F. T. Atchison.

**Society of Arts.**—At 8 p.m., ordinary meeting. "Motorcars for Popular Use," by Mr. Mervyn O'Gorman.

**Royal Meteorological Society.**—At 7.30 p.m., at the Institution of Civil Engineers, "The Variation of the Population of India compared with the Variation of Rainfall in the Decennium 1891-1901," by Mr. W. L. Dallas; "The Cause of Autumn Mists," by Mr. J. B. Cohen.

THURSDAY, APRIL 21.

**Institution of Civil Engineers.**—At 8 p.m., Twelfth "James Forrest" Lecture. Subject: "Internal-Combustion Engines," by Mr. Dugald Clerk.

**Royal Institution.**—At 5 p.m., Prof. Dewar on "Dissociation" (Lecture II.).

FRIDAY, APRIL 22.

**Physical Society.**—At 4.30 p.m., council meeting. At 5 p.m., "Calculation of Colours for Colour Sensetometers and the Illumination of Three-Colour Photographic Transparencies by Spectrum Colours," by Sir W. de W. Abney; "On Normal Pileing as connected with Osborne Reynold's Theory of the Universe," by Prof. J. D Everett; and "Note on the Diffraction Theory of the Microscope as applied to the case when the object is in motion," by Dr. R. T. Glazebrook. Exhibition of apparatus by Mr. Peter Hecle.

**Royal Institution.**—At 9 p.m., "Sleeping Sickness in Uganda," by Colonel D. Bruce.

**North-East Coast Institution of Engineers and Shipbuilders.**—At Newcastle, general meeting.

SATURDAY, APRIL 23.

**Royal Institution.**—At 3 p.m., Mr. Cyril Devonport on "Cameos" (II.).

**Association of Municipal Engineers.**—Grimsby, general meeting.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Newcastle, May 6 and 7; Buxton, May 20 and 21.

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**Talavera de Reina (Spain).** The Municipality require tenders for installation and working for seven years of an electric lighting installation. They will pay an annual subsidy of 11,000 pesetas for street-lighting. Tenders by April 26.

## LEGAL INTELLIGENCE.

### TRAMWAY ACCIDENTS.

An appeal by the Mayor and Corporation of Leeds against a decision of his Honour Judge Greenhow in the Leeds County Court was heard by the Lord Chief Justice and Justices Wills and Channell. A person named Copley was injured by a Corporation tramcar and claimed compensation. The defendants pleaded the Public Authorities Protection Act, 1893, contending that the claim for compensation had to be made within six months of the date of the accident. The county court judge said that the words in Section I., Sub-Section (*a*) of the Act "In case of a continuance of injury or damage" were not apt words to express a continuing or recurring cause of action, whilst they did exactly express the continuance of injury or damage resulting from the act complained of. His Honour thought it might well have been intended that the action need only be brought within six months of the cessation of injury or damage, since very frequently the symptoms of really serious damage did not develop or even manifest themselves at all until many months after the original injury. On this ground his Honour found for the plaintiff for £25, which was an agreed sum.

The **Lord Chief Justice**, in giving judgment, said the construction put upon the words of the Act by the county court judge, if upheld, would amount to there being no limit at all put to the time of bringing these actions. But the learned judge was clearly wrong. The point had been fully discussed in the case of Carey *v.* the Mayor of Bermondsey, and the law on the matter was clearly laid down by the Lord Chancellor.

The appeal was allowed, and the action dismissed, with costs.

## COMPANIES' MEETINGS AND REPORTS.

### WILLANS AND ROBINSON, LIMITED.

The ordinary general meeting of the above Company was held at the Cannon-street Hotel on Wednesday last, Mr. Mark Robinson presiding.

The **Chairman** in his speech attributed the unsatisfactory state of the Company's balance sheet to three separate causes. The first of these was the serious falling off in their original business of engine building. This was not confined to the firm, but in their case it was accentuated by the fact that they no longer held their old monopoly for quality and efficiency. The Willans engine was as good as ever, but it had now rivals on its own plane, which resulted in a more effective competition. This had both diminished the volume of orders and the profits. The second cause of the loss in the balance-sheet was the Queen's Ferry works. In building up a new business like the manufacture of boilers it was not unreasonable to expect a loss, and to deal with this loss by a suspense account. The expenses at Queen's Ferry were dealt with in that way up to June, 1903. Since that date they had treated the operations as commercial working, with the result that there was a considerable loss, which had been increased by a debit for depreciation. The primary cause of the loss was the repeated postponement of the commencement of work on a commercial footing, owing to technical difficulties in both the tube-drawing and steelmaking departments. While the steelmaking and the steelfoundry had reached manufacturing success, they had decided to close down these departments, in order to save at present any further loss in building up the business. The third cause was a financial one. The Chairman explained that they had decided on good advice not to issue the balance of ordinary shares authorised last year, owing to the bad state of the money market. Under the present conditions the shares could not be issued, and the directors had had to borrow from the bank, using the reserve fund as security. This explained why the preference dividend remained unpaid in spite of the large reserve fund. The Chairman added that they had in the early part of the year invited 25 of the largest shareholders to meet the directors informally to discuss the financial position of the Company as they then knew it. These gentlemen nominated a committee of five to go more fully into the matter. These gentlemen were the following: Mr. G. W. Anderson, Mr. Edmund Carver, Mr. Alfred Holland, Mr. J. C. Peache, and Mr. J. F. Robinson, all men of weight and experience. They visited Rugby and Queen's Ferry, and it was on their advice that the steelfoundry has been closed. As regards the future, they were most deeply concerned with the success of the engine works, and were trying an improvement in the Willans engine, which, if tests are to be trusted, would restore to it much of the relative superiorities it formerly enjoyed. As regards gas-engines, they had made some of the vertical high-speed type up to 250 b.h.p., which were running with great success. The larger engines would be of the horizontal type, and of a simpler construction. The steam-turbines they had taken up were of a well-tried type, and they had introduced new details in construction and novel modes of manufacture. They had no turbine running yet, and might have to go through the usual griefs of apprenticeship. These new departures had not yet proved successes, but they were full of hope for the future. The Chairman then moved the adoption of the report.

After this had been seconded by one of the shareholders, **Sir Richard Sankey**, as trustee for the debenture holders, said that, while regretting the unfavourable balance-sheet, he was sure that the report was an honest one. They knew the worst, and must look to reforms to retrieve their position. He still had great faith in the Willans engine, and had recently seen two of these of 3,000 h.p. working successfully in a power station in South Wales.

A number of speeches followed, in which certain items in the balance-sheet were severely criticised. As the outcome of these speeches it was announced that the directors were agreeable to a proposal to strengthen

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the Board by the addition of two new directors taken from the above-mentioned advisory committee. These will be Mr. J. C. Peache, whose engineering experience will be of great value to the firm, and Mr. G. W. Anderson, who will interest himself in the financial side of the work. A special meeting of the Company is to be held for the purpose of electing these two gentlemen.

The retiring directors were re-elected, and a resolution was passed authorising the directors to borrow up to the maximum amount permitted by the articles of association—viz., 50 per cent. of the paid-up capital, less the sum already authorised to be borrowed upon debenture stock. The amount of the balance which can be borrowed under this resolution is £83,330.

## LONDON, DEPTFORD, AND GREENWICH TRAMWAYS.

The half-yearly meeting was held at Winchester House on the 6th inst.

**Mr. George Eanis**, who presided, stated at once that the Board were unable to declare a dividend, though the traffic had continued to increase. Nearly 4,500,000 passengers were carried during the past six months, being 184,000 more than in the corresponding period of 1903. The omnibus competition which they had to face had been met, to some extent, by the introduction of ½d. fares. Upwards of 356,000 ½d. tickets had been issued, but on the other hand there had been a falling off of 172,000 1d. and 1½d. fares. Taking the traffic as a whole, the revenue exhibited a small advance. The expenses showed a diminution, and the general result of the half-year's working was that the adverse balance of £3,458 had been slightly reduced. On the application of the Company, Mr. H. Graham Harris had been appointed to succeed Sir Frederick Bramwell as arbitrator in regard to the County Council's acquisition of the Company's undertaking. His award might be published any day. In conclusion, he moved the adoption of the report, which was seconded by **Mr. F. J. Horrocks.**

One shareholder observed that the concern was over-capitalised from the first, and that the fares in the past were kept too high. Another enquired if the County Council were taking over the whole of the line or only a portion of it.

The **Chairman** replied that, whatever might have been the case in the past, the fares were now very low. They were carrying passengers for 1d. from London Bridge to Greenwich. Under the notices served by the County Council, and approved by the Board of Trade, the entire undertaking was to be taken over, with possibly one reservation—namely, their parliamentary right to construct another line if they cared to do so.

The report was adopted.

The **Chairman** then proposed a resolution authorising the directors, so soon as the transfer of the property to the County Council was completed, to take the necessary steps to enable them to distribute the assets, and for this purpose to register the Company under the Companies Acts, 1862 to 1900.

**Mr. J. P. Leith** seconded the resolution, which was carried.

## BUENOS AYRES AND BELGRANO TRAMWAYS.

The sixth annual general meeting of the Buenos Ayres and Belgrano Electric Tramways Company, Limited, was held on Tuesday at 52, Moorgate-street, E.C., under the presidency of Mr. J. B. Concanon.

In moving the adoption of the report (particulars of which appeared in our issue of the 1st inst.), the **Chairman** remarked that there was every reason to be satisfied with the results. Taking the receipts in currency (the safer test for comparison, because the fluctuations in the exchange to some extent affect the sterling) there was an increase of 7 per cent. in traffic receipts, against an increase of 2·8 per cent. in expenses. That 2·8 per cent corresponded almost exactly with the increased mileage run, so that if the Company had been running the same mileage the expenses would have been stationary. The traffics for the year showed an increase of £14,447 over those for 1902, but it was estimated that about £2,300 of that amount was exceptional, owing to the visits to Buenos Ayres by the Chilians in May, and of the Brazilians in July. The fluctuation in the exchange had been rather small, but it increased the sterling receipts by something like £3,700, whilst, on the other hand, the expenses, owing to the fall in the exchange, showed an actual increase of £1,500; consequently the question of exchange last year affected the net receipts by something like £2,200. As to the outlook for the present year, the first three months up to March 31 showed an increase of £2,446. The Company's manager, in his annual report, dated Feb. 15, stated that the outlook was decidedly favourable. Building along the lines between Palermo and Belgrano still continued, and new houses were already being built along the Nunez branch. Adverting to a prospective reduction of fares on one of the other large lines in Buenos Ayres, the Chairman did not think the Company would make any change in their rates for the present.

**Mr. John Morris** seconded the motion, which, after a brief discussion, was agreed to, and resolutions were passed declaring the dividends recommended in the report.

## MERSEY RAILWAY.

The half-yearly ordinary general meeting of the Mersey Railway Company was held on the 31st ult. at Worcester House, E.C., Mr. James Falconer presiding.

In moving the adoption of the report and accounts, the **Chairman** said that the report was of special interest, because it contained the results of the first half-year of the working of the railway by electric traction, though the figures could not be taken as a complete indication of what the results of the innovation would be. The receipts showed an increase of practically £8,000 for the half-year. It was gratifying to note that it was in the latter months that the increase began to tell appreciably, and there was evidence that as the public gained experience of the system and confidence in it the traffics would develop. He pointed out that the money earned had not increased in proportion with the increase of passengers. The number of passengers had improved from 2,844,000 to 4,153,000. This anomaly was due, he thought, to the fact that the accommodation of their third-class carriages had attracted people who used to travel first and second class. The number of first-class passengers had not increased in the same ratio as the third class. It had, therefore, been decided to reduce the difference between the third and first class fares. It was also noteworthy that the increase in traffics had been mainly on the local lines. There had not been anything like a corresponding increase in the through traffic between the Mersey and other lines. The directors were of opinion that the remedy for this lay in the direction of a reduction of the through fares, and he was hopeful that the other companies would soon come to the same conclusion. They had already inaugurated a system of monthly season tickets, and he had good reason to believe that the increase in traffics would continue to develop. With regard to working expenses, he confessed that the figures were not satisfactory; but it must be remembered, in making comparisons with the corresponding figures in 1902, when the railway was being worked by steam, that they were now giving the public a very much increased service of trains. The train miles run during the half-year ended Dec. 31, 1902, were 155,000, whereas during the past half-year they were 400,000. In comparing steam with electricity they must take into account the train mileage. The cost of maintenance of permanent way in 1902 was 3·9d. per train mile by steam, whereas the cost by electricity was 1·6d. per train mile. The cost of locomotive and generating power under steam was 11·3d. per train mile against 5·2d. under electricity. Traffic expenses under steam were 13 5d. per train mile, against 7·3d. under electricity; and the cost of ventilation had been reduced from 3·4d. per train mile under steam to ·2d. under electricity, while the cost of pumping had decreased from 4·85d. to 1·5d. per train mile. The total item of working expenses per train mile under steam was 41·2d., as compared with 18·2d. under electricity. The subject of claims by the Company against contractors were still under arbitration. As to the general situation, the Company was on very friendly relations with the surrounding companies, and in communication with nearly all of them with regard to the question of through fares for the development of traffic, but he was not in a position to make any statement, as no arrangement had been arrived at.

The motion was seconded by **Mr. S. G. Sheppard.**

In reply to a shareholder, the **Chairman** said that no true comparison could be made with the working of the Central London Railway, because that line was carrying so many more passengers, and thus had a much larger income from that source. The policy of the Company was to give the very best possible service, which must eventually result in increased traffic receipts. Another favourable feature was that during the half-year no claim whatever for compensation had been made against the Company.

The report was adopted.

## CALCUTTA TRAMWAYS.

The ordinary general meeting of the shareholders of this Company was held on Tuesday at Worcester House, Walbrook, Mr. H. C. Morgan (the chairman of the Board of directors) presiding.

The **Chairman**, in moving the adoption of the report and balance-sheet (which appeared in our last issue), pointed out that there still remained 37,732 shares unissued, which would be utilised when the necessity arose for further capital expenditure. In the meantime they had in hand a sum of £17,895. 10s. 3d. from the capital already subscribed, and that was deemed sufficient for all immediate requirements. It was a matter of satisfaction to be able to record that the traffic receipts continued to improve, the aggregate up to date being £35,998, or an increase of £4,125 over the total for the corresponding period of 1903. He mentioned that sanction had been given quite recently for the construction of a line in the Harrison-road, a large thoroughfare in Calcutta connecting the railway stations at Sealdah and Howrah. It was hoped that sooner or later the Port Commissioners would withdraw their opposition to the continuation of the line over the bridge direct into the Howrah Station. In regard to Howrah itself, the inhabitants of that important and populous centre had long been anxious for a similar tramway service, and nearly two years ago the Howrah Municipality notified that they were willing to consider proposals for the laying of a system of lines in their district. It was to be hoped, therefore, that before long the Municipality and themselves might be able to come to terms satisfactory to both sides. No time would then be lost in carrying out that much-needed improvement. In other directions negotiations were in progress, and might soon be brought to a conclusion, to build a line on the south to the populous district of Bahala, along the Diamond Harbour-road, with an additional line through Alipore, connecting the new line with the present line to Tollygunge at Kalighat, and on the north to Barnagore, where a considerable traffic might be looked for by reason of the mills and industrial undertakings in that important suburb. He felt convinced that, thanks to the unremitting application and exertions of Mr. Martyn Wells, their capable managing agent in Calcutta, the Company might with confidence look forward to a prosperous future.

**Mr. H. Kimber, M.P.**, seconded the motion, and the report was unanimously adopted.

## ANGLO-ARGENTINE TRAMWAYS.

The twentieth ordinary general meeting was held on Tuesday at Cannon-street Hotel.

**Mr. H. Doughty Browne**, who presided, moved the adoption of the

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report (particulars of which appeared in our issue of the 1st inst.). The receipts had risen during the year from £254 582 to £328,994, owing to the adoption of electric traction. The working expenses had decreased by £16,700, so that the net income of the Company was £91,000 greater than it was in 1902. The conversion was carried out owing to the assistance rendered by the Argentine Electric Company. The result was that over and above the income which it was necessary to pay to the shareholders, representing a sum of £65,000, there was £15,000 for reserve and renewal, £6,000 to be carried forward, and a sufficient amount to permit of a dividend of 6 per cent. on the ordinary shares, which had been created to represent the money which the Argentine Electric Company had spent on the Company's undertaking. In regard to the future, since the old difficulty between Chili and the Argentine had ceased to exist, he thought that the prospects were favourable. On the sale of horses, rails, and cars there had been a loss, and the question had been raised by certain shareholders whether provision should not be made for it. The usual course, however, had been followed, and the new outlay had been treated as capital expenditure, so that the Board did not propose specially to write off the amount of the loss. The Company's capital was not entirely representative of outlay, but some of it was for concessions.

**Mr. J. R. Corbett** seconded the motion.

The **Chairman**, in answer to questions, said that under the agreement between the Company and the Argentine Electric Company the former were to give the latter shares of the value of £850,000. Those shares stood in the name of the representatives of the Argentine Electric Company, and no price had ever been mentioned with regard to them. Before long that company might like to issue these shares. In regard to the absorption by the Company of the City of Buenos Ayres Tramways Company, he admitted the difficulties which might present themselves, but pointed out that it was quite possible to make arrangements under which the preference shareholders of this Company would receive fair treatment.

The motion was adopted, and a final dividend of 2s. 6d. per share, less income tax, making 5 per cent. for the year, was declared on the preference shares.

A resolution was afterwards passed to the effect that, as the period of five years for which Mr. Lazarus and Mr. Concanon were appointed to serve as directors without remuneration would shortly elapse, they should be continued as members of the Board, the directors' remuneration being consequently increased by £1,500 per annum.

A sum of 2,000 guineas was unanimously voted to the chairman in recognition of the special services which he had rendered during the conversion of the undertaking to electric traction.

## PERTH ELECTRIC TRAMWAYS.

The fifth ordinary general meeting of the shareholders of the Perth Electric Tramways, Limited (Western Australia), was held on Tuesday at 3, Laurence Pountney-hill, E.C., Mr. Edward Heasman (chairman of the Company) presiding.

The **Chairman**, in moving the adoption of the report and accounts (particulars of which appeared in our last issue), stated that the return for the week ending April 8, making the fourteenth week of the current year, had just been received. The estimated working expenses for the week were £670, the estimated net receipts £774, total gross receipts £1,444. Those 14 weeks gave a total increase over the earnings of the corresponding period of last year of £2,756. Favourable comments in regard to the excellence of the system were constantly being made, and the service was giving general satisfaction to the travelling public of Perth. The chairman remarked that in financial circles the Company was already recognised as probably the most flourishing of the Colonial electric tramway undertakings, and that it had possibilities which bade fair to make it rank high, even when compared with many of our home undertakings of a similar nature. After rendering valuable service to the Company for the past six years, Mr. E. E. Rogers retired from the position of managing director in Western Australia. In consequence of this change, it was thought desirable to appoint a local Board to assist the manager and engineer, Mr. Somerset, in conducting the Company's affairs. The two gentlemen appointed were Mr. Graham Price and Mr. Harold Baker.

**Mr. Oliver Wethered** seconded the motion, which was then put and carried unanimously.

The **Chairman** next moved the re-election of Mr. Charles Wren as a director of the Company. He remarked that Mr. Wren was not only thoroughly conversant with every detail of the business, but was unremitting in his attention to the affairs of the Company.

**Mr. Robert C. Ogilvie** seconded the motion, which was unanimously agreed to.

On the motion of **Mr. Holyfield**, seconded by **Mr. Holmes**, the auditor (Mr. Andrew Wood) was re-elected.

The proceedings then terminated.

## NOTTING HILL ELECTRIC LIGHTING.

The seventeenth ordinary general meeting was held on Monday at Winchester House. The report and accounts have already been published.

**Sir William Crookes**, who presided, observed that it had been found practicable to carry out all extensions in the past year with the aid of borrowed capital, and it was obviously undesirable to increase the share capital until it was absolutely necessary to do so. This left the Company with remaining borrowing powers of £17,000, but since the close of the year a further £4,000 had been issued, so that the balance for future use stood at £13,000. The total revenue was £29,443, being £616 in excess of that of the previous year. The chairman considered this highly satisfactory, in view of the fact that by reducing the charge from 6d. to 5d. a unit the Company lost about £5,000 in revenue. The reduction was agreed on with the local Council two or three years ago, and it was one of the inducements to them to withdrawn the application they were then making for a competitive provisional order over the Company's district. At that time the decision had not been given in the case of the St. Marylebone Council and the Metropolitan Company—a decision which had now created an equitable precedent that no local authority could be granted an electric lighting provisional order until they had bought out the undertakers, who might have parliamentary powers of supply over the district. In consequence of the Company's agreeing to reduce the price and making other concessions, the Kensington Borough Council did not oppose the company's Bill for the purchase of the Council's land on which the Wood-lane works had been built, and they gave the Company favourable consideration in fixing the purchase price of the land. The directors had transferred to depreciation, renewal fund, and reserve fund account out of profits £1,250 for last year, bringing up the total to £17,750. This might be considered by some to be insufficient, but he asked them to examine the figures of the capital account, because on a right appreciation of these figures depended the policy the Company should adopt in order to assure that when, in 1931, the local authorities had the right to buy up the undertaking at a valuation, which would allow nothing for goodwill, their shares should be worth their face value, and possibly more. But in considering this policy the present generation should have as much as could be safely distributed of the earnings of the concern. The directors had abandoned the suggested alterations in regard to the founders' shares, as that body were opposed to any change. He concluded by moving the adoption of the report and the payment of dividends at the rate of 6 per cent. per annum, less income tax, on the ordinary shares for the half-year ended Dec. 31, and of 5s. per share on the founders' shares, less income tax.

**Mr. J. W. Swan** seconded the motion.

A discussion followed, in the course of which the management expenses were criticised as too heavy, and it was also contended that sufficient provision had not been made to meet depreciation.

**Mr. Arthur E. Franklin** replied, and the resolution was afterwards adopted *nem con.*

## BABCOCK AND WILCOX, LIMITED.

The report of the directors from Jan. 1 to Dec 31, 1903, states that the net profit, after deducting depreciation on plant, etc., amounts to £180,042. 13s. 5d., to which has to be added the balance brought forward from last account, £17,878. 3s. 5d., making a balance of £197,920. 16s. 10d. After deducting the interim dividends to June 30, 1903, of 3 per cent. on the preference shares and of 7 per cent. on the ordinary shares, amounting to £40,100, there is left a balance of £157,820. 16s. 10d., from which the directors recommend that the following dividends be paid for the half-year ending Dec. 31, 1903: dividend of 3 per cent. on the preference shares, from which income tax is to be deducted, £3,000; dividend of 8 per cent. on the ordinary shares, free of income tax, £42,400; bonus of 2 per cent. on the ordinary shares, free of income tax, £10,600; placing to the reserve fund £50,000; placing to the dividend equalisation fund £25,000; and leaving a balance to be carried forward of £26,820. 16s. 10d. The directors recommend that the same additions be made to the reserve and dividend equalisation funds as last year.

## BIRMINGHAM AND MIDLAND TRAMWAYS.

The total revenue for the year 1903 amounts to £86,399, and after deducting all expenses chargeable to revenue, including repairs, maintenance, and interest on debentures, there remains a profit of £19,652. 11s. 2d. Deducting the dividend on the preference shares, amounting to £222. 10s., and adding the amount of £1,979 brought forward from the previous account, there remains an available balance of £21,409. The directors propose to place to depreciation and reserve fund £9,000, and to pay a dividend on the ordinary shares (now 7 per cent. preferred ordinary shares) of 6 per cent. for the year, leaving to be carried forward £695. By a special resolution the nominal capital of the Company was increased from £500,000 to £1,050,000 by the creation of 55,000 new shares of £10 each, and the capital was divided into 35,000 5½ per cent. cumulative preference shares, 35,000 7 per cent. preferred ordinary shares, and 35,000 deferred ordinary shares, all of £10 each. The Company has since issued 20,523 5½ per cent. preference shares, 15,477 7 per cent. preferred ordinary shares, and 35,000 deferred ordinary shares, and these have been subscribed for at par by the British Electric Traction Company, Limited. The Company has purchased from the British Electric Traction Company a controlling interest in the Dudley, Stourbridge, and District Electric Traction Company, the South Staffordshire Tramways (Lessee) Company, the Wolverhampton District Electric Tramways, and the City of Birmingham Tramways Company. Negotiations are now proceeding with a view to the various tramways and light railways owned, leased, or controlled by these companies being worked as one undertaking. The joint undertakings operate over 94 miles of tramways and light railways, and about 40 miles of omnibus routes, and, in addition to the lines already constructed, this Company and the other companies above-mentioned have powers to operate when constructed approximately another 23 miles of tramways and light railways. It is anticipated that the shares and debentures and other interests acquired, together with the profits on the working of this Company's lines, will produce a net revenue for the year 1904 of about £49,000, which the directors hope will, in due course, be increased by reason of the economies and improvements which it is expected will result from the proposed combined working under one management. A contract has been entered into with the Rowley Regis Urban District Council for the construction and electrical equipment by this Company on behalf of that Council of 3 miles 6 furlongs equivalent single line of tramway, a lease for the working of which will be granted to the Com-

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pany when the lines are completed. It is proposed to make an issue of debenture stock, to enable the Company to discharge its liabilities in connection with the reconstruction and electrification of the existing lines and the erection of the power-house at Smethwick, and to provide capital for the construction of some of the authorised lines, and for general purposes. The omnibus department of the Company has shown considerable improvement, and it is expected that this department will show still better results when arrangements have been made for combined working with the omnibus department of the City of Birmingham Tramways Company. In view of the extension of the Company's business, it has been decided to transfer the registered offices to Birmingham, so as to facilitate the administrative and economical working of the various undertaking, and offices have been taken at Central House, New-street, Birmingham.

## INDO-EUROPEAN TELEGRAPH.

The report of the Indo-European Telegraph Company, Limited, for 1903, to be submitted at the meeting on the 27th inst. makes reference to the International Telegraph Conference. Further reductions in tariffs have been introduced in connection with this conference. The Company's foreign concessions have all been extended up to the end of 1924. Terms of the agreement for the leasing of land lines in this country and submarine cable wires from Lowestoft to the German coast have been agreed between the Postmaster-General, the Imperial German Post Office, and the Company, and the detailed agreement is now in course of preparation. The lines of the Company continue to work efficiently, and the direct Wheatstone working between London and Teheran, which has been completely satisfactory, has been extended to Manchester and Liverpool. The award in regard to the arbitration on the question of the incidence under the Cis-Indian Purse of higher "paid-outs" was substantially in favour of the Company. In consequence of this a certain sum, provisionally retained on suspense account, is now released. The retirement scheme for the staff has now assumed definite shape, and has been in operation since Oct. 1, 1903. The directors propose to allocate to the purposes of this scheme the sum available in consequence of the arbitration award—namely, £12,394. A fund was provisionally established at the last general meeting for the purpose of the retirement scheme, and the directors propose, at an extraordinary general meeting, to ask for the consent of the shareholders to an alteration in the articles of association to enable them to form a trust fund, and to hand over to the fund the sum of £5,000 voted by the shareholders last year (with interest at 3½ per cent.), the sum of £12,394 now proposed to be voted (also with interest at 3½ per cent.), and any sums to be voted hereafter. Revenue from all sources for 1903 amounted to £139,094, an increase of £4,789. Expenses were: on commercial and general account, £42,453; on maintenance account, £26,450—total, £68,893, an increase of £4,541. Deducting the above expenses from the total revenue a balance remains of £70,201, from which income tax paid, £3,542, has to be deducted, leaving £66,658. To this has to be added the amount brought from 1902 of £17,207, and £12,394 held in suspense and now transferred, being available in accordance with the award in the Cis-Indian Joint Purse arbitration, making a total of £95,260. From this sum has to be deducted the interim dividend of £10,625, leaving an available balance of £85,635. The directors now propose to add £15,000 to the fund for the equalisation of dividends; to hand over, as proposed above, £12,394 to the retirement trust fund to be formed; to write off a further sum of £10,000 for depreciation of reserve fund investments; and to declare a dividend for the six months ended Dec. 31, 1903, of 17s. 6d. per share (making, with the dividend already paid, 6 per cent.), and a bonus of 20s. per share, making in all 10 per cent. for the year, carrying forward £16,365.

## DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The report for 1903 states that gross receipts for the year amounted to £45,295, and expenditure to £34,217, including £2,000 placed to depreciation and renewals account, interest on debentures, cost of repairs and maintenance, and all other expenditure properly chargeable against revenue, leaving a net profit of £11,078. After deducting the dividend on the preference shares accrued to Dec. 31, 1903, and adding the balance of £365 brought forward from the last account, there remains available for distribution £6,443. The directors recommend that this should be applied as follows: to reserve (sinking fund), £2,100; payment of a dividend of 4 per cent. on the ordinary shares, leaving to be carried forward £343. There has been added to capital account during the year £14,270, principally on the installation of a small additional power station, doubling a portion of the permanent way, and the completion of the purchase of the Lye line. The Birmingham and Midland Tramways, connecting this Company's system with Birmingham, are being reconstructed for electric traction, and the work is approaching completion. That company has acquired the controlling interest formerly held by the British Electric Traction Company in this undertaking. Negotiations are now proceeding between the Birmingham and Midland Tramways, Limited, and the other companies owning or leasing lines in the district for the working of the various undertakings as one system and under one management. This Company will then form part of a system consisting of over 90 miles, all of which are of a uniform gauge of 3ft. 6in. Considerable economies, it is anticipated, will result from such a scheme.

**Damascus.**—Tenders are required by the Municipal Government for material and installation of electric lighting of the town. Particulars may be obtained from Noman Bey, 12, rue du Pot d'Or, Liège (Brussels).

## NEW COMPANIES REGISTERED.

**Pneumatophone, Limited.**—Capital, £3,000. Objects: to acquire patent rights relating to an invention by H. L. Short for improvements in methods of and apparatus for increasing the volume of sounds from telephonic and phonographic instruments, and transmitting such sounds to distances, and to develop and turn to account the same. Registered office: Palmerston House, Old Broad-street, E.C.

**Kensington Garage, Limited.**—Capital, £2,000. Objects: to carry on the business of garage proprietors, manufacturers of, dealers in, and letters to hire of motorcars, etc. Registered office: 29, Abingdon-road, Kensington, S.W.

**Lowne Electric Clock and Appliances Company, Limited.**—Capital, £8,000. Objects: to adopt an agreement with R. M. Lowne, R. J. M. Lowne, and B. T. Lowne, and to carry on the business of automatic electric clock and timepiece makers, automatic electric pendulum makers, electrical recording vane and anemometer makers, electric signal makers, electrical engineers, etc. Registered office: Ravenscroft, Bromley-road, Catford.

**Suspended Railways Contractors, Limited.**—Capital, £2,000. Object: to acquire electric, gas, water, and other works, railways, tramways, motorcars, etc.

**Britannia Electric Carriage Syndicate, Limited.**—Capital, £12,000. Object: to adopt an agreement between L. Garcin and A. Renault and F. G. Holland for the acquisition of patent No. 23,426 of 1902 to manufacture and deal in carriages, carriage appliances and devices, and to carry on the business of electricians, etc.

### Liens Registered.

**Hyde Electrical Manufacturing Company, Limited.**—£900 5 per cent. debentures; charged on the undertaking and all the property, including the uncalled capital for the time being.

**Finchley Electric Light Company, Limited.**—£400 debentures, part of a series created Dec. 7, 1903 to secure £2,000; charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £100.

**London Electromobile Syndicate, Limited, London, E.C.**—£997 10 per cent. debentures. No trustees. Charged on the undertaking and all the property, including the uncalled capital for the time being.

**Madras Electric Tramways (1904), Limited, London, E.C.**—Trust deed for £50,000 first mortgage debenture stock. Trustee. Anglo-American Debenture Corporation, Limited. Charged on freehold land in Madras, and all the undertaking, property, and assets, including the uncalled capital.

**London Electromobile Syndicate, Limited.**—£996. 19s. debentures, created March 22, and dated March 29, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

**Hyde Electrical Manufacturing Company, Limited.**—£900 debentures, created and dated March 15, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holders: Miss S. Harrison, Woodend-lane, Hyde, Cheshire; and A. H. Davies, Wilton Villa, Caerau, Mon.

## APPOINTMENTS VACANT.

**Electrical Engineer**, Singapore. Salary £360 to commence, Applications to Mr. C. C. Lindsay, M.I.C.E., 217, West George-street, Glasgow, by April 19.

**Cable Jointer,** Burnley Borough Council. Applications by April 20. See advertisement in last issue.

**Assistant Engineer,** York. Salary, £200 per annum. Applications to the Resident Engineer, Central Bank-chambers, by 16th inst.

**Chief Assistant Engineer,** Preston Tramways Committee. Salary, £200 per annum. Applications by April 16. See advertisement in last issue.

**Chief Shift Engineer,** Exeter. Salary, £109. 4s. per annum.

**Electrician for Wiring.** Apply, No. 595, *Electrical Engineer* Office. See advertisement.

**Draughtsman** for the design and arrangement of all classes of switchgears. Apply, Box L 91, *Electrical Engineer* Office. See advertisement.

**Gas Engineer and Manager and Electrical Engineer,** Malvern. Salary, £400 per annum. Applications to Mr. H. L. Whatley, Council Offices, Malvern, by April 23. See advertisement in former issue.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tenders for rails and other material.

**Amelia (Peruqia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Punta Arenas, Chile (Straits of Magellan).**—Tenders are required for the electric lighting of the town for five years from Jan. 1, 1905. Tenders by June 28.

**Royton and Crompton.**—The Urban District Council invite tenders for Section A of tramways—permanent way. Tenders by April 30. See advertisement.

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**Aberdeen.**—The Electric Lighting Committee invite tenders for the supply and erection of surface-condensing plant, air-pump, and piping. Tenders by April 30. See advertisement.

**Rhyl.**—The Urban District Council invite tenders for carbons, meters, lubricating oils, etc., for a period of 12 months from April 1. Tenders by April 18. See advertisement in last issue.

**Talavera de la Reina.**—The Municipality require tenders for electric lighting of the town—430 incandescent and a number of arc lamps are required for street lighting. Tenders by April 24.

**Derby.**—The Tramways Committee invite tenders for wiring for electric light of new car-sheds. Specifications, etc., may be obtained from the Electrical Engineer. Tenders by 12 noon on 19th inst.

**Edinburgh.**—The Council invite tenders for extension switchboard panel and steam and exhaust pipework. Specifications, etc., may be obtained from the Resident Electrical Engineer. Tenders by April 23.

**Wigan.**—The Corporation invite tenders for steel framework for construction of electric tramway car-sheds. Specifications may be obtained from the Tramways Engineer. Tenders by 12 noon on 23rd inst

**Glasgow.**—The Corporation invite tenders for an electric light installation for the Woods de District Library. Specifications, etc., may be obtained from Mr. A. B. Watson, 189, St. Vincent-street, Glasgow. Tenders by 21st inst.

**Todmorden.**—The Corporation invite tenders for the erection of the buildings, etc., required for electricity supply and refuse destructor purposes—viz.: (Section 1) buildings; (2) chimney; (3) steel roof trusses, etc. Tenders by April 18.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant: excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc. Tenders by May 17. See advertisement.

**Swansea.**—The Corporation invite tenders for the erection of an electricity station and offices at the destructor works. Specifications, etc., may be obtained from the Borough Engineer, 13, Somerset-place. Tenders by 12 noon on 19th inst.

**Martorell.**—The Provincial Government at Barcelona require tenders for installation of a telephone system with a central station at Martorell and sub-stations at Capellades, Igualada, Esparraguera and Monistrol de Monserrat. Tenders by April 18.

**Barrow-in-Furness.**—The Corporation invite tenders for surface condenser, air and circulating pumps, pipework, etc., and one electrically-driven feed-pump and connections. Specifications from Mr. H. R. Burnet, Electricity Works. Tenders by April 20.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required for their steamer and ferries, including electric globes and carbons. Particulars from the Manager's Office, Egremont Ferry, Cheshire. Tenders by May 9.

**Heckmondwike.**—The Electric Lighting Committee invite tenders for the supply and erection of feed pump and pipework, steam traction generator, water-tube boiler, main switchboard panels, induced-draught apparatus, and underground feeders. Tenders by April 26. See advertisement.

**Loughborough (Leics.).**—The Corporation invite tenders for erection of buildings for their electricity supply station to be erected in Bridge-street. Specifications, etc., can be obtained from Mr. Albert E. King, architect, Baxter-gate, Loughborough. Tenders by 12 noon on April 16.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required at the electricity supply works, including meters, cable and junction boxes, switches, and cut-outs. Particulars from the Electrical Engineer. Tenders by 27th inst.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Manchester.**—The Tramways Committee invite tenders for the supply of special (permanent-way) track work, and permanent-way points, tongues, etc. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester Tenders by 5 p.m. on 18th inst.

**Cheltenham.**—The Corporation invite tenders for the supply of slack coal to the electric works, Arle road, for six and 12 months alternatively, commencing on June 1, 1904. Particulars may be obtained from the Borough Electrical Engineer, High-street, Cheltenham. Tenders by 19th inst.

**Bray (Ireland).**—The Urban District Council invite tenders for 12 months' supply of goods required at the electric light works, including cables, carbons, house wires, switches, lamps, holders, incandescent lamps, etc. Specifications, etc., may be obtained from the Town Clerk. Tenders by May 2.

**London, S.W.**—The Westminster Electric Supply Corporation invite tenders for the supply, delivery, and erection at their Duke-street sub-station of high-tension switchboard and low-tension switchboard. Specifications, etc., may be obtained from Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders before 10 a.m. on April 18.

**Hammersmith.**—The Borough Council invite tenders for the supply of two 1,500-kw. steam turbines or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters, capable of evaporating a total of 40,000lb. of steam per hour. Tenders by May 18. See advertisement.

**Salford.**—The Corporation invite tenders for the construction of partitions, iron staircase, internal and external painting, and other works at the old electricity generating station, Frederick-road, Broughton. Particulars may be obtained at the Borough Engineer's Office. Tenders by 4.30 p.m. on April 18.

**London County Council.**—The Council invite tenders for erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Specifications, etc., may be obtained at the Architect's Department (Highways Section), Trafalgar House, 13, Charing-cross, S.W. Tenders by 10 a.m. on April 26.

**Grimsby.**—Tenders are required for wiring and supply of fittings for the electrical installation at the Alderman Dobson Schools in Harold-street, Grimsby, for the Education Committee. Specification may be obtained from Mr. W. A. Vignoles, M.I.E.E., borough electrical engineer, Corporation Electricity Works, Grimsby. Tenders not later than first post on April 18.

**Park Royal.**—The Directors of the Great Western Railway invite tenders for motor-generators, natural-draught cooling towers, electrically-driven and hand-driven overhead travelling cranes and runways, conveyors, etc. Specifications, etc., can be obtained at the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, London, S.W. Tenders by April 26. See advertisement in former issue.

**Dublin.**—The Lighting Committee invite tenders for the supply and erection of a steam generating three-phase extra-high pressure set of plant, consisting of Bellis engine and condensing plant, combined with alternators of the make of either Dick-Kerr, Electric Construction, Oerlikon, or Westinghouse, sizes 1,000 kw., 1 250 kw., or 1,500 kw., whichever can be delivered most quickly, steam and exhaust piping, and extension to switchboard. Tenders by May 9. See advertisement.

**Antwerp.**—The Board of Trade have received through the Foreign Office from H.M. Consul-General at Antwerp, a dispatch stating that the Municipality of Antwerp will proceed on 26th inst. to the public adjudication of the tenders submitted for the electric lighting of the Flemish Theatre in that town. The deposit payable on each tender is £200. A copy of specification, enclosed with the dispatch, may be seen on application at the Commercial Intelligence Branch of the Board of Trade any day between 10 a.m. and 5 p.m., and on Saturdays 10 a.m. and 1 p.m.

**London County Council Tramways.**—The London County Council invite tenders for the following switchgear—namely: (*a*) one extra-high-tension three-phase board, with operating table and instrument board; (*b*) one low-tension combined direct-current and three-phase board; (*c*) one combined extra high-tension and low-tension sub-station board; and (*d*) one extra high-tension and low-tension transformer board; and for the erection and connecting-up of the same at the Council's electricity generating station, Greenwich. Tenders by May 17. See advertisement.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto, at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Fareham.**—The Urban District Council have accepted the tender of J. Fraser and Co. for supply of a new boiler for the electric light works, at £360.

**Warrington.**—The Borough Council have accepted the tender of the British Thomson-Houston Company, Limited, Rugby, for one year's supply of electrical motors.

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**Sparkhill (near Birmingham).**—The Yardley Rural District Council have accepted the tender of Curtis and Morand, Bromsgrove-street, Birmingham, for the maintenance of fire-alarm installation.

**Hackney.**—The Guardians have accepted the tender of Messrs. Jackson Bros., Broadway, Plaistow, E., £568. 18s., for lighting with electricity the casual wards and other buildings in course of erection in Gainsborough-road.

**War Office.**—The Army Council have placed an order with Messrs. Bruce Peebles and Co , Limited, Edinburgh, for the motor equipment of the Small-Arms Factory, Enfield Lock. The contract will comprise about 1,000 h.p. in motors.

**Glasgow.**—The Corporation have accepted the tender of Archibald Low, 78, Merkland-street, Partick, Glasgow, at £2,705. 2s. 5d., for mains, cables, switchboard, distribution boards, wiring, and accessories for transmission of electric power to motors, and for lighting at Dalmuir outfall works.

**Canterbury** —The City Council have accepted the tender of Pritchetts and Gold, Feltham, Middlesex, for new battery of accumulators, at £565, the firm undertaking to maintain the battery at 90 per cent. of the original capacity for term of 10 years for an annual payment of £80.

**Leek.**—The Urban District Council have accepted the following tenders for supply of electricity meters: Reason Manufacturing Company, Limited, Lewes-road, Brighton, meters up to and including 10 amperes; Chamberlain and Hookham, Limited, New Barthomolew-street, Birmingham, meters above 10 amperes.

**Broughty Ferry.**—The Town Council have accepted the following offers in connection with the extension of the electric lighting mains to Barnhill and Seafield districts: cables, St. Helens Cable Company, £502; bitumen, W. H. Keys, West Bromwich, £7. 5s. per ton; timber, Suttie Bros., Broughty Ferry, 7s. 5½d. and 2s. 5½d. per 100ft. run.

**Maidenhead.**—The Corporation have accepted the following tenders for the supply of stores to the electric power station for 12 months, ending March 31, 1905; General Electric Company, 71, Queen Victoria-street, E.C., and Johnson and Phillips, Old Charlton, for lamps, globes, burners, etc.; Mr. Chas. Balting, Maidenhead, tools, ironmongery, engine-room and general stores.

**Arc Lamps.**—The British Thomson-Houston Company, Limited, report the following orders for arc lamps: West Ham Corporation—195 continuous-current double-carbon open arc lamps for street lighting; North-Eastern Railway—285 110-volt continuous-current multiple-enclosed arc lamps for lighting workshops, 600 7½-ampere multiple alternating enclosed arc lamps, 40 cycles, for lighting railway stations, 100 compensators for operating the alternating-current lamps from a 250-volt circuit.

**Engines and Dynamos.**—Messrs. Browett, Lindley, and Co, Limited, report the receipt of the following orders: Messrs. W. P. Theermann and Co., Manchester, for an 80-kw. engine and dynamo for Messrs. Porrits, Sunny Bank Mills, Holmshore; the British Westinghouse Electric and Manufacturing Company, Limited, for a 150-kw. engine for the Longford Wire Company, Warrington; Messrs. J. M. Sumner and Co., for a 250-h.p. engine for Russia; the New Explosives Company, Stowmarket, for a 50-kw. engine for dynamo driving; and the Electrical Company, London, for a standard 60-kw. engine for the Irwell Bank Spinning Company.

**Poplar.**—The Council have received the following tenders for the supply and erection of five three-phase alternating-current motor-generators, three switchboards (three-phase, alternating and direct current), hand travelling cranes:

Motor-generators—viz, two 250-kw. sets, two 500-kw. sets, and contingencies.

| | | | |
|---|---|---|---|
| Electrical Company | £7,392 | 0 | 0 |
| British Thomson-Houston Company | 8,323 | 0 | 0 |
| British Westinghouse Company | 8,345 | 0 | 0 |
| Dick, Kerr, and Co. | 8,532 | 0 | 0 |
| Mather and Platt, Limited | 8,740 | 0 | 0 |
| Bruce Peebles and Co., Limited | 9.060 | 10 | 0 |
| Ditto (alternative tender) (accepted) | 7,815 | 10 | 0 |
| General Electric Company, Limited | 9.060 | 0 | 0 |
| Johnson and Philips | 9.205 | 0 | 0 |
| Siemens Bros. | 9,661 | 0 | 0 |
| Electric Construction Company | 10,075 | 0 | 0 |

Switchboards and gear.

| | | | |
|---|---|---|---|
| Johnson and Phillips | 2 970 | 0 | 0 |
| Cowans, Limited, Manchester (accepted) | 3,078 | 10 | 0 |
| Kelvin and J. White | 3,297 | 12 | 6 |
| Ferranti, Limited | 3 600 | 0 | 0 |
| Siemens Bros. and Co. | 3 670 | 0 | 0 |
| Electric Construction Company | 4,537 | 0 | 0 |
| British Thomson-Houston Company | 4,930 | 0 | 0 |

Two 15-ton hand travelling cranes for sub-stations.

| | | | |
|---|---|---|---|
| J. Carrick and Sons, Edinburgh | 512 | 0 | 0 |
| Carrick and Ritchie, Edinburgh (accepted) | 560 | 0 | 0 |
| J. Hitchen, Halifax | 550 | 0 | 0 |
| Marshall, Fleming, and Jack, Motherwell | 555 | 0 | 0 |
| J. Spencer, Manchester | 630 | 0 | 0 |
| Pickerings, Limited, Stockton | 641 | 0 | 0 |
| Hunter and English, Bow | 690 | 0 | 0 |

**The Spen Valley Tramway Dispute.**—In reference to the difficulty in the working of the Spen Valley tramway system, owing to a dispute between the traction company and the Heckmondwike District Council regarding the rate of payment to be made to the latter for current, the Board of Trade have replied to the company that they cannot interfere with the agreement between the two parties,

# BUSINESS NOTES.

## TRACTION.

**Wicklow.**—Notice is published of an intended application for power to construct tramways.

**Salford.**—The Corporation are recommended by the Tramways Committee to purchase 20 additional cars.

**Motherwell.**—Owing to the success of the electric tramways, the company have resolved to double the line of rails in Hamilton-road and Brandon-street.

**Bradford.**—The proposal that the resolution of the City Council to take over the Shipley tramways should be rescinded was defeated at Tuesday's meeting.

**Metropolitan Electric Tramways.**—Letters of allotment for the issue of 4½ per cent. debenture stock to the amount of £350,000 have been posted by the company.

**Great Northern, Piccadilly, and Brompton Railway.**—Considerable progress is being made with the construction of this railway. The tunnelling is now almost complete.

**Fareham.**—At the meeting of the District Council plans for the generating station and workshops in connection with the new tramway scheme were submitted by the surveyor and approved.

**Walsall.**—During the five weeks ending the 2nd inst. the Corporation tramways carried 395,029 passengers, the receipts being £2,200. 17s., and averaging 8·87d. per car per mile run.

**Rotherham.**—Some officials of the Sheffield Corporation are about to confer with the Corporation in regard to the proposed connection of the Rotherham and Sheffield tramway systems at Tinsley.

**Perth.**—The Town Council have disapproved of the action of the Special Provisional Order Committee in deciding to request additional borrowing powers for tramway purposes to the extent of £10,000.

**Wolverhampton.**—The new Lorain tramway route from Wolverhampton to the borough boundary at Moseley village was opened on Saturday. An eight minutes' service of cars was maintained during the day.

**Torquay.**—A committee of residents has decided to present a petition to the House of Lords against the tramway scheme, alleging that it is unnecessary, and would depreciate the value of house property.

**Airdrie.**—At the monthly meeting of this Council it was resolved to ask the tramway company, in the event of an early extension of their line to Clarkston, to double the line in the centre of Airdrie at the same time.

**Rhondda Tramways.**—It is stated that the Rhondda District Council have now arranged terms with the British Electric Traction Company for the purchase of the portions of the tramways, stables, etc., within their district.

**Clacton and St. Osyth Light Railway.**—The Board of Trade has, after modification, confirmed the order made by the Light Railway Commissioners authorising the construction of light railways from St. Osyth to Clacton-on-Sea.

**Proposed Light Railway.**—At the last meeting of the Gloucestershire County Council a special committee was formed to report on the proposed scheme for a light railway from Gloucester to Worcester. The district is badly served except by road.

**London United Electric Tramways.**—At the last meeting of the Slough Urban District Council it was explained that the allegation as to the Council requiring an 80ft. road had arisen from the Council being confused with another local authority.

**Hull.**—There are 16 covered tramcars now working, and others are in course of construction. The road at the bridge on the Holderness-road is being lowered to accommodate the double-decker, and covered cars are also to be introduced on to the Hedon-road.

**Sowerby Bridge.**—At the last meeting of the District Council the plan and letter from the Halifax Corporation asking for the Council's consent to the proposed doubling of the tramway in Bolton-brow was again considered in committee, but the Council could not see their way to give the required consent.

**Wednesbury.**—The Town Council have decided to oppose any further extension of the license of the South Staffordshire Tramways Company for the use of steam on their route, and have appointed the mayor and town clerk as a deputation to wait upon the Board of Trade and explain the Council's views.

**Liverpool.**—We have received a copy of the Corporation official tramway hand-book, published at the exceedingly modest price of 1d. Its sixty odd pages are simply crammed with useful and interesting information concerning the service and the city, supplemented by a couple of excellent reference maps.

**Croydon.**—The British Electric Traction Company has obtained, subject to the sanction of the Board of Trade, an amendment in the by-laws of the tramways which will enable, during inclement weather, six or eight passengers respectively in excess of the seating accommodation to use the interior of the single-truck and bogie-truck cars.

**Stourport.**—At the last meeting of the Urban District Council a letter was read from the Board of Trade sanctioning the by-laws for overhead wires in the district, and stating that the electric tramways company had asked for their wires to be exempt for five years. It was required that no overhead wires should be less than 30ft. from the ground.

**Electric Traction on Railways.**—Mr. T. R. Thompson and Mr. Robert Forrest, directors of the Barry Railway Company, Mr. Richard Evans, general manager, Mr. Waddell, engineer to the company, and Mr. J. H. Hosgood, locomotive superintendent, are paying an extended

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visit to the Continent for the purpose of studying electric traction on railways.

**Royton.**—The District Council resolved at its last meeting that the seal of the Council be affixed to an agreement with the Corporation of Oldham relative to the purchase, construction, and working of tramways in Royton. It was also decided to make application to the Board of Trade for power to borrow money for the construction of tramways.

**Covered Cars.**—It was noted at Glasgow that during the two or three weeks that a double-decked tramcar had been running, the fares from it amounting to £1 a day more than from any other car on the route. In Liverpool the drawings from covered cars work out at an increase at the rate of £200 per car per annum as compared with uncovered cars.

**Liversedge.**—The District Council have decided to enquire of the British Electric Traction Company when they intend to complete the Hightown section of tramways by connecting the same with the Cleckheaton section *via* Mainbottom. Negotiations are in progress with the Yorkshire Electric Power Company with the view to the supply of electrical energy.

**Worcester Tramways.**—Mr. Robert Doyle, of the Worcester Tramways, Limited, has written the Board of Trade stating that the company has under consideration the wishes of the Corporation and the citizens of Worcester for the construction of the Bath road line, and every effort is being exerted to carry out, if practicable, the work within the period limited (three months).

**Scarborough.**—At the last meeting of the Corporation it was reported that the difficulties between the Tramways Company and the Aquarium Company had been satisfactorily settled, and that the Board of Trade had accepted the responsibility of satisfying themselves with regard to the strength of the roof of that structure before the tramways were allowed to run over the Aquarium top.

**Lowestoft.**—The tramway returns up to April 9 were: receipts, £7,535. 7s. 11d.; passengers, 1,676,994; mileage, 195,043; receipts per day, £28. 13s. The Great Eastern Railway have consented to the erection of a passenger shelter on their land in front of the Central railway station at an annual rent of £5. The question of the curves into the car-sheds has been referred back by the Corporation to the committee.

**Lancs-Yorks Railway.**—The electric service has been suspended for a few days in order that one or two small adjustments may be made in the equipment, which can be quickly done. It is officially notified that there is no defect in the system. The company carried out the promise for speedier running on Sunday, and the distance between Formby and Liverpool was covered in 25 minutes, special engines being used.

**Halifax.**—A trial has been made of an improved "top." The idea is to so construct the sides of the car on the roof that they shall be at once a security to the passenger from anything in the shape of an overhanging pole, etc., and also a shelter from the wind. The improved addition is the work of employés in the Halifax tramway depôt, carried out under the direction of the manager, Mr. F. Spencer. Everything passed off satisfactorily on an experimental trip.

**Chester.**—The preliminary returns of the trams to the end of the Corporation year, March 25, show a surplus, after paying all working expenses, the interest and sinking fund charges, including £805 to the last-named fund, of over £300. It is estimated that the profits made during the period between March 25 and April 6—the date on which the trams first year closed—will bring the total profit for the year up to £350. The details are: 1d. tickets, 1,878,802; 2d. tickets, 141,849; scholars' tickets, 18,068; workmen's tickets, 31,377—total passengers, 2,070,096. The total receipts were £9,178. 14s. 7d.

**Leeds.**—At a meeting of the Tramways Traffic Sub-Committee returns as to tramway fares and the cost of compensation for accidents were presented. The total amount paid as compensation for damage and personal injuries during the year ending March 25, 1903, was £2,197. 10s. 5d., equal to ·83 per cent., or 16s. 7d. for every £100 of the receipts. In the year just closed the amount was only £765. 12s. 7d., being ·27 per cent., or 5s. 4d. for every £100 of receipts. The total car receipts for the year amounted to £277,665, and the increase of £15,000 is attributed in great measure to the introduction of overlapping stages, and to some extent from the ½d. fares, which on some of the routes have led to an encouraging increase of revenue.

**Municipal and Private Lines.**—The Manchester and Glasgow Corporations have communicated with a number of corporations in regard to the successful application in the House of Lords by the Tyneside Tramways Company for compulsory running powers over practically the whole of the Newcastle Corporation tramways, suggesting that a conference on the subject be held at the Westminster Palace Hotel on April 19, and inviting the committees to send representatives to the conference. An announcement has been issued from the Private Bill Office of the House of Commons that the Newcastle Corporation have lodged a petition against the Tyneside Tramways and Tramroads Bill, which originated in the House of Lords, and has passed the various stages in the Upper House.

**Glasgow-Paisley.**—The deadlock between the Corporation and the company has not yet been removed. The subject was referred to at the meeting of the Corporation the other day. In reply to a question, the convener of the tramways department said that they had intended to open the car service to Paisley Cross, leaving the financial arrangement between the company and the Corporation for future consideration, but were now unable to do so. If they did not agree with the company as to terms, they had power to go to the Board of Trade. It is stated that negotiations are at a standstill. The Corporation have accepted an offer by the Electric and General Assurance, Limited, who undertake for one year the third-party risks for a premium of £14,000, payable in four quarterly instalments, and, in addition to the security offered by them to have their policy covered at Lloyd's, the limit for any one accident to be £2,500, and the indemnity for the year to be £25,000.

**Birmingham.**—The City Council have adopted the report of the Electric Supply Committee, recommending that sanction be sought to a loan of £441,142 for the first equipment of Summer-lane generating station, underground cable, etc., and that the committee be authorised to proceed with the work. In connection with the electrical equipment and working of the tramways running between Birmingham and Dudley, through Smethwick and Oldbury, two power stations are to be erected, one at Smethwick and the other at Oldbury, at an estimated cost of over £100,000. The plant, it is said, will cost something like £50,000, and will be laid down with the view to the generation of electricity for use on the tramways, and for public and private lighting purposes. An electric tramway is also shortly to be constructed between Old Hill and Blackheath at an estimated cost of £30,000.

**Belfast.**—At a meeting of the Law Committee of the Corporation held on Monday, the reply of the directors of the Belfast Street Tramways Company to the terms of the proposed agreement as amended by the Corporation was considered. The company have accepted practically all the amendments proposed by the Corporation. They are also willing to accept the latter's proposals in regard to the Sydenham and Ligoniel lines, with the exception that they ask for the cost of the lines to the company plus 10 per cent. instead of their value when taken over by the Corporation plus 10 per cent. There are still, however, one or two important points of difference which stand in the way of a settlement. The Corporation offer three years' net profits on the basis of the average profits for the last five years. The directors, who had originally asked for 3½ years' profits, based on the average annual profits for the last seven years, now express their willingness to accept 3¼ years' net profits, but they adhere to the seven years as a basis. It is understood that the Law Committee decided to recommend the Corporation to adhere to three years' net profits on the basis of the profits for the last five years, but to agree to the rate of interest on any outstanding purchase money being 4¼ per cent.

**Southport.**—On Monday an interesting experiment in connection with the Southport tramway service was commenced, and will be continued for the remainder of the week. This is the introduction of one of the tramway company's cars upon the Corporation route, and the transfer of a Corporation car to the Churchtown and Crown Hotel route—a mutual exchange entered upon with the view of providing relative information as to the cost of the electricity required to run the cars on the two systems. The Southport Corporation cars are furnished with two motors, while the company's cars have only one, and there is a consequent reduction of the quantity of current required by the latter. The company's cars were at first run with two motors, but it was found advisable to introduce the one-motor principle. The Corporation cars have a more difficult route to cover, and the time allowed for the corresponding stages is less. Though there is an appreciable saving of current by the use of one motor, the available speed is insufficient to compass the distance in the scheduled time, and it is regarded as probable that, should it be decided to change the motors, a compromise will be effected between the present instruments in vogue on each system and a new style of motor adopted.

**Automatic Railway Signalling.** — The automatic signalling apparatus which has been installed on the main line of the North-Eastern Railway between Alne and Thirsk by the Hall Automatic Signalling Company, of New York and Chicago, was put in service on Sunday. This is the first installation of automatic signalling in Great Britain. The system is one of electric control and mechanical operation. Each signal column is fitted with a small apparatus operated by carbonic acid gas for lowering the semaphores, the mechanism being set in motion by an electric current conveyed to the signal columns by track batteries which are operated by the passage of the trains over the metals, all of which have been bonded and supplied with a current of electricity. While a train is on a section it cuts off the current from the columns, and holds the semaphores of two sections to its rear at danger, and no succeeding train can get a clear signal until its predecessor has passed over two sections in front of it. There is an additional element of safety provided by the fact that the normal position of the signal will always automatically be at danger, so that in the event of any train meeting with a mishap it holds the line for two blocks behind at danger, it being impossible for a train to enter those sections except in the face of the signal. For the present the automatic service will be worked concurrently with the existing mechanical signals, and a man will be stationed at each automatic semaphore to report on its working. The patent automatic signalling apparatus, which has been devised by Mr. W. L. Raven, assistant mechanical engineer of the North-Eastern Railway Company, has been adapted to each signal.

## LIGHTING AND GENERAL.

**Nelson.**—Steps are to be taken to extend the electric lighting area.

**Dewsbury.**—Mr. Peace has been elected a member of the Electricity Committee.

**Glastonbury.**—An electric lighting provisional order has been granted by the Board of Trade.

**Hereford.**—The Town Council have received sanction to a loan of £500 for electric light extensions.

**Bury.**—The Council have instructed the electrical engineer, in erecting any arc lamps in the future, to fix 800-c.p. lamps.

**Elland.**—An enquiry has been held into the application of the District Council to borrow £4,000 for the purposes of electric lighting.

**Wakefield.**—The Electricity Committee have decided to reduce the charge per unit to 4d. and to abolish meter rent, this to take effect in July next.

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**Manchester.**—On Wednesday the Council sanctioned a proposal to borrow £135,000 for additional works in connection with the electricity department.

**Armagh.**—The Machinery Committee of the Asylum Board are considering a suggestion to purchase another engine and dynamo combined as a stand-by.

**St. Annes.**—The Council have received sanction to a loan of £4,000 for electric lighting mains. The period of repayment has been extended from 23 to 30 years.

**Southport.**—The Electricity Committee expect to be in a position to hand the sum of £2,000 towards the relief of the rates for the year ending March, 1905.

**Maidstone.**—Electric mains are to be extended at an estimated cost of £35, £42, and £480 respectively. The latter extension will enable the sanatorium to be lighted.

**Holyhead.**—Mr. Price White, the consulting electric engineer, has taken in hand a scheme of public lighting by electricity to every public lamp with the urban district.

**Oldbury.**—Plans submitted by the British Electric Traction Company for the erection of an electric power station at Dudley-road, Oldbury, have been approved.

**Heckmondwike.**—The District Council have agreed to the minute referred back to committee (noticed in our issue of April 1), and will proceed with the additions to the electrical plant at a cost of £5,000.

**Northwich.**—An extraordinary meeting of shareholders in the Northwich Electric Supply Company has been called to authorise the transfer of the undertaking to the Cheshire Electricity and Power-Gas Company.

**Bridgwater.**—On Tuesday, Alderman Alfred Peace, J.P., chairman of the Bridgwater and District Electric Supply and Traction Company, laid the corner stone of the power station, which is being erected on a site in Mount.

**Penzance.**—The Board of Trade have issued an electric lighting provisional order to the Penzance and District Electric Supply Company, Limited, whose registered office is at the office of Mr. J. V. Thomas, solicitor, Penzance.

**Lincolnshire and Yorkshire Electric Power Bill.**—It is understood that the promoters of the Lincolnshire and Yorkshire Electric Power Bill have withdrawn their measure from the House of Commons for the present session.

**Middlesbrough.**—The Electric Lighting Committee's recommendation that a rate of 4d. per unit be offered to consumers as an alternative to the present maximum demand system was discussed on Tuesday, and referred back to committee.

**Felixstowe.**—The following extensions are to be put in hand at once: (1) two feeders (estimated cost, £1,200); (2) extension of buildings (£350); (3) switchboard additions and remodelling to be carried out by the company (£300).

**Birmingham.**—The City Council on Tuesday authorised the Electric Supply Committee to proceed with the scheme for establishing electric light and power stations in various parts of the city, details of which we have already noted.

**Runwell (Essex).**—The rector, having experienced trouble in getting bell-ringers, has had fixed in his belfry an automaton connected with the electric current used for lighting. The church bells are now rung with perfect precision and order.

**Chepstow.**—The electric light installation was formally opened on Saturday by Mr. Henry Clay, of Piercefield Park. Extensive premises have been built by Messrs. J. and G. Griffiths and an up-to date plant laid down by the Silvertown Electrical Company.

**Berwick.**—The formal opening of the Urban Electric Supply Company's power station and works took place last week. The engines were started by the Mayoress, Mrs. A. C. Burn. The works have been running smoothly for fully six months past.

**Indo-European Telegraph Co.**—The directors recommend a dividend for the six months ended Dec. 31 of 17s. 6d. per share (making with the interim dividend already paid 6 per cent.) and a bonus of 20s. per share, both tax free, in all 10 per cent. for the year.

**Louth.**—The Council are considering a proposal of the Electric Lighting Committee that £17,000 be borrowed in order to carry out an agreement proposed by the National Electric Construction Company, Limited, for introducing electric light and power into the borough.

**Wisbech.**—The Town Council have sealed the contract with the National Electric Construction Company, Limited, for the supply of electric lighting in the town. Messrs. R. Hammond and Sons are the engineers, and an application will be made for sanction to a loan of £25,000.

**Halifax.**—The Education Committee have been authorised to spend £450 on the necessary equipment for classes in electrical engineering at the technical school. A bed-plate has just been cast for another 1,400-i.h.p. engine, which Messrs. Pollit and Wigzell are making for the generating station.

**Dudley.**—The number of electrical units supplied from the generating station during the past year was 1,729,994, showing an increase of 560,000 upon the output of the previous year. The cost has been £5,700. It is stated that the public lighting has improved where the lamps have been removed from the tramway poles.

**Sales of Plant.**—Particulars will be found in another column of the sale by the East Ham Urban District Council of a 150-i.h.p. cross-compound engine by John Musgrave and Sons, Bolton, direct coupled to a 100-kw. Dick-Kerr direct-current generator; and of others referring to gas-engines, dynamos, etc., and to special portable accumulators.

**Anglo-American Telegraph Co.**—The directors, after placing £6,000 to the renewal fund, have declared an interim dividend for the past year of 12s. 6d. per cent. on the ordinary stock, giving 25s. per cent. to the preferred stock. A year ago the distribution was 15s. per cent. on the ordinary stock and 30s. per cent. on the preferred stock.

**Gorton.**—Representatives of the District Council have interviewed the Electricity Committee of the Manchester Corporation, and offered the lease of the Gorton electric lighting order for a period of 21 years, subject to the Corporation paying a sum of £500. The deputation was informed that the matter should receive early and careful consideration.

**Leigh.**—The Tramways and Electricity Committee have engaged Mr. G. F. Metzger, of Manchester, to report and advise as to what steps should be taken to effect the most efficient economical working of the electrical undertaking in the future. The committee have also withdrawn for the present the application for sanction to borrow £8,030 for extensions at the electricity works.

**Londonderry.**—The electrical engineer reported on Monday upon several cable breakdowns, and submitted a scheme whereby these may be reduced by connecting the public arc lamps to the private lighting system. He also recommended that half the lamps be transferred at once, at an estimated expenditure of £170, and that the remainder be connected at a later date. The matter was adjourned for a fortnight.

**Airdrie.**—The directors of the Pumpherston Oilworks have placed an electrical installation amounting to over 1,500 h.p. with Messrs. Bruce Peebles and Co., Limited. The installation will consist of two 750-h.p. high-speed engines coupled direct to alternators, and will comprise in the first instance between 50 and 60 large motors. The whole work will be carried out on the three-phase alternating-current system.

**Kensington.**—The following particulars show the number of lamps used for lighting the streets in the borough: electric arc lamps, 114; refuge lamps, 42; ordinary lamps, 4,330—total, 4,486. In addition to the public lamps mentioned, there are 72 private lamps erected on the public footways or in other public positions which are lighted, extinguished, and cleaned by the Council's men at the cost of the owners of the lamps.

**Swansea.**—There are now 501 consumers on the books. The necessity of extending the present switchboard gallery is being urged, as in the immediate future provision must be made for installing a traction switchboard and also a high-tension switchboard for the lighting of Morriston. A sub-committee will deal with the matter. It has been decided to invite tenders for the supply of 1,000 tons of coal for the generating station.

**Blaydon.**—In a previous issue we noted that a committee of the District Council were considering communications from the Priestman Power Company, Limited, and from the County of Durham Electrical Power Distribution Company, Limited. The following resolution has now been passed by the Council: "Seeing that the committee have not come to any definite decision in the matter, the Council cannot see their way clear to accept either proposals at the present time."

**Dunfermline.**—Difficulties have arisen in connection with the erection of the Fife Power Company's electric generating station at Townhill, Dunfermline, between the Dunfermline Town Council and some of the proprietors as to the supplying of water to the company for the use of their engines from the Town Loch, the question at issue being to whom does the loch belong. One of the proprietors, it is stated, claims absolute right, while the others repudiate this. It is thought that the matter will be amicably settled.

**Yarmouth.**—The Town Council will light Fish Wharf and will find £300 for the purpose out of electric lighting revenue, provided £120 be borne by the Fish Wharf Committee. The resident electrical engineer in his last report states that during the past month 21 new consumers were connected to the mains, representing 677 8-c.p. lamps. There are now connected to the mains 485 consumers, representing 23,896 8-c.p. lamps. Extensions of mains are to be carried out in London-road South to about opposite Kirkley Cemetery.

**Bursiem.**—The chairman of the Electric Lighting Committee (Mr. Willett) having found that his duties as chairman of the Education Committee required so much time and attention, has resigned, and Mr. Davidson has been appointed chairman of the committee. The electrical engineer has submitted plans for a steam-driven plant to be erected on the site in Scotia-road. This has been approved by the committee, and application is to be made for sanction to borrow £21,000 to provide funds for the erection of a steam-driven electric lighting plant.

**Walton-on-Naze.**—The question of improving the public lighting on the Parade and in High-street having been considered in conjunction with suggestions made by the Coast Development Company, the Urban District Council last week resolved to offer the company 10s. per annum extra for each of 20 public lights to be fitted up with one-quarter ampere lamps, the same as now used at the end of Saville-street, the lamps to be maintained at the expense of the company in the same manner as the other lamps, and the Council to contribute £2. 10s. towards the initial cost.

**Oriental Telephone and Electric Co.**—The directors have resolved to recommend to the shareholders at the annual general meeting to be held 27th inst., and subject to final audit of the accounts, the payment of the following dividends: at the rate of 6 per cent. per annum on the preference shares for the period ending Dec. 31 last, less income tax; a final dividend of 3½ per cent. on the ordinary shares, free of income tax, making a total of 6½ per cent. for the year. The warrants will be posted on the 30th inst. The share transfer books of the company will be closed from the 16th to the 27th inst., both days inclusive.

**Derby.**—The Town Council have fixed the maximum price for electric current under the sliding scale system of supply at 5d. per unit instead of 5½d. per unit, as at present. This resolution will affect

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the smaller consumers now paying 5½d. The following estimate of expenditure on capital account for the year ending March 31, 1905, has been prepared by the electrical engineer and approved by the committee—viz., mains, £3,000; services, £600; motors for hire, £1,800; extension of lighting board, £60; meters, £400; telephones to substations, £40; sundries and contingencies, £600—total, £6,500.

**Hastings.**—Last week a recommendation by the Electricity Committee was agreed to to light the four lamps proposed to be placed in St. Helen's Park-road, between Hillside-road and Valehurst, by incandescent electric lights instead of by gas, there being an electric main in the road from which current could be obtained, the cost of wiring and fitting each lamp being put at £3, and of lighting each lamp per annum £3. 10s. The Town Council have consented to the placing of an underground telegraphic line by the General Post Office, on condition that any damage done in the placing or maintenance of the line be made good.

**New Branch.**—The Reason Manufacturing Company, Limited, of Brighton, have decided to much enlarge their street-lighting department. They have engaged Mr. Haydn T. Harrison, M.I.E.E., who is well known in connection with this branch of the business, to manage the department, and have opened offices at 11, Victoria-street, S.W., where all enquiries should be sent. We are informed that it is the intention of the company to undertake all classes of electric street-lighting, and that they will shortly be issuing a pamphlet which will illustrate many novelties for increasing the efficiency and reducing the cost of street illumination by electricity.

**Folkestone.**—At the last meeting of the Electric Lighting Committee the Town Clerk reported that he was satisfied that power for the erection by the Folkestone Electricity Supply Company of overground pillars was given by the Folkestone Electric Lighting Order of 1896, which order had been transferred to the company. The Borough Surveyor reported that these pillars would be objectionable, and he had seen the manager of the Folkestone Electricity Supply Company thereon, and suggested that an underground chamber in place thereof would be preferable, and with his suggestion the company agreed. The committee agreed to the construction of such underground chamber.

**Worthing.**—The proposed applications for sanction to borrow certain sums for street improvements and electric lighting purposes have been deferred till next month. The contractors have completed the work of reconstructing the storage battery, and the same is reported to be working satisfactorily. A great saving of fuel is expected to result. A committee is to be appointed consisting of two representatives of the Finance, Highways, and Electricity Committees, with the mayor as chairman, to consider and report upon the amount paid for street-lighting to the electricity undertaking, and to make recommendations thereon, such representatives to be selected by the several committees.

**Margam.**—An enquiry has been held into an application of the District Council for sanction to borrow £15,000 for purposes of electric lighting. Mr. Prusmann, electrical engineer of the Swansea Corporation, gave a detailed account of the proposed electric lighting scheme, and said that the South Wales Electrical Power Company had practically agreed to supply the District Council with electric light at 1½d. per unit to three points in the district. The commissioner said that it was highly improbable that the Board would sanction the loan of £15,000 upon the present terms, and he could not see his way to recommend it; but he recognised that it was necessary that they should have their own lighting.

**Hull.**—There are now over 1,000 subscribers to the municipal telephone. During the last six weeks orders for 220 telephones have been obtained by the canvasser, and practically the whole of the members of two of the principal industries of the port have agreed to become subscribers to the Corporation system. Nearly the whole of the applicants want the full service at £6. 6s. and £5. 15s. for second and subsequent instruments. Only a few applications have been received for the £3 and 1d. a call rate. The Henley Telegraph Works Company have completed 8¼ miles of the underground work, and the actual laying of the cables will be proceeded with this week. It is expected that the service will be in working order by the first week in June.

**East London and Lower Thames Electric Power Bill.**—A Select Committee of the House of Commons, Mr. Cawley presiding, on Wednesday commenced the consideration of this Bill, which is promoted with the object of incorporating and giving powers to a company for the supply of electric energy within an area of 169 square miles on either side of the Thames, extending from Hackney on the west to Orsett on the east, and from Romford on the north to the borough of Woolwich on the south. Petitions against the Bill have been lodged by many of the local authorities within the area, by the London County Council, the London Corporation, and by electric supply companies authorised to supply within the districts included. The ultimate capital required is £2,000,000.

**Stock Exchange.**—The Stock Exchange Committee have appointed April 20 special settling day for Consolidated Electrical Company's 109,251 ordinary shares of £1 each fully and partly paid, Nos. 1 to 109,251. The committee have also ordered the under-mentioned securities to be quoted in the official list: Mather and Platt's further issue of 7,495 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 32,506 to 37,500 and 87,501 to 90,000; Oxford Electric Company's further issue of 2 500 ordinary shares of £5 each, fully paid, Nos. 14,311 to 16,810; Bath Electric Tramways' 59,394 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 59.394, and 75,606 preferred ordinary shares of £1 each, fully paid, Nos. 75,001 to 150,606.

**Maidenhead.**—The electrical engineer in his last report said the load on the station continues to rise from week to week, and looks like attaining the height of the winter peak again if consumers continue to come on at the present rate. The load had dropped to 131 kw. by the end of January; it has now risen again to 146 kw. Thirteen consumers have been put on since the last meeting of the committee, and eight applications received. The equivalent 8-c.p. lamps connected are now over 11,500. The Council have adopted a recommendation that application be made for sanction to a further loan to cover the cost of the works referred to in Messrs. Burstall and Monkhouse's last report, and of any additional public lighting which the Council may determine upon in the near future.

**Perth.**—The lighting of the old Perth bridge by incandescent electric lamps is at present costing the lighting department £65. 10s. per annum, and the Electric Lighting Committee are of opinion that by the introduction of arc lamps a saving of over £20 could be effected. Consideration of the matter has been deferred until it is definitely ascertained whether the tramways are to be equipped with the electric system. Another matter to be considered is the substitution of arc lamps for the incandescent lamps in Princes-street, Marshall-place, and King-street. This, it is estimated, would cost about £25 more per annum than the present system, but not only would the lighting be better, but the extra cost would be more than met by the saving in other proposals.

**London Electrical Contractors' Association.**—The third annual banquet of the above association was held on Wednesday evening last at King's Hall, Holborn Restaurant. The president, Mr. E. L. Berry, was in the chair, and presided over a large number of members and guests. The toast-list was kept short, and was interspersed by an excellent musical programme. From the speeches which were made, we gather that the association is doing good work, and that it is officially recognised both by Government departments and by local authorities. The arrangements for working in conjunction with the Electrical Manufacturers' Association are proceeding satisfactorily, and will conduce to the usefulness of both parties. The dinner was made the occasion of a presentation to Mr. E. J. Hogan, who, as hon. secretary of the association, has done a very large amount of pioneering work.

**Agencies.**—Messrs. W. T. Glover and Co, Limited, electric cable makers, etc., Trafford Park, Manchester, have appointed Mr. John Ardrey, Granville-buildings, 43A, High-street, Belfast (telephone No. 1,134), to represent them in Ireland. A large stock of vulcanised wires and cables is kept in Belfast. We are informed by Messrs. Barry, Head, and Co., 26, Lombard-street, E.C., that in consequence of Messrs. Cochran and Co., Annan, Limited, having gone into voluntary liquidation, with a view to reconstruction, their agency for the said company was thereby abrogated. The firm have now made arrangements with Mr. James Blake, of Middlesbrough-on-Tees, whereby they become his sole agents in London and district for the sale of the "Blake" vertical multitubular boiler, and they are also now in a favourable position to supply vertical, cross-tube, marine, locomotive, Lancashire, and Cornish boilers.

**Bootle.**—The Electric Power and Lighting Committee have agreed upon the following scale of charges in lieu of the present scale: For private consumption—A flat rate of 3½d. per unit, with the option to the consumer of the demand-indicator system at 6d. per unit up to such an amount as would be used by 90 hours' continuous burning at the average highest demand for the three separate months of each quarter; 2d. per unit for any amount used in excess of the above. Whichever system be adopted by the consumer, it must operate for not less than 12 months. For power, heating, and similar purposes—2d. per unit for the first 500 units per quarter, 1½d. per unit for the next 2,500 units per quarter, 1d. per unit for all in excess of the above. In a recent report Mr. S. B. Cottrell, of the Overhead Railway Company, says with regard to the Ferranti engines that in his opinion the set tested is fully capable of giving a continuous output of 600 kw.

**Huddersfield.** — A deputation representing the Huddersfield Chamber of Trade and other users of electric light in the borough waited upon the Huddersfield Corporation Electricity Committee last week for the purpose of submitting reasons for a reduction in the price of the supply and for a revision of the meter rents. The deputation presented a comparative statement showing, *inter alia*, the price for a given number of units in Huddersfield at 4½d. per unit, with a fixed discount of 5 per cent., and an increasing extra discount from 1 per cent. for 1,000 units to 15 per cent. for 6,500. At Halifax the discount was shown at 5 per cent. whatever the quantity used, but the price per unit decreases from 4d. per unit for 1,000 units to 3d. per unit for 6,500 units. At Heckmondwike there was a charge of 4d. per unit through, with a fixed discount of 5 per cent., and an extra discount beginning at 5 per cent. for 1,500 units and ending at 15 per cent. for 5,000 units.

**Long-Distance Telephones.**—The new service between a number of provincial towns in England and in France was opened to the public on April 12, and the following congratulatory telegrams passed between the French and British Administrations: "(Translation) Under-Secretary of State for Posts and Telegraphs, to Postmaster-General, London.—On the occasion of putting into operation the new Franco-English telephone convention, the Under-Secretary of State and the French Administration of Posts, Telegraphs, and Telephones send to the Postmaster-General and the English Administration their cordial greetings" "Sous Secrétaire d'Etat, Postes, Télégraphs, et Téléphones, Paris.—Lord Stanley, on his own behalf, and on behalf of the British Post Office, warmly thanks M. Berard and the French Administration for their kind message, and cordially reciprocates their friendly sentiments." We have seen reports from Liverpool, Manchester, Birmingham, Cardiff, Leeds, Norwich, and a number of other places referring to the smooth working of the lines.

**Durham.**—A conference was held on Saturday to consider a proposal to establish electric power works on a large scale in the county of Durham under the control of the public. Several resolutions were adopted urging local authorities in the county not to enter into any arrangement with private companies for the supply of lighting or for the laying down of tramways until the report of the committee appointed by the County Council on the subject has been issued, and

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asking local authorities to help the County Council with local information. It was also resolved to urge the County Council to endeavour to arrange a conference of all local authorities with a view to the formation of a scheme for the county. A committee, consisting of the Rev. Canon Moore Ede, Mr. John Wilson, M.P., Messrs. Joseph Hopper, Vovill (South Hetton), Collins, Lowery, Davis (Hebburn), Adair, White (Sleetburn), Geegan, M. McCunon (Sacriston), P. Lee, and Barker (Neville's Cross), was formed.

**Cheltenham.**—The terms on which it is proposed to sell one of the disused 100-kw. alternators have been approved. The borough electrical engineer in a recent report on the results of his tests of the large Belliss engine which has been altered to the triple-expansion principle, says that the results were in every way satisfactory. The other large engine is to be altered to triple expansion on the same terms, subject to the sanction of the Local Government Board being first received to the necessary loan, an amount for this purpose having been included in the last application to the Board. The borough electrical engineer estimates the income and expenditure for the current financial year, after writing off £100 half sale value of No. 3 Galloway boiler and £70 for possible bad debts, as follows: income, £17,200; expenditure, £9,800; the trading surplus thus being £7,400 as against £6,780 last year. This latter sum is equal to 5 per cent. on the capital expended. Application is to be made for sanction to a loan of £2,760, made up as follows: small extensions to mains, £1,500; house services, meters, etc., £1,000; and extensions of mains to St. Paul's Church and others already sanctioned, £260. There are now 48,000 lamps wired.

**Aldrington.**—The Hove Town Council yesterday considered a report prepared by the Lighting Committee on the question of the electric lighting of Aldrington. The committee recommend the adoption of the "solid" system throughout the district. If their view finds favour, only a portion of the district will be laid for lighting in the first instance. To curtail the initial expense, it is suggested that mains be laid down one side of most of the streets instead of both sides, as originally proposed, the duplication of the mains being left till the single main proves insufficient to meet the requirements for current. As regards the provision of current, the committee have been for some time in communication with the Brighton Corporation and the Hove Electric Lighting Company with the view to ascertaining upon what terms they would supply to the Hove Corporation the current which would be required. The Hove Council do not think it desirable or economical to erect a generating station of their own, and the Council believe it would be more beneficial to get the current in bulk from the power stations at either Brighton or Hove, and distribute it where required from a small distributing station, which, comparatively speaking, would be of no expense. The negotiations with the two authorities are still pending.

**Islington.**—The Lighting Committee will report at to-night's meeting of the Council as follows: "Referring to the report which we presented to the Council on Dec. 4, 1903, we have had under consideration the probable expenditure upon services and outside works during the half-year ending Sept. 30 next. It is estimated that in this period the undermentioned works or materials would be necessary: 25 services, lighting in compulsory area, £200; 35 services, lighting in extension area, £525; 24 services, power—two and three wire, £480; 70 house terminal boxes, including compound, etc., £56; 24 house terminal boxes for power, £33. 12s.; 10 extra junction boxes on paper mains and transfer boxes joining paper to rubber mains, £55; 10 brick pits and surface covers for junction and transfer boxes, £65; 25 buried service boxes for paper cable, with compound and fuses complete, £70; reinstating and connecting on service connections to mains, £35—total estimated cost, £1,519. 12s. The foregoing estimate includes service lines, terminal boxes, fuse boxes, meter fixing, trenching, relay, and other incidental works amounting in the case of any consumer to less than £50. The Finance Committee will submit the following capital estimates: provision and laying of service lines from the existing mains, including terminal boxes, fuse boxes, meters, etc., during half-year ending Michaelmas, 1904, £1,519. 12s.; provision and laying of low-tension distributing main in Cross-street, £65; provision and laying of additional low-tension mains and transformers in Pentonville-road, £150; dividing arc circuits in Upper Holloway and Caledonian-road districts into sections with necessary high-tension switch fuses, street transformer tanks, and incidental works, £285."

**Ayr.**—A report by the burgh electrical engineer, Mr. Roland Marshall, has been agreed to, stating that during March all departments of the works ran satisfactorily. He had laid the necessary service cable for Railway Station Hotel supply, and was giving them a temporary connection for supplying about one-half of the hotel, which had already been wired. The number of lamps connected during the month exceeded those connected for the same month last year by 475, the figures being for March, 1903, 139 lamps connected, and for March, 1904, 614 lamps connected. He had also connected two additional motors, and doubled the capacity of one previously connected. The following specification by Mr. Marshall on the items for which the borrowing powers are required has also been adopted: Extensions this year—two boilers (each 250 kw.) with foundations, pipework, etc., £2,500; one 200 kw. continuous-current steam generator, £2,000; switchboard instruments, etc., £200; pipework, £250; extensions to cables, meters, and connections to consumers, etc., £2,500; extras, £50. Extensions next year—one 600-kw. steam alternating-current generator, £5,500; pipework, etc., £500; cable extensions, £1,500—total, £15,000. The two boilers have been already installed. It has been remitted to the Electricity Committee to deal with tenders for the extensions. The electricity undertaking is now making rapid progress, as is evidenced by the fact that last year the number of lamps connected showed an increase of 48 per cent., while the increase this year is even greater, and still further progress next year, necessitating the extensions aforementioned, is anticipated. The balance-sheet for last year shows a net surplus of £300. The revenue to date shows a satisfactory increase, while the expenditure is very little greater than last year.

**London Gazette.**—The partnership between Denys Leighton Selby Bigge, Richard George Bell, and George Harland Bowden, carrying on business as electrical contractors and engineers, Newcastle-upon-Tyne, Glasgow, Manchester, Swansea, and elsewhere, under the style or firm of D. Selby Bigge and Co., has been dissolved by mutual consent, so far as regards George Harland Bowden. A general meeting of the members of the Auxiliary and Light Railways and Tramways Company, Limited, will be held at 20, Victoria-street, Westminster, on May 11, at 12 noon, to have an account laid before them showing the manner in which the winding up has been conducted and the property of the company disposed of, and to determine the manner in which the documents of the company shall be disposed of. The partnership between Edward George Warren Smith, Warren Boden Smith, Edward Wythe Smith, and John Meadows Smith, carrying on business as electrical engineers, gas engineers, builders, plumbers, decorators, and house agents, Nos. 66 and 68, College-street, Chelsea, Middlesex, under the style or firm of Warren Smith and Co. as electrical engineers and gas engineers, as Brown and Smith as builders, plumbers, decorators, and house agents, has been dissolved by mutual consent. Edward George Warren Smith, Warren Boden Smith, and John Meadows Smith will continue the businesses. A general meeting of the members of the Electric Lighting Boards (British Manufacturing Company), Limited, will be held at 75, Aldermanbury, London, E.C., on May 13, at 12.30 p.m., to have an account laid before them showing the manner in which the winding up has been conducted and the property of the company disposed of. The Sheffield Electric Advertisements, Limited, will be wound up on account of liabilities. Mr. John Wilson Naylor, 4, York-street, Sheffield, incorporated accountant, has been appointed liquidator. The Electric Generating Stations, Limited, will be wound up voluntarily on account of liabilities. Mr. P. F. Huddlestone, 72, Finsbury-pavement, London, E.C., electric and mechanical auctioneer, has been appointed liquidator. A first and final dividend of 1s. 6½d. in the £ has been declared in the estate of William Henry Hooley and John William Talbot (trading as Hooley, Talbot, and Co.), Regent-street, Rugby, Warwick, electrical engineers and contractors; payable April 16 at the Official Receiver's Office, 17, Hertford-street, Coventry. A first and final dividend of 3s. in the £ has been declared in the estate of George Alfred Bagot, draper and stores assistant to firm of electrical engineers, 61, Liverpool-road, Eccles, near Manchester, Lancaster; payable April 15 at the Official Receiver's Office, Byrom-street, Manchester. The capital of the Blackpool Electric Tramways (South), Limited, has been reduced from £350,000 to £100,000, and that of the Blackpool, St. Annes, and Lytham Tramways Company, Limited, from £150,000 to £125,000. Creditors who have not sent in their claims in the estate of Arthur Stacey Redick, electrical engineer, Market-street, Dewsbury, Yorks, are requested to send before April 16 to Arthur Greenwood, Market street, Dewsbury.

**Dublin.**—Mr. Hammond's report on the official trials of the plant at the Pigeon Fort station contains the following respecting the engines: "(1) Principal points in which the generating plant complies with the specification—capacity of engines, parallel running, absence of nuisance outside the works, ability to run condensing and non-condensing, capability of working with superheated steam, cyclic variation, hand adjustment of governors, steady running, capacity of alternators, insulation resistances, temperature rise of alternators, self-regulation of alternators, excitation watts of numbers, capacity of exciter, temperature rise of exciter, freedom from sparking. (1) Principal points in which the generating plant does not comply with the specification—range of governors, momentary variation of governors, excitation watts of No. 4 regulating resistances. The above summary brings out very clearly the fact that in all points which can be measured the plant in nearly all cases complies with the printed specification, and in the important matter of the capacity of plant the contractors have given more than was asked for. In spite of the excellent results recorded above, I regret that I am unable to certify that the tests on completion have been satisfactory. In points of detail the engines leave much to be desired. The consumption of oil is very heavy, indeed, and much of it is splashed on to the floor and lost. The high-pressure guides run hot. The larger engines have a considerable rock, and the hammering of the dashpots is very marked. The 'wypers' on the valve gear are unduly worn in the sleeves. The engines are not entirely free from 'knock,' and the wobbling of the exciter, due to undue wear in the end bearings, is objectionable. Oil creeps along the engine shafts and on to the flywheels. There are leakages of steam past the valve spindles when running, and leakages of water when the engines are standing. The above are the most important points in which the engines are, in my opinion, deficient. There are other minor defects, but it would serve no useful purpose to set these out in detail here, especially as I feel that I have no other course open to me save to reject the engines under Clause 41 of the general conditions of the contract, they having failed to pass the specified tests on completion. It is now for you to decide as to the next step to be taken." The committee, after considering the report, were interviewed by Mr. Hirst, manager of the contracting company, the General Electric Company, who proposed to overhaul the Duncan-Stewart engines so as to make them satisfactory. He suggested that should the unfortunate case arise that the engines have to be removed, or during the progress of the repairing be not available, to meet the current demands of the approaching winter to divide beforehand for such contingencies in the following manner: "(1) We are prepared to erect a new 1,000-kw. or 1,500-kw. set of any make of reciprocating engines that you may desire, or any size that you may decide upon, such set to be made in accordance with the specification of your engineer. (2) We would supply this set, and have it erected as soon as possible, so that you may have the use of it in the coming winter while we are working on

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the reconstruction of the present engines. (3) The new set of plant will be erected by us upon the following conditions—viz.: (*a*) The tests to be made by the engineer under the conditions of the existing contract. (*b*) As soon as the growth of the demand for electricity necessitates the purchase by you of additional plant, the new set erected by us to be taken over by you, but the payment therefor not to be due until the expiry of two years from the date when the set of plant is certified by the engineer to have complied with the tests on completion. (*c*) The price to be paid by you to be based on fair competitive rates, to the satisfaction of the Corporation and of the Local Government Board; the same to be fixed before any work is done under this agreement, except such urgent work on the existing plants (done without prejudice) that may be necessary. (*d*) Failing the growth of the demand necessitating additional plant, no charge whatever to be made by us to you in respect of this extra set of plant." This offer was recommended for acceptance by the committee. At Monday's meeting of the Corporation resolutions were agreed to approving the committee's action in refusing acceptance of the engine portion of the generating plant by giving the contractors a further period of nine months from the date of the meeting, and such further extended period (if any), not exceeding in all 12 months from this date, as the Lighting Committee may determine, to fulfil their contract, but subject in all other respects to the terms of the specification and general conditions of the existing contract, and provided that the contractors undertake at their own expense and to the satisfaction of the committee to maintain the plant in such a condition as to be capable of affording an uninterrupted supply of energy up to the full contract working capacity and output for the proper working of the system during the period hereby given for completion of the contract, pending which the contractors shall be responsible for all loss and damage sustained by the Corporation by reason of any interruption of the supply or any portion thereof, and that the law agent is hereby directed to prepare a contract to carry out these terms; directing the Lighting Committee to invite tenders for the supply and erection of a set of generating plant not exceeding 1,500 kw., and agreeing that in case the committee considers any tender of the General Electric Company the most favourable, the Council accepts the terms contained in the paragraphs numbered (1), (2), and (3) above referred to, subject to the approval of the Local Government Board, and to the said terms being carried out by a separate contract between the Council and the contractors; if the terms of this resolution are not accepted in writing by the contractors and their sureties within seven days, and all necessary contracts entered into by them as contemplated by this resolution within 14 days of the furnishing of the drafts of same (or within such further time as committee may determine), or if such contracts when entered into are not fully carried out by the contractors, then the committee is hereby directed to put the terms of Clause 41 (*b*) of the original conditions of contract in force.

## PROVISIONAL PATENTS, 1904.

MARCH 29.

**7418. An improved hydrometer for use with electric storage batteries.** Joseph Hutton, 37, Huntriss row, Scarborough, Yorks.

**7428. Improvements in apparatus for moving electrically the points on electric tramways and railways.** Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, Booterstown, Dublin.

**7429. Improvements in metallic conduits for electric light cables and the like.** Laurence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool.

**7489. An improvement in or connected with X-ray apparatus.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

**7497. Improvements in electric arc lamps.** John James Rathbone and Eric Rivers Smith, 173, Fleet-street, London.

**7505. Improvements in electric fuses.** William Richard Macdonald and George Edward Heyl-Dia, 322, High Holborn, London.

MARCH 30.

**7527. Improvements in or relating to electro-engine vehicles.** Henri Pieper, 24, Temple-row, Birmingham.

**7543. Means for signalling and for controlling the electrification of conductor rails on railways.** William Edward Walmsley, 10, St. George's-crescent, Liverpool.

**7562. Improvements in or relating to arc lamps.** Charles Nomdedeu, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, April 11, 1903, being date of application in France.) (Complete specification.)

**7584. Improvements in or additions to overhead wires or electrical conductors of electric tramways and the like, and in supports for the same.** Arthur Henry Lucas and Thomas Greenfield, 7, Staple-inn, London.

**7586. Improvements in submarine telegraphy.** Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

**7610. Improvements in and relating to electric arc lamps.** Charles Edwin Foster, Edwin Rudolph Grote, and Milton Victor Ely, Palace-chambers, Westminster, London.

**7614. Improvements in or relating to apparatus for generating and applying electricity on railway and other vehicles.** Frederick John Beaumont and William Mudd Still, 46, Lincoln's-inn-fields, London.

MARCH 31.

**7627. Improvements relating to electroliers, gas and oil pendants, and the like.** Ernest Wilfred Sanders, 18, Southampton-buildings, Chancery-lane, London.

**7642. Improvements in and relating to electric fuses.** Leicester Richards Lee, 20, Hartington-road, Chorlton-cum-Hardy, Manchester.

**7660. Improvements in electric arc lamps.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States.)

**7661. Improvements in electric arc lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

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**7663. Improvements in electric arc lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**7676. Improvements in telephonic communication.** John Hodgson Lee, 4, Elm-grove, Peckham, London.

**7684. Combined hat rack and electric light bracket.** Henry Leitner, Lynton, Dartnell Park, Byfleet, Surrey.

**7685. Improved light diffuser for electric incandescent lights.** Henry Leitner, Lynton, Dartnell Park, Byfleet, Surrey.

**7702. Improvements in electric toy motors.** William Broad, 19, Holborn-viaduct, London (Date applied for under Patents Act, 1901, Oct. 5, 1903, being date of application in United States.) (Complete specification.)

**7710. Improvements in electric arc lamps.** Charles Edwin Foster, Edwin Rudolph Grote, and Milton Victor Ely, Palace-chambers, Westminster, London.

**7733. Electric igniting device for explosion engines.** The Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A. G., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Oct. 19, 1903, being date of application in Germany.) (Complete specification.)

APRIL 2.

**7742. Improvements in electro-mechanical apparatus for automatically operating the shunting points on electric tramways and railways.** George Dudley Aspinall Parr, The Yorkshire College, Leeds.

**7748. Improvements in switches for use in connection with electric lights and the like.** George Chisholm, 5, Corporation-street, Birmingham.

**7755. An adjustable platform and ladder for trimming electric arc lamps and like purposes.** Thomas McVey, 37, West Nile-street, Glasgow.

**7807. Improvements in machines for the transformation and generation of electric currents and energy.** Jans Lassen La Cour and Theodore Rich, 104, St. George's-square, London.

**7812. Improvements in means for supporting and lowering arc lamps or other hanging weights.** The Improved Electric Glow Lamp Company, Limited, and Norman Watsham, 1, Queen Victoria-street, London.

**7814. Apparatus for electric roasting by incandescence, and for various applications thereof by means of luminous or radiating tubes having combined calorific effects.** Charles Bauer, 72, Cannon-street, London. (George Edmond Dutertre and Marie Françoise André Nodet, France.) (Complete specification.)

APRIL 5.

**7823. Telephone transmitters.** Wallace Fairweather, 65, Chancery-lane, London. (American Electric Telephone Company, United States.) (Complete specification.)

**7824. Cluster lamp sockets.** Wallace Fairweather, 65, Chancery-lane, London. (The Benjamin Electric Manufacturing Company, United States.) (Complete specification.)

**7825. Twin lamp socket.** Wallace Fairweather, 65, Chancery-lane, London. (The Benjamin Electric Manufacturing Company, United States.) (Complete specification.)

**7833. Improvements in and relating to the ventilation and drying of electric transformers and electrical apparatus.** Leicester Richards Lee, 20, Hartington-road, Chorlton-cum-Hardy, Manchester.

**7838. Improvements in or connected with medico-electrical apparatus.** John Trotter, 121, West George-street, Glasgow.

**7869. An improved automatic power cut-out for electric railways.** Harry Frederick Pieper, 6, Breams-buildings, Chancery-lane, London. (Complete specification.)

**7881. Improvements in or relating to dynamos.** James Finney McElroy, 19, Holborn-viaduct, London. (Complete specification.)

APRIL 6.

**7937. Improvements in and relating to electric meters.** Bruno Krausse, 55, Chancery-lane, London.

**7977. Improvements in receiving devices for use in wireless telegraphy.** Georg Möller, 322, High Holborn, London. (Date applied for under Patents Act, 1901, May 2, 1903, being date of application in Denmark.) (Complete specification.)

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**7986. Improvements in or connected with electric fuses or cut-outs.** Julien Henri Mercadier, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, April 7, 1903, being date of application in France.) (Complete specification.)

**7985. Improvements relating to attachments for electric incandescent lamps.** Henry D'Olier, jun., 7, Southampton-buildings, Chancery-lane, London.

APRIL 7.

**8001. Improvements relating to electric brushes and the like.** Timothy Morris, 18, Southampton-buildings, Chancery-lane, London.

**8024. Improvements in electrical interruptors.** Albert Edward Burton and Thomas Joseph Leach, 17, St. John's-road, High-street, East Ham, London.

**8064. Improvements in or relating to the working of single lines of railway on the electric staff or other electric systems.** Charles Mark Jacobs, 70, Chancery-lane, London.

APRIL 8.

**8077. Improvements in or relating to the trolley heads of electric tramcars and the like.** Samuel Richardson Thompson, 55, Market-street, Manchester.

**8078. Improvements in tubes or conduits and like means of carrying electric or other conductors.** John Filmer Davie, 7, Campbell-road, Hanwell, London.

**8079. An improved shade carrier for electric or other lights.** Edward Phillips, 88, Gladstone-road, Sparkbrook, Birmingham.

**8089. Improvements in or relating to electromagnets for lifting a number or group of objects, such as tram-rails, bars, ingots, and the like.** Steel, Peech, and Tozer, Limited, and Henry Edward Bowen, Bank-buildings, George-street, Sheffield.

**8096. Improved means or device for catching and supporting overhead electric cables or wires when fractured.** Herbert William Denton Ingham and Thomas Morris Jones, 16, Hazeldon-road, Crofton Park, London.

**8103. Improvements in electric lifting and hauling machinery.** Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, Janus Works, Queen's-road, Battersea, London.

**8134. Improvements in automatic regulating apparatus especially adapted for use in electricity generating stations.** Frederick Richard Webb, 322, High Holborn, London.

APRIL 9.

**8139. An improved bayonet collar for electric lamps and the like.** Leonard Barlow, 8, London-street, London.

**8188. Improvements in and relating to electrical insulation.** Percy Robert Taylor, 28, St. Domingo-vale, Everton, Liverpool.

**8216. An improved electric furnace for converting pig iron into steel.** Gustave Gin, 72, Cannon-street, London (Complete specification.)

**8221. Improvements relating to electric tramways and railways working on the overhead trolley system.** Andrew Edwin McCracken, 7, Southampton-buildings, Chancery-lane, London.

**8227. Improvements in alternating-current motors.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London.

**8234. Improvements in telegraphic signalling apparatus.** Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane. (Joseph Goffin, Belgium.) (Complete specification.)

**8235. Improvements in systems of electrical distribution.** John Sedgwick Peck, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 1, 1903, being date of application in United States.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 28, 1904.*

1903.

**4972. Telegraphic apparatus.** Méray-Horváth.

**7616. Switches for starting and regulating electric motors.** Mould.

**7716. Means for controlling the working of periodically-operating electric machinery.** Johnson. (Elektrizitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co.)

**7619. Lifeguards for electric tramcars and other vehicles.** Bowring.

**9810. Electric fuse boxes.** Carolan. (General Electric Company.)

**10871. Method of making electric switch covers.** Bond, Deacon, and Leather.

**11609. Electric fuse plugs.** Carolan. (General Electric Company.)

**12260. Apparatus for controlling and operating the rail points and overhead points or frogs of electric and other railways and tramways.** O'Neill.

**14163. Apparatus for electric lighting.** Le Tall. (Cooper-Hewitt Electric Company.)

**18602. Adjustable support or carrier for an electric incandescent lamp.** Taylor.

**18712. Double point of electric rails of the conduit system so that the car can always pick up the current.** Holbrow.

**23805. Electric furnaces.** Schneider.

1904.

**2467. Clockwork electricity meters.** Aron.

**2602. Interchangeable electric display apparatus.** Levy. (Date applied for under International Convention, Feb. 10, 1903.)

**3631. Circuit controllers for induction coils.** Hays. (Varley Duplex Magnet Company.)

**3774. Vapour electric lamps.** Wood. (Date applied for under International Convention, Feb. 14, 1903.)

**4138. Telphers.** Siemens Bros. and Co., Limited. (United Telpherage Company.)

**4451. Electrical switches.** Sperryn and Wood.

**4646. Metallic circuit intercommunication telephones.** Petmeky.

**4698. Non-magnetic compensating balance for horological instruments.** Guillaume.

**4891. Electric ignition apparatus for internal-combustion engines.** Brotherhood and Bryant.

**5071. Apparatus for regulating and controlling the voltage of alternating-current circuits.** Stuart. (Date applied for under International Convention, March 12, 1903.)

**5560. Coils for electrical machines.** De Kaiser. (Date applied for under International Convention, May 1, 1903.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ¼-⅛ |
| Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5⅞-6¼ |
| —— 5 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5⅛-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3⅞-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 92-95 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | .. | ⅛-⅜ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | ⅛-1¼ |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | .. | 96-99 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 72-77 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1½-2 |
| —— 5 per cent. Debentures ..... | 100 | .. | 96-99 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ⅛-1¼ |
| —— 5 per cent. Debentures ..... | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | .. | 1½-1⅜ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¼-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9-9¼ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 11¼-12¼ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | .. | 18-19 |
| —— 4 per cent. Debentures ..... | 100 | .. | 98-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14¼-15¼ |
| Telegraph Construction and Maintenance ..... | 12 | .. | 33-36 |
| —— 5 per cent. Bonds ..... | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | .. | ⅜-½ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | .. | 113-116 |
| Bournemouth and Poole, Ordinary ..... | 10 | .. | 12-13 |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | .. | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 102-105 |
| Brompton and Kensington, Ordinary ..... | 5 | .. | 10¼-11 |
| —— 7 per cent. Preference ..... | 5 | .. | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | .. | 6¼-7 |
| —— Nos. 20,001-30,000 ..... | 5 | .. | 7-8 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | .. | 14½ |
| —— " £10 Ord. .... | 6 | .. | 10⅜ |
| Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock | 100 | .. | 105-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7-7½ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 102-104 |
| Chelsea Electricity Supply ..... | 5 | .. | 6-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary ..... | 10 | .. | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref. ..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary ..... | 10 | .. | 7-8 |
| —— 6 per cent. Cum. Pref. ..... | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | .. | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5⅜-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | .. | 5⅜-6⅛ |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11-12 |
| —— per cent. Debenture Stock Red. ..... | 100 | .. | 101-104 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅝-10¼ |
| London Electric, Ordinary | 5 | – | 1-1½ |
| —— 6 per cent. Pref. | 5 | – | 4½-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 94-97 |
| Metropolitan Ordinary | 10 | – | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | .. | 98-102 |
| Oxford Electric, Ordinary, 1-96 and 4,-14,310 | 5 | .. | 5½-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98-101 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | – | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | – | 95-90 |
| South London, Ordinary | | – | 3-3½ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 |
| —— 3½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4⅛-4⅞ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4⅞-5 |
| Westminster, Ordinary | 5 | – | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6⅛ |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 90-93 |
| —— 4 per cent. Pref. | 100 | – | 98-101 |
| —— ,, ,, deferred | 100 | – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-113 |
| City and South London, Consolidated Ordinary | 100 | – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 123-126 |
| —— ,, ,, ,, '96 | 100 | – | 120-123 |
| —— ,, ,, ,, '01 | 100 | – | 118-122 |
| Liverpool Overhead, 5 per cent. Pref. | – | – | 13-13½ |
| —— Ordinary, 1-50,000 | – | – | 7⅞-8 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 103-104 |
| Waterloo and City, Ordinary | 100 | – | 89-92 |

## Electric Tramways.—

| | | | |
|---|---|---|---|
| Anglo-Argentine, 1-260,007 | 5 | – | 4⅛-5⅛ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13½-14½ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 | .. | 99-102 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 | .. | 10½-10⅝ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-105 p.c. |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 8½-9⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10½-10⅝ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 116-119 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-3 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5½-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 104-107 |
| —— Prov. Cert., all paid | 100 | – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | – | 1½-2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅜-5½ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 101-104 |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 13-14 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— Debentures | 100 | – | 96-99 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-13½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 22-22½ |
| —— 6 per cent. Cum. Pref. | all | – | 14½-15½ |
| —— 4½ per cent. Deb Stock | 100 | – | 112-114 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | .. | 3½-4 |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11½-11⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | – | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | – | ¾-1 |
| New General Traction, Ordinary | 5 | – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 10½-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 | – | 11½-12½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | – | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8½-9⅛ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,132 5 per cent. Preference | 1 | – | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 103-106 |
| —— Deferred Stock | 100 | – | 85-87 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 10-12 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 4⅞-5⅛ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 97-99 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 99-101 |
| Oriental Telephone and Electric Company | 1 | – | 15/16-1 1/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 9 | 1,206 | 934 | + 271 | +10,906h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 2 | 184 | 185 | – 1 | + 161 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 9 | 36 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 10 | 1,059 | 1,070 | – 11 | – 59 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 9 | 319 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 8 | 1,122 | 1,058 | + 64 | + 650 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 7 | 1,445 | 376 | +1,057 | + 1,069 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 9 | 632 | 582 | + 49 | + 34 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 10 | 1,810 | 2,390 | – 580 | – 238 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 6 | 1,565 | 850 | + 715 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 9 | 4,805 | 3,801 | +1,004 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 10 | 980 | 98) | — | — h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 8 | 5,782 | 4,772 | +1,010 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 9 | 971 | 1,028 | – 57 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 10 | 363 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 9 | 2,194 | 1,872 | + 321 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 9 | 231 | 210 | + 21 | + 316 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 9 | 6,673 | 6,513 | + 160 | + 319h | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 10 | 2,822 | 2,713 | + 109 | – 811h | 6⅝ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 7 | 461 | 478 | – 17 | – 146 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 1 | 273 | 225 | + 48 | – 239 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 9 | 245 | 246 | – 1 | – 121 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 10 | 144 | 126 | + 18 | + 103h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 8 | 4,018 | 3,735 | + 273 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 8 | 918 | 824 | + 94 | | | | | | | | | | | |
| Dundee City Tramways | ,, 6 | 851 | 823 | + 38 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 9 | 833 | 723 | + 110 | + 72 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 2 | 13,411 | 13,174 | + 237 | +55,049h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | ,, 6 | 3,003 | 2,272 | + 731 | + 339 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 9 | 1,546 | 1,186 | + 360 | + 8,914 | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | ,, 9 | 2,213 | 2,001 | + 211 | – 153 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilkeston Corporation | Mar. 30 | 132 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | April 6 | 233 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 9 | 6,185 | 5,358 | + 827 | + 2,139 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 2 | 9,943 | 9,685 | + 248 | + 3,223 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 10 | 1,776 | 1,685 | + 91 | + 349h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | Mar. 12 | 10,129 | 8,604 | +1,525 | +84,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 19 | 124 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | April 9 | 12,147 | 12,083 | + 64 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 9 | 107 | 84 | + 23 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 9 | 3,791 | 3,337 | + 454 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 9 | 561 | 434 | + 127 | + 151 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 9 | 2,468 | 1,852 | + 616 | + 616 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 4 | 148 | 119 | + 29 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66f |
| Rotherham Corporation | Mar. 17 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | April 11 | 3,771 | 4,063 | – 292 | – 234 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 10 | 4,886 | 4,476 | + 410 | – 437 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 7 | 1,074 | 908 | + 166 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Sunderland Corporation | ,, 10 | 1,249 | 1,224 | + 25 | — | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 11 | 789 | 662 | + 125 | — | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 7 | 807 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 6 | 705 | 413 | + 292 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**Faraday House.**—In the recent examination of the Electrical Standardising, Testing, and Training Institute, Leonard Van Vestrant, of Wellingborough Grammar School, gained a Faraday Scholarship of 80 guineas per annum, tenable for two years.

**The "Biophotophone."**—A demonstration was given last week in the Fulham theatre of a new electric apparatus, termed the Gaumont-Messter biophotophone, which displays speaking living pictures, being, in fact, a combination of the cinematograph and the gramophone. The effect was most realistic.

**Index to Mining, etc., Literature.**—"The Index to Mining, Mechanical, and Metallurgical Literature for the Year 1901," published by the North of England Institute of Mining and Mechanical Engineers, has made its appearance, price 42s. The work, which is of world-wide scope, has been done very thoroughly, the number of publications indexed exceeding 900, whilst references to electricity alone run into four figures. Its value is undoubted, and the range covered would account in some measure for the delay between the period treated and the date of issue, but a reduction of this interval would be welcomed. We understand that the index for 1902 is in course of preparation, and will shortly be issued.

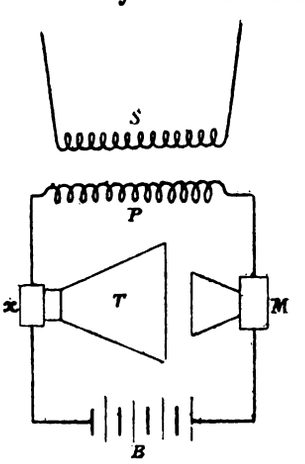
**New Use for the Searchlight.**—The *Electrical World and Engineer* of New York relates an instance of the effective use of the searchlight. Prof. C. L. Cory, of the University of California, the head of the electrical engineering department, recently caused a sensation at Berkeley, Cal., by adopting modern military methods to prevent a prohibited college "rush." One of the classes had planned to storm a high hill near the university and paint their class number in white on the hillside where it could be seen for miles around. Prof. Cory had an electric searchlight trained on the hill from the top of the mining building. A force of armed policemen lay in ambush until 1 a.m., when one of them gave the signal, which resulted in the capture of the luckless students, revealed by the powerful rays turned on them as they scaled the heights.

**The Metric System.**—In moving the second reading of the Weights and Measures Bill last Friday, Mr. Bousfield remarked that the fourth section proposed to substitute the metric system for troy and apothecaries' weights after Jan. 1, 1908, and so effect a portion of the reform embodied in the measure now before the House of Lords. Sir Howard Vincent and Sir Albert Rollit cordially approved of this scheme, but Mr. Gerald Balfour and Sir G. Bartley, who expressed a preference for the duodecimal system, if there were to be a change, were strongly opposed to it. The President of the Board of Trade considered that the clause should not have been introduced, as, besides being a distinct subject, it only touched the fringe of the metric system. Ultimately the Bill was passed for its second reading on Mr. Bousfield undertaking to withdraw this section in committee.

**Swansea Telephones.**—The municipal telephone exchange at Swansea has now been working about five months, and the accounts of the department have been recently carefully gone into by the borough accountant. His conclusions are that the result of the first year's working will most likely show a surplus fund after the interest and sinking fund charges have been met. There are now some 750 subscribers connected to the exchange, while 205 orders for connection have still to be met. It would seem that orders are coming in quite as fast as connections are being made. In consequence, the number of subscribers is likely to reach 1,000 before the end of the summer. The original loan will be exhausted by then, and the Corporation are now looking into the advisability of applying for sanction to borrow £15,000 more for the extension of the system to provide for 1,500 lines.

**"The Tyneside Electrical Pioneer."**—We have received No. 1 of the above periodical, which is being issued by the Newcastle-on-Tyne Electrical Supply Company for the purpose of developing the demand for the supply of electric light and power in the Newcastle area. It consists of eight pages of matter, several of which are entirely taken up by high-class illustrations, and a highly coloured wrapper. The information given is of a technical order, but here and there an observation is included which, as the editor puts it, is intended to be humorous. Amongst these is one to the effect that it is considered bad form in the higher circles of society to attempt to blow out the electric light. Use the switch instead. A short reference to the use of electric motors in printing work is well prepared, and is accompanied with a list of 12 different firms in the Newcastle area who use electric power in their printing works. We wish our small contemporary every success in the direction for which it is issued.

**The Production of Alternating Currents.**—M. Ducretet describes in *l'Eclairage Electrique* an interesting method of producing alternating currents. The arrangement is shown diagrammatically herewith. B is a battery, T a




loud-speaking telephone (the transmitter, M, being placed exactly opposite the receiver, $x$), and P – S the primary and secondary windings respectively of a transformer. By tapping T, vibrations are set up in the system which produce a sound similar to that of an organ pipe in intensity and purity, the key depending on the distance between $x$ and M. With this arrangement the current may amount to one ampere. The author remarks that the receiver can be connected with M through a tube of suitable length, and then proceeds to describe an arrangement for assisting in the production of currents up to two amperes. It should be mentioned that the function of the transformer, P S, is to convert the undulating currents into alternating currents.

**Automatic Ore Loader.**—We notice in the columns of the *Scientific American* an interesting description of an automatic ore loader used by the Illinois Steam Company at South Chicago, for handling the ore and lifting it from the ore dump into the iron wheelbarrows used to charge the furnaces. The machine in question was built by the Park Manufacturing Company, of Chicago, and consists of an endless chain of metal scoops which are mounted on a stout metal table, the table itself being mounted pivotally on a truck, to enable it to adjust itself to the pitch of the ground and the height to which the material is to be elevated in loading. The chain of scoops, which is driven by an

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electric motor, passes around sprockets arranged at the opposite ends of the machine. By means of chains, sprockets, and suitable clutches, the electric motor also serves to propel the loader, moving it to any desired point of the yard. This particular type of machine has been tested successfully in the handling of limestone, coal, and salt, and it has shown a considerable saving of time and money in loading over hand-labour with a shovel. The capacity of the machine is 90 cubic feet per minute of loose material. We are not quite clear, however, that the apparatus has much advantage over an electrically-driven grab, such as has frequently been used in this country in connection with coal-handling in and about electric lighting stations.

**Lighting and Traction at Rangoon.** — The Municipal Council of Rangoon, having decided upon electric lighting and traction, invited tenders. It appears from *Indian Engineering* that the selection was narrowed down to those of the Brush Electrical Engineering Company and Messrs. Darwood and Co., of Rangoon. The tender of the first-named was the lower by Rs.1,386, but attached to it was the stipulation that the date of purchase should be extended from 42 to 49 years, while their offer of Rs.4,000,000 for the existing tramway was less than half that of the Rangoon Company. The Municipal Council, however, recommended the Brush Company's tender to the Local Government. The Local Government intimated that under the Indian Electricity Act of 1903 an extension of the term of the license beyond 42 years was *ultra vires*, pointed out the disparity between the offers for the existing tramway, and suggested that enquiry should be made as to the financial capability of the Brush Company in regard to the scheme. Thereupon the Municipal Council communicated with the Brush Company as to what guarantee the latter would give, whether they would agree to the term being 42 years, and whether they would pay any excess over their tender for the tramway that might be fixed by the arbitrators as its value. At this stage Messrs. Darwood and Co. protested against the treatment of the tenders, and claimed the same privileges of amending their tender as were being accorded to their rivals. The reply of the Brush Company was that they would give suitable guarantees, but that they adhered to their original terms as regards the period of the concession, and finally the Municipal Council decided in favour of Messrs. Darwood and Co.

**Cost of Supply.**—We have received from Rotherham a local paper in which there are some interesting comments on the Corporation's method of charging for current. These comments, evidently written in good faith, call our attention to a special duty which is incumbent on all electrical engineers in charge of electric supply undertakings in small towns. It is not enough that they should inform their committees of the inter-relation between the cost per unit sold and the number of units produced with a plant of a given size, but they should also organise classes for the editors of the local papers, so that they may avoid obstructive comments of the kind before us. It seems that a proposal was made to light the workhouse electrically, which would require some 700 lights and consume about 30,000 units per annum. The electrical engineer advised that this should be supplied at 3d. per unit, although the average cost per unit at Rotherham for last year was higher than this. It seems, however, that in this total cost there was no less than 2½d. per unit for capital charges, owing to the fact that the plant had not obtained a load commensurate with its capacity. This fact is well known to the editor of the paper in question, as he alludes to it in his comments, notwithstanding which he fails to see that by increasing the number of units sold a decrease is immediately effected in the average cost per unit. We have no doubt that the engineer at Rotherham will be able to demonstrate both to his committee and to the Council the advantage of accepting his figures as commercially sound, but we are equally sure that there will be a number of readers of our contemporary in question who will conclude that the electric lighting undertaking is anxious to light the workhouse because it is likely to end its days in that establishment.

**An Electrical Heading Machine.**—Some time ago we referred to the paper on "Electric Coal-Cutting" read by Mr. W. Walker at the annual meeting of the Institution of Mining Engineers. Since then a paper has been read by Mr. Percy C. Greaves on "An Electrical Heading Machine." The author describes the result of the introduction of an electric heading machine into the colliery with which he is connected. As there was no British machine on the market, the "Jeffrey," an American invention, was selected. The machine, which stands 18½in. high (21in. on the runners) and weighs about 30cwt., consists of a moving frame, round which the cutting chain travels, with the motor and gearing fixed on it. This frame travels through guides on a stationary frame, 9ft. long, which is fixed in the direction of the cut by means of two jacks; one at the front is placed against the coal-face and set at an angle, in order to take the thrust of the machine as the chain is entering the undercut; the other jack is set from the back of the stationary frame to the roof, and the two jacks hold the frame firmly in position. The motor, of 15 h.p., runs at a speed of about 900 revolutions per minute. The rate of feed for cutting has been reduced from 2ft. to 1ft. per minute, but the withdrawal of the machine can be made in 30 seconds. At the present rate of cutting the machine takes 26 amperes at 480 volts, say 16½ h.p., so that the motor is somewhat overloaded, and Mr. Greaves recommends some increase in its size. As no run exceeds six minutes, there is plenty of time for the motor to cool. Taking a quarter's working, the author found that the machine made 226 cuts to an average depth of 5ft. 7in., 223 shifts had been worked, and 415 yards had been driven. This shows a highly favourable result, as an economy of 3s. 1d. per yard was effected on the schedule price that had been paid for hand labour—*i.e.*, 9s. 7d. per yard. It was a demand for an increase to 11s. 3d. per yard which led to the trial of the "Jeffrey."

**International Electrical Congress.**—At the first meeting of the International Electrical Congress Reception Committee of the American Institute of Electrical Engineers, held at New York on Thursday evening, March 24, the programme in connection with the visit of the foreign guests of the institute, who are expected to arrive in the American capital by Sept. 3, was formulated, and will doubtless prove both enjoyable and instructive. The itinerary will commence on Sept. 4 with a journey up the Hudson River by steamer. In the course of the week the visitors will be entertained by the New York corporations, under whose guidance they will inspect the power-houses of some of the chief New York companies; there will be a formal reception under the auspices of the institute; the party will be received and entertained at Schenectady by the General Electric Company, following which they will leave for Albany, and in the evening start on an all-night trip to Montreal; McGill University and large transmission plants in the neighbourhood will be visited; the Niagara Falls will receive attention on the Friday; and the next day will see the party exploring Chicago, leaving in the evening for St. Louis. On Monday, Sept. 12, the opening of the international electrical congress, at 10 a.m., will take place, and on the Wednesday there will

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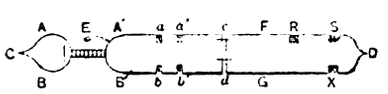
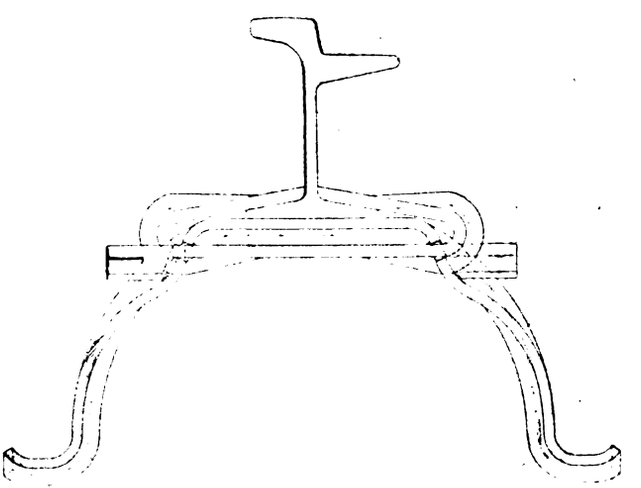
be a special joint session between the American and British institutions. Sessions of the various sections of the congress will be held from the 13th to the 17th, after which the party will leave St. Louis for Pittsburg. The following week, commencing Sept. 19, will begin with a reception and entertainment by the Westinghouse Company, other events being the inauguration of the National Bureau of Standards at Washington, and visits to Philadelphia and Harvard University, the Massachusetts Institute of Tech nology, and other places of interest at Boston. This is a very comprehensive programme, and will, of course, entail a large amount of travelling, but the committee are evincing every solicitude for the comfort of their visitors, special arrangements being made for the ladies that are expected.

**Telephone for Measuring Self-Induction.**—The *Physical Review* publishes an account by Messrs. W. Duane and C. A. Long of some experimental work they have done by means of the differential telephone for measuring self-induction. A differential telephone receiver is one on the bobbin (or bobbins), of which two coils, A A′ and B B′, are wound side by side. By suitable means these coils are adjusted so as to have equal self-inductances and equal resistances, and so that the magnetising effect of a current flowing through one coil from A to A′ is exactly annulled by that of an equal current flowing through the other coil from B to B′. A variable self-inductance standard, S, is joined in series with coil A A′, and the coil of unknown self-inductance, X, in series with coil B B′. A non-inductive variable resistance, R, is inserted in series with S or X,




according as the resistance of X is greater or less than that of S. The two entire circuits are then joined in parallel, and an alternating E.M.F. is applied to the branch points, C and D. By varying R and S values can be found easily such that no sound is heard in the receiver. When this is the case the two parallel currents must be equal to and in phase with each other, and, therefore, the self-inductance of X must equal that of S. With this apparatus the author claims to get an accuracy of over one-fiftieth of 1 per cent. The advantages of using a differential telephone as described above for measuring a self-inductance are: (*a*) that the apparatus is portable and does not get out of order easily; (*b*) that great accuracy can be attained and the manipulation is not difficult: (*c*) that the heating of the circuits by the currents does not alter the self-inductance balance, and, therefore, that large E.M.F.'s may be used; and (*d*) that only one standard is required. It is not necessary to know the values of any resistances or the lengths of a bridge wire. The disadvantage is that the self-inductance of the standard must equal that of the coil to be measured. If, however, the self-inductance to be measured is smaller than the smallest inductance obtainable in the standard, a fixed standard may be placed in series with the unknown coil and the sum of their self-inductances measured, and if the self-inductance to be measured is greater than the greatest inductance obtainable in the standard, a fixed standard may be placed in series with the variable standard. Thus the range of measurement may be increased indefinitely beyond the limits of the variable standard.

**All-Steel Tramway Construction.**—In the *Street Railway Journal* for April there is a description of a new type of tramway construction, a short length of which was recently laid down in Pittsburg to the design of Mr. S. E. Duff. It consists of three parts of all steel, which are respectively the girders, tie-plates and clips, and the rails. The girders are constructed in lengths of 7ft. 6in., and are normally carried on broken stone or gravel ballast. The ends of each succeeding pair of girders are lapped over the ends of the immediately preceding pair, so as to maintain the strength of the system. In order to keep the level up, ballast can be forced in under the large girders as under longitudinal railway sleepers. If preferred, the girders can be embedded in concrete, in which case the inventor recommends that a space of about 2in. be left unfilled under the top flange of the girder. This allows a certain amount of elasticity to moving loads, and also leaves the clips free, so that they can be removed. Although the initial cost of this construction will be somewhat high, the manufacturers claim that it is much more durable, and that the joints do not give the same trouble as with the normal construction. The expense of laying is not great. The



weight of the sub structure used for steam railway work is about 110lb. per foot, and that used for tramway work 80lb. per foot run. It is thought that these weights may be reduced.

**Wireless Telegraphy.**—The success of wireless telegraphy in the Russo-Japanese war has been most marked, as it has enabled information to be sent from a scouting-boat to a shore cable office on land. It seems likely, however, that the continued use of wireless telegraphy is not to be expected, the Russian Government having announced that it will confiscate vessels using such means of communication, and treat the staff as spies. The American company which has been working the system on the De Forest method has protested to the Washington Government, but up to the present no action has been taken. It seems to us that Russia is quite within her rights, and as it is said that the service will be continued, this question will come up for discussion between the two Governments in the near future. Apropos of the use of wireless telegraphy in warfare, it is interesting to note that, according to an announcement in the *Figaro*, French military engineers have commenced trials of wireless telegraphy, the Eiffel Tower being utilised for the purpose. It is hoped that by this means communication between Paris and the French Channel Squadron will be established. It is also reported that a wireless telegraph station is to be established at Calais for vessels of the French navy, and that it will be available for the Channel mail steamers. A letter appeared in Tuesday's *Times* in which a barrister, Mr. E. S. Moberly Bell, avers that, whatever may be the right of the Russian Government to treat steamers fitted with apparatus for wireless telegraphy as prizes of war and to confiscate their apparatus, the claim that the correspondents on board should be treated as spies is clearly contrary to all the rules of international law. Mr. Bell proceeds to state that the definition of a spy is well settled by jurists,

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and he quotes that laid down by Lord Thring ("British Manual of Military Law," chapter on "The Customs of War"), which reads: "A spy, in a military sense, is a person who is found in a district occupied by the enemy, collecting, secretly and in disguise, information respecting their conditions and designs, with a view of communicating such information to the opposing force. Secrecy and disguise are the essential characteristics of a spy in a military sense." Unless, therefore, concludes Mr. Bell, it could be proved that a correspondent was transmitting his information to the opposing force he could not be treated as a spy. Permitting that this view is correct, Mr. Bell omits to refer to the following point—*i.e.*, that the message might be received by the Japanese, although sent with the idea of reaching the operators' receiving station at Wei-hai-wei or elsewhere. Of course, as mentioned in Monday's *Times*, the messages may be sent in a secret code, but this would not prevent them being received by the Japanese, and circumstances might arise under which the code could be read.

**German Criticism of the Liverpool-Southport Railway.** — A correspondent to the *Elektrotechnische Zeitschrift* ventures upon a pertinent criticism respecting the equipment of the Liverpool-Southport Railway. He questions the wisdom of providing a bonded rail in the centre of the track to serve as a return conductor, while at the same time omitting to bond the running rails, on the ground that, instead of facilitating the maintenance of the permanent way, the plan adopted introduces fresh difficulties. The presence alone of this centre rail, he argues, will seriously hamper the execution of ordinary track maintenance work. In under-packing the sleepers, for instance, and straightening the running rails longitudinally or transversely, the centre conductor rail will be so displaced as to itself call for readjustment. Moreover, since this conductor receives current through the bearing rails, cross bonds must be provided at intervals of about a train's length, and these bonds are necessarily also involved in the movements of the track. From the economical point of view, advantage is lost of the large section of the bearing rails, whose use as return conductors would serve to considerably reduce the fall of pressure over the system. It seldom occurs that the electrical connections of both rails are broken at opposite joints simultaneously, one bond invariably remaining intact to judge from experience on the Wannsee line, which has further shown that even third-rail bonds are liable to break if not sufficiently flexible. On the other hand, a broken connection on the Liverpool system would throw the whole of the current on the fishplates, since one bond only per joint has been provided. The correspondent also finds it remarkable that traction engineers in America and England still favour a working pressure of 600 volts, notwithstanding that experience in Germany has proved a normal pressure of 800 volts to be thoroughly reliable. The above criticisms of the return-current arrangements on the Liverpool-Southport Railway are not quite correct, because the correspondent has not understood the full details of the system. In the first place, the bonded fourth rail in the centre of the track is only used as a return circuit There are no collectors on it, and hence its alignment is not a matter of importance. The greatest mistake made, however, by the correspondent is the question of bonding As will be clear from our description, each end of each running rail is bonded on to the fourth rail, and hence the running rails form a valuable part of the return circuit. Also, as the joints in the running rails are not, as a rule, opposite the joints in the fourth rail, the former serve as an additional circuit to the bonds in the fourth rail. In the matter, therefore, of continuity the Liverpool and Southport arrangements are distinctly better than any system of bonding round the rail joints in the running rails. As regards the voltage for railway working, which in this country has been fixed at 600 volts, we have no doubt whatever that 800 volts would be quite reliable. In this respect the most important feature is uniformity between various systems, and it was after conference that 600 volts was adopted. If a step higher is to be allowed, it would be much better to go to overhead construction and employ some thousands of volts in order to reduce first cost.

**Books Received.** — The "Electrical Industry," by A. G. Whyte. In the introductory chapter Mr. Whyte refers to the experiments conducted before 1879, to which date he assigns the birth of the electrical industry. Following this, he describes the early days of electric lighting, and traces the development of this branch up to the present time. Electric traction is comprehensively treated in three succeeding chapters, entitled the "Early Days of Electric Traction," the "Development of Electric Interurban Tramways," and "Electric Railways." The employment of electrical power in mills and factories, and its economic advantages for this purpose, are duly dealt with, and Mr. Whyte recapitulates the circumstances attending the formation of the large power companies. Electrical engineers in embryo will find considerable information on the prospects offered by the profession. In a brief concluding chapter the author undertakes the *rôle* of prophet. He forecasts a network of tramways over the whole of our populous areas, extending into rural districts; the conversion of our railways; and the supercession of horse or steam haulage on canals. Of our industries he says: "A supply of cheap electric power will be available wherever it is wanted, and the direct use of steam power will become as rare as water-mills are now." In other directions, too, the author expects great expansion—in fact, to give his own words, "the whole future might well be summed up in the statement that electricity will play a dominant part in almost every department of external human existence. . . . Electricity is the most versatile and controllable form of energy yet discovered by man. The mere catalogue of its protean accomplishments is bewildering." This interesting book is published by Messrs. Methuen and Co. at the price of 2s. 6d.—"Practical Slide-Making," by G. T. Harris (London: Iliffe and Sons. 1s.). This concise treatise—the second of a series on photography—contributes in a lucid manner the result of the author's own experience in slide-making. All the processes by which different effects can be obtained are described, including some for producing very artistic results by the use of collodio-bromide, albumen, wet plate, carbon, etc. The book is written so as to be intelligible to the novice, and at the same time to furnish a reference book for the more experienced worker —"How to arrange with your Creditors' (by R. Shuddick) may appear somewhat foreign to electricity, but even electrical engineers occasionally have need to practice the delicate art described by the author. This little volume opens with a brief review of commercial systems from the earliest times. The reader is then acquainted with the procedure for carrying out private arrangements with creditors, which is the course recommended by the author where practicable. A warning is given against the predatory money-lender and the "wrecker" accountant, who approach the insolvent in the guise of benefactors. Some useful forms of deeds of assignment are given for cases where this method is utilised, accompanied by several useful hints. In conclusion, the author deals with the Bankruptcy Acts, and alludes to the advantages and drawbacks of liquidation by such process.

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The book, which is the latest of a series of practical guides, is published by Mr. Fisher Unwin, and the price is 1s.

**Oil-Cooled Transformers.**—In a recent issue we gave extracts from a paper read before the American Institution of Electrical Engineers on the relative risks from fire with various types of transformers. This paper was issued in advance of the meeting, and it has now been discussed. We gather from the report of the discussion in the *Electrical World* that the opinion of those present was almost unanimously in favour of the oil-cooled being more safe than the air-blast transformer. In support of this view, Dr. Perrine mentioned that the fire underwriters, and particularly the instructions of the Mutual Fire Insurance Company, favour the oil over the air-cooled transformer. Mr. Peck stated the case against the air-blast transformer, which he said is more susceptible to damage by fire from static discharges, arcs, bad contacts, etc., than the oil-insulated transformer; though, he added, on the other hand, owing to the small amount of combustible material in the former, it is possible to have such material entirely destroyed with comparatively little fire risk to neighbouring apparatus or buildings. As to precautions to be observed in installating oil transformers, all concurred that the case should, where possible, be made of riveted boiler iron which will withstand a pressure of 100lb. per square inch, and that it should be properly vented. Mr. Peck said that where sheet iron construction is necessary, the case should be made practically air-tight and provided with a very large safety valve, so that an internal explosion cannot burst the case. It was generally agreed that transformer units should be located in fireproof compartments, and some advocated locating them in vaults. In any case the transformer case should be so constructed as not to be broken in the case of the floor or walls of a burning building or heavy weights falling upon it. Mr. Mershon disapproved of a bottom drain, owing to the fact that as oil went out air would enter the transformer case, and might cause an explosion. He described an arrangement which he had used which provides for pumping water into the bottom of a transformer, which forced the oil out at the top. He dwelt upon the necessity of so arranging the draining system that in case of falling floors or walls the pipes would not be broken. One suggestion was that the transformers should be placed in vaults that could be closed and to which steam could be admitted to smother flames in case of the oil taking fire. Several of those taking part in the discussion drew attention to the fact that the oil-cooled transformer was not an extreme fire hazard if proper precautions were observed, and that this should be made plain in order that the discussion would not cause alarm. In the course of further discussion on the transformer terminal question, Mr. de Muralt said that in Europe the air-blast transformer is considered a greater fire risk than the oil-cooled transformer. The desirability of fireproofing the buildings of electrical plants was illustrated by Mr. Lyford, who cited the fact that the only two buildings left intact in the Baltimore burned district were the new power-house and sub-station of the electric company. Mr. Hazard suggested sealing the space above the oil in the transformer with an inert gas, such as carbon dioxide supplied by a gas generator. One suggestion was that the oil used in transformers should have a fire test of approximately 400deg. F., and another that it should have a flash test not below 175deg. C., as in that case there would practically be no evaporation at 100deg. C.

**Electrolysis Caused by Tramway Currents.**—Great interest surrounds the question of the corrosion of pipes under the street surface by the return currents for tramway systems. On the one hand, the owners of these pipes wish to make tramway undertakers liable for all corrosion on their systems; on the other, it is exceedingly difficult for the tramway authorities to determine what proportion of the corrosion is due to their stray currents. In a recent article in the *Street Railway Journal* of New York, Mr. Albert B. Herrick goes into the question exceedingly fully. In the first instance, he states: "It has been assumed that there are certain characteristics on the surface of a metal which indicate electrolytic action. For instance, in cast iron a pit in the surface of a pipe which is filled with a graphitic substance can be readily gouged out with a knife, leaving a greater or less depth of pit in the metal. In the case of wrought iron, the developed fibrous structure of the metal is considered indicative of this action. Both of these conditions have been found also to be produced on metal surfaces by the corrosive action of the soil alone, and I have found no expert willing to state that these are of necessity indications of electrolysis. In lead, the indications are external to the surface itself, insomuch that the carbonate of lead, or the compound that is formed, migrates through the soil in veinings towards the receiving plate. Carbonate of lead without the seaming through the soil is not indicative, for ashes around a lead pipe will produce a compound identical in appearance, but adhering to the pipe. Iron pipe will show fibre structure when exposed to a natural or artificial gas leak, and also condensed water, or pure water, will eat iron pipe and develop its fibrous structure as well as water-bearing sulphurous acid. Steel pipe will show pitting identical with that caused by electrolysis when free particles of carbon have been incorporated in the surface of the metal during the process of rolling. Here the action is local, the carbon particle forming one pole and the surrounding metal the other, the moisture adjacent to the pipe surface forming an electrolyte. A very good example of this is found in the Rochester (N.Y.) main from Hemlock Lake. Numerous pits were found in portions of this pipe, some of which penetrated completely through the metal of the pine, yet no current flowed over this pipe." As a means of ascertaining whether electrolysis is actually taking place or not, Mr. Herrick advocates the placing on these pipes of two concentric sheaths at a short distance apart. One of these sheaths, which should be of the same metal as the pipe, is connected to it, while the other i insulated. After a year or two these sheaths can be removed, and after being cleaned they can be weighed. The extra loss in weight of that sheath which is connected to the pipe will then represent the loss due to electrolysis from the tramway currents. This method of testing should be adopted at the same time as any steps for reducing the drop in the earthed return, in order that the tramway engineer may see how far the same are effective. Mr. Herrick emphasises the fact that the old method of predicting electrolytic risks to piping from the voltage between the pipes and the rails is of little value, owing to the fact that it includes the resistance of the earth and other materials between the pipe and the rails. It is the voltage between the pipe and the electrolyte immediately surrounding it which is the important quantity, and the author describes a method by which this can be ascertained. For this purpose he uses two exploring rods, with insulated coverings round the outsides. At the lower ends are exploring points of cadmium. One rod is driven down into contact with the pipe, while the other is driven into the soil in the immediate vicinity. The voltage between the two cadmium points is thus ascertained on the Poggendorf method. This article by Mr. Herrick also goes fully into the best way of protecting pipework systems, and emphasises the need of ascertaining exactly where there is contact under the streets or on bridges between the pipes and the running rails.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 602.)*

*Electrolytic or Chemical Detectors.*

These in some cases act in the opposite direction to coherers; in other words, their resistance goes *up* instead of *down* when subjected to the influence of Hertz waves. Prof. Neugschwender used a detector consisting essentially of a cut on a silver-on-glass mirror, with rods, rings, or wires attached. When the mirror was slightly breathed upon, its resistance immediately went up when acted on by etheric vibrations of the proper freqency. If connected to a telephonic receiver and battery, a click was heard for each discharge of the radiator no matter how quickly these discharges followed each other, showing that this detector—unlike the ordinary coherer—is self-recovering. The inventor attributes the increase of resistance to the break up of electrolytic trees which form across the cut or gap when the current flows, this break up being coincident with and due to the influence of Hertz waves. The break up increases the resistance very greatly.

*The cut-on-glass receiver* of Neugschwender referred to above is sometimes called a coherer, but is really an anti-coherer, as the resistance increases on the incidence of ether oscillations.

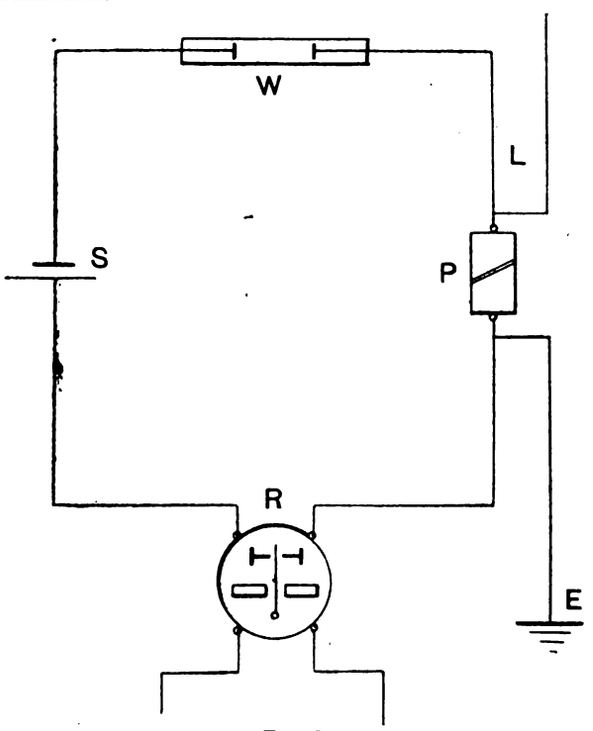


FIG. 26.

*Schäfer Anti-Coherer.*—This receiver, the invention of the son of the leading electrical engineer of Budapest, acts on the same principle as that of Neugschwender, and consists of a piece of silvered glass—an ordinary mirror will do—having the mercury backing divided by one or two grooves or scratches. The action of the ether waves—electrolytic or chemical—is to increase the resistance of the apparatus, and careful trials by Dr. Joseph Tuma, professor of physics at the Imperial University, Trieste, as well as others conducted between Lavernock Point and Weston-super-Mare (1899), at Bremen (1901), and Frankfort (1902) showed this receiver to be equal in point of sensitiveness to the ordinary filings coherer then in use, with, of course, the advantage of requiring no de-cohering, since the resistance drops to normal amount as soon as the ether waves cease. A specially prepared glass is found to give best results, and an air-tight covering is advisable to prevent interference by atmospheric influences. These and other improvements have been carefully thought out by Prof. Schäfer. The circuit employed by him is shown in Fig. 26, where L is the aerial, E the earth, P the anti-coherer, W a water resistance, S a battery, R the relay.

*The De Forest Detector or Responder* is really a little electrolytic cell consisting of the hollow or spherical-shaped space between two screws in a tube. The liquid in this space is probably composed mainly of glycerine and water, but with other ingredients not very clearly specified. The ends of the screws are coated with peroxide of lead. The electrolytic action has the effect of building up chains of particles across the space between the two screws, but the incidence of an oscillating current from the aerial breaks up these chains, the result being that a click is heard in the telephone. The responder is, of course, self-restoring.

*New Schlömilch Indicator.*—This is a "cell of decomposition or polarisation" with platinum electrodes, which becomes in a high degree sensitive to electric waves, when a feeble auxiliary current is passed through the cell so as to produce a regular development of gas at the electrodes—the impressed E.M.F. being slightly greater than the counter E.M.F. of the cell. Unlike the De Forest receiver, this one is said to act so as to give an *increased* current under the incidence of electric waves. "When the wave effects meet the cellule the bubbles of gas produced by the decomposing current disengage themselves more quickly from the electrodes, are more closely together, and in greater number." If there is an intense action of the electric waves, "one is able, so to speak, to signal, through the Morse machine, by the simple disengagement of gas." If, instead of platinum, two metals widely apart on the galvanic tension scale be used, an auxiliary current may be dispensed with, the cell being then like a primary element without current on account of polarisation, but which depolarises itself immediately under the action of the electric waves. The cell, indeed, resembles a small Wehnelt interrupter, with, after the manner of the Fessenden bolometer, several reserve positive electrodes, which may be put into circuit one after the other if necessary. Any such step is, however, said to be little necessary, owing to the constancy of the cell, which is stated to be greater than that of a filings coherer, and the intensity of the action varies in some degree with the intensity of the received waves. It works best when the positive electrode is *very* small—even microscopic in dimensions. These particulars were furnished by the Gesellschaft für Drahtlose Telegraphie, Berlin.

*Optical Detectors.*

*Hertzian Heliography.*—Herr R. Blochmann (November, 1902) used mirrors with high dielectric constant to concentrate the electromagnetic radiations on a distant receiver, which is itself a lens. Mirrors of 80cm. diameter sufficed for waves 20cm. long, and signals could be sent and received correctly over several miles. The apparatus was practically a heliograph for *invisible* light waves, used much in the way in which an ordinary heliograph is used for visible light. The receiver is in this case, of course, not the eye, but a suitable sensitive Hertz-wave receiver, which may be made to print a message if necessary. These *invisible* rays are not intercepted by fog or by non-conducting solids, but mountains do act as obstacles, which, however, can be overcome by a series of relays. The direction in which the rays come to the receiver can be distinguished with considerable accuracy, and thus several messages may be received at the same time, or sent out at the same time in different directions.

*Classification of Detectors.*

Dr. Fleming suggests the name "kumascope" (from κυμα a wave), as a better term than detector or receiver, for the instruments used to give evidence of the presence of Hertzian vibrations. The term, however, is too suggestive of a toy to be likely to meet with general scientific approval. A classification of the detectors, or responders, here described, somewhat on the lines suggested by Dr. Fleming is given below.

*Microphonic or Coherer Types.*—Non-restoring: Branly (coherer); Blondel (coherer); Marconi (coherer); Minchin (cell). Self-restoring: Hughes (microphone); Lodge-Muirhead (coherer); Castelli-Solari or Italian Navy (coherer).
*Magnetic.*—Marconi.
*Electric.*—Hertz; Neugschwender; Schäfer.
*Electrolytic*—De Forest; Schlömilch.
*Thermal.*—Boys; Gregory; Fessenden.
*Optical.*—Boltzmann.

*(To be continued.)*

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## NEW ELECTRICITY WORKS FOR BIRMINGHAM.

We give below the full text of the Electricity Supply Committee's report on the extension of the electricity supply system in Birmingham. This report came before a special meeting of the Council on April 12, and, as stated in our last issue, it was accepted. The committee are therefore authorised to proceed with the work, and to apply to the Local Government Board for a loan of £441,142 to meet the expenditure on the first part of the scheme. The committee's report reads as follows :

On July 31, 1901, the Electric Supply Committee submitted to the Council a scheme for the erection of a generating station on the site acquired by the Council for that purpose in Summer-lane. The plans provided for a station of the ultimate capacity of 10,000 kw., at an estimated cost of £239,220, but the committee recommended that the station should only be equipped in the first instance to a generating capacity of 3,200 kw., at an estimated cost of £128,890. The Council approved this scheme and authorised an application to the Local Government Board for authority to the borrowing of the £128,890, together with the following sums : for mains, a sub-station, etc., £75,000 ; capital expended on purchase of Summer-lane site, £23,174. 8s. ; and extension of Water-street station, £41,909. 3s. 2d. A loan for £251,975 (the sum of the above amounts less £17,000, the estimated cost of works omitted on account of the abandonment of the Edgbaston and Harborne tramway scheme) was sanctioned by the Local Government Board in June, 1902, for a period of 28 years.

As the Council is aware, the scheme, owing, in the first instance, to uncertainty as to tramway development in the city, and later, owing to the impending change of engineer, has not been proceeded with, and only a portion of the loan has been spent or borrowed, as set out in the following table :

| | Amount sanctioned. | | | Amount spent. | | |
|---|---|---|---|---|---|---|
| Water-street extensions to January, 1902 | £41,909 | 3 | 2 | £41,909 | 3 | 2 |
| Purchase of Summer-lane property ..... | 23,174 | 8 | 0 | 23,174 | 8 | 0 |
| Buildings, etc..... | 64,000 | 0 | 0 | 1,170 | 5 | 3 |
| Architects' commission, etc..... | 3,600 | 0 | 0 | 58 | 10 | 0 |
| Engines and dynamos ..... | 26,520 | 0 | 0 | — | | |
| Boilers and economisers..... | 6,000 | 0 | 0 | — | | |
| Condensing apparatus, etc. ..... | 4,320 | 0 | 0 | — | | |
| Steam-piping, etc. ..... | 5 000 | 0 | 0 | — | | |
| Coal-handling plant ..... | 3 000 | 0 | 0 | — | | |
| Water-tanks, etc. ..... | 5,200 | 0 | 0 | — | | |
| Switchboards, balancers, transformers, and accumulators ..... | 9,850 | 0 | 0 | — | | |
| Crane ..... | 1,400 | 0 | 0 | — | | |
| Subsidiary station ..... | 10,300 | 0 | 0 | 2,021 | 7 | 0 |
| Mains ..... | 46,700 | 0 | 0 | 14,863 | 3 | 8 |
| Meters ..... | 1,000 | 0 | 0 | 1,000 | 0 | 0 |
| | £251,973 | 11 | 2 | £84,196 | 17 | 1 |

The unexpended portion of the loan is thus £167,776. 14s. 1d.

Under the Corporation Act, 1903, the Council obtained powers to work tramways in the city, subject to the existing leases, and in May last the Tramways Committee forwarded to your committee a resolution in the following terms : "That the Electric Supply Committee be informed that in the opinion of this committee it is desirable that they should proceed without delay with the provision of electrical energy for working the whole of the tramways in the city, the leases of which expire in 1906." The length of the tramways referred to in this resolution, including the Aston line within the city, is about 24½ miles. The leases of the remaining tramways, having a length of about nine miles, expire in 1911. It is certain, however, that in the hands of the Corporation the tramway undertaking will in the near future be largely developed by the opening of new routes and the extension of existing ones, and that for these extensions electrical energy will also be required. There is also the increasing demand for current for private lighting and power, for which provision must be made. The present stations are taxed to their utmost capacity in times of top load, and no considerable extension of them is possible.

Since the appointment of the new engineer, Mr. R. A. Chattock, in September last, your committee have gone fully into the whole subject, and have had before them plans and estimates. The result of a careful consideration is that they are convinced that a larger scheme than that submitted to the Council in 1901 (which did not, in fact, provide for the 1906 tramways) is not only necessary, but will prove in the end to be more economical. In the laying-out of a scheme for the new station, regard has been had to the demands for current for both tramway and ordinary purposes, so far as they can reasonably be foreseen, for about the next 10 years, in order that the scheme may be so planned as to admit easily of extension from time to time as need may arise. The energy required, taking this basis, is estimated at about 22,000 kw.—viz , 13,000 for ordinary lighting and power, 7,500 for tramway purposes, and 1,500 spare. As regards the estimated amount of energy required for private lighting and power, your committee find that for some years the annual rate of increase was about 10 per cent. Since the reduction of the charges last year it has been about 16 per cent. The total kilowatt capacity of the existing stations is 5,260. On the 10 per cent. rate of increase, compound, the kilowatt capacity required in 10 years would thus be about 13,640. The estimated cost of erecting and equipping the station to a capacity of 22,000 kw. is £510,000, including £130,000, the estimated cost of the necessary building. For the present your committee believe that the needs of the department will be met by the equipment of the station to a capacity of 8,500 kw.—viz., 3,500 for private lighting, 3,500 for tramway purposes, and 1,500 spare plant, at a cost of £260,620.

Your committee think it best to lay before the Council a description of the scheme in its entirety, notwithstanding that they are only asking the Council's sanction to the installation of a little more than one-third of the plant at the present time. The buildings will be arranged very much in the same way as was reported to the Council in July, 1901. The site at Summer-lane has an area of 19,409 square yards, with frontages to Summer-lane and Lower Loveday-street. There is also convenient canal wharfage at the rear. The sketch plan submitted herewith shows the ground plan of the proposed buildings. Two chimney stacks will be required in the positions shown on the plan, each of a height of 230ft. and an internal diameter of 15ft. The engine-house will be 275ft. long by 100ft. wide by 65ft. high. The end of this building will abut on Summer-lane. On one side of the engine-house, and running parallel to it, will be situated the boiler-house. This building will be 275ft. long by 98ft. wide by 60ft. high. An overhead coal store, capable of accommodating 2,000 tons of coal, will be installed over the boilers close to the roof of the boiler-house. Parallel to the boiler-house an economiser house will be erected, and in it the chimneys referred to above will be situated. At the rear of the engine-house, and situated between it and the private canal basin, will be built a small pumping station for providing the circulating water required for condensing purposes. On the south-western side of the engine-house, and also abutting on Summer-lane, it is proposed to build a workshop, engineer's store and offices, and a storage battery room. Having regard to the fact that the switchgear, offices, workshop, and battery room will have to be provided for at one end of the buildings, and arrangements made for pumping the condenser cooling water at the other end, your committee consider that it will be necessary to complete the shell of the main buildings as part of the first equipment. The generating plant can then be installed as required. It is proposed to divide the engine-house by a central gangway, and to instal the high-tension plant on one side and the low-tension plant on the other. High-speed engines will be adopted, direct-coupled to the generators, and each engine will have its own equipment of surface condenser and air-pumps. In two subways under the central gangway the cables connecting the generators to the switchboard will be run. The low-tension and high-tension switchboards will be situated at the front end of the engine-house, mounted upon a gallery, and will be kept distinct from each other and divided by the main entrance from the road. Spanning the engine-house will be a large overhead electric travelling crane, to be used for erecting and overhauling the plant.

The boiler-house will be equipped with underground flues, so arranged that any battery of boilers can be run on either of the chimneys. It is proposed to arrange the boilers in four batteries, each containing six boilers of the water-tube type. Each of these boilers will be of very large capacity, being capable of evaporating 24,000lb. of water per hour into steam and superheating it. The coal from the overhead store will be automatically fed into mechanical stokers attached to these boilers. The ashes produced from the boilers will accumulate in underground chambers, from whence they can be fed into a conveyor and delivered either into carts or into barges on the canal, or, if necessary, stored in a separate bunker. Two distinct pump-houses will be placed in the centre of the boiler-house, equipped with steam-driven feed pumps arranged to feed the boilers. Overhead tanks for storage of cold and hot water will be provided in the boiler-house and also in the economiser house.

It is proposed to equip the economiser house with four sets of economisers, each economiser being split up into four divisions. It will be possible to cut out any division in any economiser for repairs and cleaning purposes. The circulating water pumping station will contain high-speed steam-driven and motor-driven centrifugal pumps. These pumps will draw the water from the canal basin through suitable strainers, pump it through the condensers, and discharge it through a 30in. pipe into the canal again at a point at the Corporation wharf in Lancaster-street. An overhead hand-operated crane will be provided in the pump-house for overhauling this plant. The coaling appliances will be so arranged that coal can be delivered either by canal barge or by cart. It will be handled by a system of conveyors, which will deliver it either into the overhead coal

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store in the boiler-house, or into an auxiliary coal store, capable of holding another 3,000 tons, which it is proposed to erect on the bank of the canal basin. A duplicate system of conveyors will ultimately be put in.

Owing to the large amount of energy that it will be necessary to transmit from the generating station, and to the long distances over which it will have to be carried, your committee are advised by their engineer that it will be necessary to employ high-tension transmission to the outlying districts both for tramway traction and lighting purposes. This high-tension current will be transformed to low-tension current in suitably arranged sub-stations. Six sub-stations will ultimately be necessary, including the existing station at Parker-street, where certain alterations will be required. The others will be erected in convenient situation, having regard to the demands upon the system. One of the stations will be built on land belonging to the department at Court-road. The ultimate cost of the sub-stations and equipments is estimated at £132,200. For the first equipment it is proposed to instal four of such stations, one of them being the Parker-street station, at a total estimated cost of £55,186. These sub-stations will be of a total capacity of 3,900 kw. They will be laid out on similar lines, and will comprise the following plant: On the ground floor will be situated the static transformers for transforming the high-tension alternating current into low-tension alternating current, and the rotary converters for transforming the low-tension alternating current into direct current at pressures suitable for either lighting supply or tramway traction supply. On galleries above the floor level, running down each side of the sub-station, will be installed the necessary high-tension and low-tension switchgear. Above these an overhead travelling crane will be installed for the purpose of conveniently erecting and overhauling the plant. On the first floor will be installed a storage battery, which will be used for the lighting supply only. This battery will enable a steady pressure to be given for lighting purposes, and will provide means of economically supplying the current required at night-time.

The underground cables that your committee propose to instal for the first equipment will be as follows: Three high-tension cables will be run direct from the main generating station to each sub-station. One of each of these three cables will be utilised for tramway traction supply, one for lighting supply, and one as a spare to either. The low-tension tramway traction cables will be laid along each route of tramway track, and will be coupled by means of switch pillar boxes to the overhead wires, at points roughly about a quarter of a mile apart. The tramway routes in the neighbourhood of the main generating station at Summer-lane will be supplied direct from the low-tension generating plant in that station by means of a network of low-tension feeder cables. The tramway routes in the neighbourhood of each sub-station will be supplied independently by a network of low-tension feeder cables from that sub-station. The low-tension lighting cables will be laid in the form of a network in the neighbourhood of each sub-station and in the neighbourhood of the main generating station. These networks will be laid out on the lines that have been adopted for the existing supply in the city, and as occasion serves they will be coupled up together and eventually form one large network over the whole of the city. Low-tension lighting trunk mains will be required for coupling up the new main generating station with the two existing stations, and it is proposed to lay three heavy trunk mains from the main generating station to the Dale End generating station, and one trunk main from the main generating station to the Water-street generating station. Telephone cables and pilot cables will be laid in order that telephonic communication may be made between any feeder switch pillar on the tramway route and the station supplying that route, and also between the main generating station and each sub-station. The pilot wires will be used for carrying out the requirements of the Board of Trade as regards the drop of potential in the rail returns in the tramway system.

The cost of the first equipment, as detailed below, has been gone into carefully by your committee, and they have obtained tenders for as much of the plant as has been possible. In a scheme of such magnitude many of the details in the generating station, such as pipe connections, switchboards, etc., must depend upon the type and the arrangement of the main generating plant that it is proposed to adopt, and tenders for these cannot be obtained until the question of main plant has been approved. Your committee have, therefore, estimated such expenditure under these headings as advised by their engineer. It has also been necessary to estimate the expenditure on the buildings on account of the fact that your committee are only now asking the Council to appoint an architect. An amount of 10 per cent. has been added on each firm's tender for contingencies. The estimated cost of the first equipment is as follows:

MAIN GENERATING STATION.

| | |
|---|---|
| Buildings, including engine-house, boiler-house, coal stores, flues, economiser house, one chimney, pumping station, offices, workshop, stores and battery room, wiring for lighting buildings, and architect's commission | £106,000 |

*Boiler-House Plant.*

| | |
|---|---|
| Eight water-tube boilers, fitted with superheaters and mechanical stokers, including brickwork (tender of Babcock and Wilcox, Limited, plus 10 per cent.) | 16,559 |
| One economiser, having four sections, 1,280 tubes and dampers | 2,200 |
| Four feed pumps (tender of G. and J. Weir, Limited, plus 10 per cent.) | 638 |
| Hot and cold water storage tanks | 2,000 |
| Steam piping and valves | 3,000 |
| Feed piping and valves | 2,000 |
| One coal conveyor | 2,000 |
| One coal conveyor, tower, and bridge, for unloading coal from canal | 1,550 |
| | £29,947 |

*Engine-House Plant.*

| | |
|---|---|
| Four 2,500-h.p. high-speed steam-engines, including condensers and air-pumps, three 900-h.p. high-speed steam-engines, including condenser and air-pumps (tender of Belliss and Morcom, Limited, plus 10 per cent.) | 57,140 |
| Three 150-kw. direct-current generators (tender of Dick, Kerr, and Co., Limited, plus 10 per cent.) | 7,353 |
| One 1,500-kw. alternating-current generator, three 500-kw. alternating-current generators (tender of British Westinghouse Company, Limited, plus 10 per cent.) | 4,141 |
| Two 200-kw. steam-driven exciters | 4,477 |
| One 500-kw. direct-current turbo-generator (tender of C. A. Parsons and Co., plus 10 per cent.) | 3,850 |
| One condenser and air-pumps for same | 1,500 |
| One 200-kw. direct-current motor-generator | 1,392 |
| One 200-kw. rotary converter and transformer | 1 370 |
| Two 100-kw. balancers | 1 595 |
| One traction battery, 2,500 ampere-hours | 4,950 |
| Two battery boosters | 1,980 |
| Two 1 000-ampere lighting boosters | 1,100 |
| Direct-current switchboards | 8,250 |
| Alternating-current switchboards | 6,820 |
| Cables for connecting up | 4,400 |
| One 40-ton overhead electric crane, 100ft. span | 3,300 |
| | £113,618 |

*Circulating Water Plant.*

| | |
|---|---|
| Two 20in. centrifugal steam-driven pumps | 1,760 |
| One condenser and air-pump for same | 880 |
| One 12in. centrifugal motor-driven pump | 330 |
| Circulating water piping and valves in station and discharge to canal | 5,940 |
| One eight-ton overhead hand-operated crane, 23ft. span | 220 |
| | £9,130 |

*Workshop Equipment.*

| | |
|---|---|
| One large lathe | 300 |
| Small lathes | 130 |
| One drilling machine | 250 |
| One screwing machine | 120 |
| Planing machine | 300 |
| Motors, shafting, and tools | 400 |
| One five-ton overhead hand-operated crane, 32ft. span | 250 |
| Contingencies, 10 per cent. | 175 |
| | £1,925 |
| Total, Summer-lane first equipment | £260,620 |

SUB STATIONS.

| | |
|---|---|
| Land | 2 500 |
| Buildings, three stations | 10,500 |
| Equipments, comprising 13 sets of transforming apparatus, each having a capacity of 300 kw., and including rotary converters, static transformers, regulating appliances, switchboards, and storage batteries (tender of British Westinghouse Company, Limited, plus 10 per cent.) | 42,186 |
| Total, sub-stations and first equipments | £55 186 |

UNDERGROUND CABLES.

| | |
|---|---|
| It is estimated that the following amounts will be required for the first equipment: high-tension cables, 22 miles 1,690 yards; low-tension tramway traction cables, 20 miles 780 yards; telephone cables and pilot cables, 18 miles 540 yards; low-tension lighting trunk mains, 6 miles 490 yards; 48 switch pillars, with the necessary overhead connecting cables; trenching, 23 miles 155 yards; cost calculated on schedule of prices by the Callender Cable and Construction Company, Limited, plus 10 per cent. | 58,336 |
| Lighting mains | 65 000 |
| | 123 336 |
| Meters | 2,000 |
| Grand total | £441 142 |

Your committee are alive to the heavy annual charges which will be entailed by the large addition to the capital of the undertaking. If during the first year or two, before the

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station is fully at work, there should be a deficiency in the revenue, it would be necessary to have recourse to the reserve fund, which now stands at £26,394, and to which the result of the present year's working should enable an addition to be made. With a gradually increasing revenue and the reserve fund to fall back upon, the committee have no doubt that the department can bear the increased charges for interest and sinking fund until the new capital becomes remunerative, and in this connection it should be remembered that a large customer is assured in the tramway department. The following figures show that there has been a steady growth in the department since its acquisition by the Corporation, and there are good grounds for believing that this will continue :

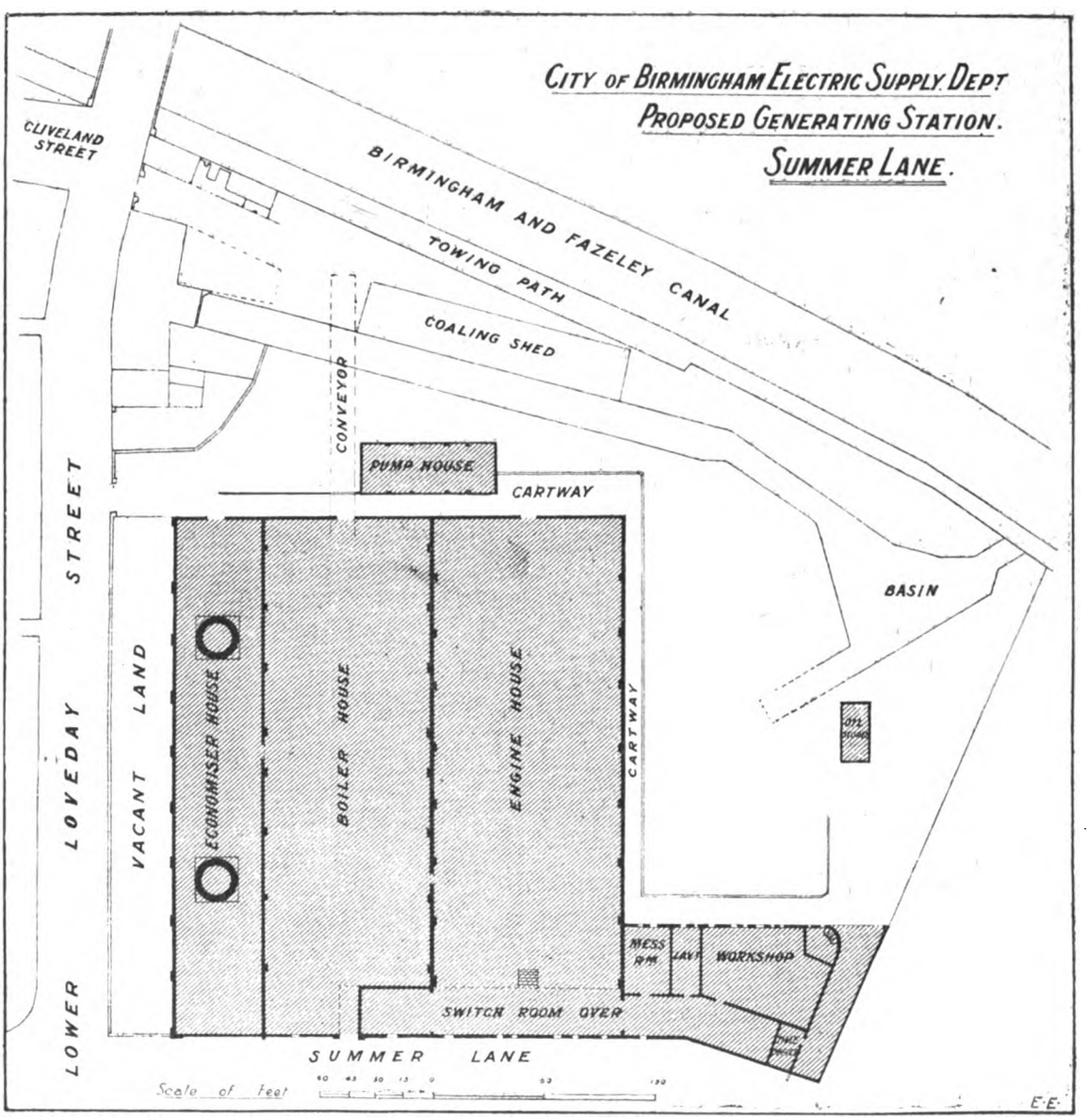
| | Years ending March 31. | | | |
|---|---|---|---|---|
| | 1901. | 1902. | 1903. | 1904. |
| Units sold ..... | 3,040,822 | 3,391,099 | 3,737 419 | *4,336 024 |
| Increase per cent. ..... | — | 11·5 | 10·2 | 16·01 |

* Exact figures not available until after March 31, but estimated at.

| | |
|---|---|
| Summer-lane station—first equipment ..... | £260,620 |
| Sub-stations and first equipments ..... | 55,186 |
| Underground cables ..... | 123,336 |
| Meters ..... | 2,000 |
| | £441,142 |

The committee also recommend that application be made to the Local Government Board for sanction to borrow the sum of £630. 13s. 6d., an amount paid for the acquisition of the unexpired leasehold interest in premises 18 and 18½, Summer-lane, part of the site of the proposed new station.

In view of the Council's instructions to committees respecting architectural work of a value over £10,000, your committee have not yet appointed an architect for the preparation of the plans. In their opinion the present case is not one for competitive designs, the character of the building being governed entirely by the type and quantity of machinery to be installed. A competition would, moreover, involve great delay. Your committee recommend that Mr. Ewen Harper, who prepared




The cost of the Summer-lane station under the present scheme, as compared with the cost of the scheme proposed in 1901, is as follows :

| | Kw. capacity. | Cost. £ | Cost per kw. £ s. d. |
|---|---|---|---|
| 1901 scheme—first equipment ..... | 3,200 | 128,890 | 40 5 7 |
| Present scheme—first equipment ... | 8,500 | 260,620 | 30 13 2 |
| 1901 scheme—ultimate capacity ... | 10,000 | 239 220 | 23 18 5 |
| Present scheme—ultimate capacity. | 22,000 | 510,000 | 23 3 7 |

The committee have not found it possible to make a reliable comparison as to the cost of sub-stations, as the 1901 scheme was in this respect on an entirely different scale. Your committee recommend that the Local Government Board be asked to cancel their sanction to the previous loan so far as relates to the unexpended portion, amounting to £167,776. 14s. 1d., that the Finance Committee be authorised to apply for the necessary sanction to the borrowing of the following sums, and that, subject to such sanction being obtained, your committee be authorised to proceed with the work :

the plans for the scheme submitted to the Council in 1901, and who then took out all necessary levels, etc., be appointed architect for the present scheme. The building estimate given in this report is based on rough quantities taken out by him.

*Water-street Station, etc.*—With a view to the more economical working of Water-street generating station, the committee propose to equip the 14 Lancashire boilers with superheaters, from which it is anticipated that a saving of at least 15 per cent. will be obtained in the steam used by the engines. This would correspond with a reduction of £1,000 per annum in the coal bill for this station. The estimated cost of equipping the 14 boilers is £2,300. It is also proposed to fit two steel chimneys, 42ft. 6in. high, on the top of the existing cooling towers at Water-street station. This is for the purpose of carrying the vapour produced to a greater height in order to remove any ground of complaint by residents in the neighbourhood. The heightening of the towers will also reduce the cost of working them by creating a natural draught, and enabling them to be run at light loads without expending power upon driving the

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fans that are now required to produce an artificial draught. The cost of these steel chimneys, for which a tender has been obtained, is £550. Your committee recommend that the Finance Committee be authorised to apply to the Local Government Board for sanction to a loan for the above sums of £2,300 and £550, together with £2,506. 13s. 10d., an amount spent on sundry lighting mains and services, making together a total of £5,356. 13s. 10d.

At the same meeting of the Council last week, Mr. Ewen Harper was appointed architect for the work as recommended above. The report gives full details of the scheme adopted, and also the expenditure, but the following further information of a more technical character will be of interest to electrical engineers. In the first place, the new works at Summer-lane will be equipped with three-phase plant, and also a certain amount of direct-current plant. The three-phase plant will generate at 5,000 volts and 25 frequency, and will distribute this high-voltage current to the various sub-stations throughout the Birmingham area, which is, roughly, 7½ miles long by 3½ miles broad. For the purposes of distribution this area is divided into nine smaller areas, each of which will be supplied either from a generating station or a sub-station. Thus in the one area the Water-street generating station will serve, in another the Dale End generating station, while the new works at Summer-lane will supply a considerable area from its direct-current plant. After completion of the new station, however, one of the older generating stations will be converted into a sub-station. The remaining six areas will be supplied from sub-stations as follows: the Harborne sub-station, the Court-road sub-station, the Parker-street sub-station, the Dudley-road sub-station, the Bordesley sub-station, and the Saltley sub-station. With the introduction of the three-phase system for transmission, a number of new areas will be opened up for electric supply which at present are not even equipped with mains for lighting. There are at the present time connected to the Birmingham Corporation mains electric motors aggregating some 1,200 h.p. While this figure may seem considerable, it should be remembered that there are at Bradford motors of nearly four times this aggregate power supplied from the central station, and yet one would expect that at Birmingham there should be more demand for electrical power than at Bradford. The reason for the difference is that of cost. At Birmingham the charge for motor power at present varies between 3d. and 2d. per unit, whereas at Bradford the average price obtained for all units sold for power purposes was last year 1·14d. With the larger and more economical works at Birmingham the committee will be able to reduce their price, and in this way secure a large increase in the motor load.

An interesting feature in the Birmingham sub-station equipment will be the use of rotary converters for supplying the lighting mains. These rotaries for the lighting and power service will be exactly similar to those for the traction work, so as to be interchangeable. When working on the traction load, the rotaries will have a series coil round the fields in action. This class of machine has not been used much for lighting loads, owing to doubts as to the possible range of regulation. We understand, however, that the British Westinghouse Company have given full guarantees that the voltage on the direct-current side can be regulated conveniently over the whole range required by Mr. Chattock. These rotary converters will be started by means of a small induction motor coupled on to the shaft of the rotary converter armature.

The large developments of electric traction in Birmingham will call for a considerable amount of electrical energy from the new station. Under the present expenditure the low-tension cables for supplying the tramway load either from the main generating station or the sub-stations are included, as are also high-tension cables required for the same service. The electricity supply department will lay all these low-tension cables and connect them up to the trolley wire, and also the earth return cables up to the rails. The tramway department will be responsible for the track, the overhead equipment, and the cars. In view of the comparatively short period for which loans are granted, the capital charges on this cable work make a considerable increase in the cost per unit of the electrical energy supplied to the tramway department. This increase with a 25 years' loan may be as much as from ·3d. to ·4d. per unit. Under the arrangements made for cable-laying the contractors supply and lay the cables. They also excavate the trenches and temporarily make good the surface. The final making good is then done by the borough engineer at the expense of the electric supply department.

The illustration which we give herewith of the general arrangement of the proposed building on the Summer-lane site is interesting. It will be seen that there is on the site a private basin or siding from the Birmingham and Fazeley Canal, which will be very convenient for getting in the coal. This canal water is also to be used for condensing purposes. The intake for circulating water will be in the private basin, and the water, after passing through the condensers, will be discharged into the canal about a quarter of a mile higher up in the Cliveland-street direction. Mr. Chattock estimates that with a 30in. pipe from the works to this point the first instalment of plant can be served with condensing water, and that it will not cause any objectionable heating in the large volume of canal water between the intake and outflow pipes. After the plant has been increased to the ultimate capacity of the station, it will be necessary to lay a new pipe to a point on the canal about half a mile away. In any case, cooling towers will be avoided if possible. It will be gathered from the report that the cooling towers at the Water-street station have been a cause of complaint by residents in the neighbourhood, and in certain states of the atmosphere it is exceedingly difficult to get any artificial system of cooling condensing water which does not discharge objectionable vapours over the surrounding property.

We have to thank Mr. Chattock for the information he has kindly given us with respect to his new scheme, and to wish him every success in the carrying out of the same.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

### Convention Programme.

The ninth annual convention of this association will be held at Derby, Nottingham, and Sheffield this year, the dates ranging from June 29 to July 2. Mr. T. P. Wilmshurst, the borough electrical engineer of Derby, is president this year. The programme, as far as arranged at present, is as follows:

On the first day, Wednesday, June 29, the meeting will be at Derby, and will be commenced by a reception of the members by the Mayor. Mr. T. P. Wilmshurst will then give his presidential address, which will be followed by a paper by Mr. C. Shawfield, of Wolverhampton, on "The Commercial Practicability of Electric Traction by Surface Contacts." The afternoon will be devoted to an excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation.

The meeting on Thursday, June 30, will be at Nottingham, where, after a reception by the Mayor, three papers will be read and discussed. The subjects of these are as follows: "Polyphase Sub-Stations, their Equipment and Working," by Mr. S. L. Pearce, of Manchester; "Some Notes on the Bristol Electricity Works Fire," by Mr. H. Faraday Proctor, of Bristol; "Boiler-House Economies," by Mr. R. S. Downe, of Southport. In the afternoon visits are arranged to the electricity and other works, and the annual dinner will be held that evening.

On Friday, July 1, the meeting will be at Sheffield, where, after a reception by the Lord Mayor, the following two papers will be read and discussed: "The Financial Position of Municipal Electrical Undertakings," by Councillor Blakeway, of Southampton; and "The Organisation and Management of the Meter Department," by Mr. A. Cridge, of Sheffield. The afternoon will again be devoted to visits to works.

The annual general business meeting, for members only, will be held at Derby on Saturday, July 2.

All communications respecting the convention should be addressed to the secretary, Mr. C. McArthur Butler, Staple-inn-buildings, Holborn, London, W.C.

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## THE EDUCATION OF THE AMERICAN ELECTRICAL ENGINEER.*

BY PROF. W. E. AYRTON, F.R.S.

Although I take a keen interest in primary and secondary education, as well as in business and technical education, and although, therefore, I visited various American elementary schools, trade schools, schools of commerce, and technical schools, in addition to universities, technical colleges, and factories, the shortness of the time during which I could stay last autumn in the United States induced me to devote myself almost entirely to the study of one branch of education, viz., that of the young electrical engineer. And the information I gained during the three weeks, combined with what I have learned during former visits, enables me to state conclusively that, as far as the training of the young electrical engineer is concerned, the United States are, on the whole, distinctly ahead of Great Britain.

It was not because I found some of the electro-technical laboratories in the States larger and better equipped than in my own country, nor because some of them contained full-sized machinery instead of mere models, nor because I saw large numbers of students working in them, that this opinion of the superiority of the teaching of the young electrical engineer was forced on me. Indeed, in New York, for example, I found no electro-technical laboratory comparable in equipment with what may be seen in more than one teaching institution in London. But it was because in this city, as in all other places that I visited in the United States, I saw that there actually existed that close bond of union between the industry and the teaching which only the more sanguine of us have hoped they might perhaps live to see introduced into our own country.

I talked with manufacturers and managers of works, with engineers having a large consulting practice, with engineers having a small one, with municipal engineers, with presidents of engineering societies, with presidents of universities, with professors of engineering, with the staffs in laboratories, with students in college, and with the editors of technical papers, regarding the relation between a college and a factory. I took down exactly what they said, so that it should be their views, and not the opinions that I have for years been urging in my own country, that should form the basis of this short report.

All the people of the classes enumerated above whom I met were unanimous on two points—there was not one dissentient voice. Everywhere I was told: *An engineering apprentice in a factory should be a college-trained man*; *an engineering professor in a college should be actively engaged in the practice of his profession.*

At the Westinghouse Electric and Manufacturing Works at Pittsburg, where some 10,000 men are usually employed, where, in addition to manufacturing all kinds of electrical apparatus and machinery, they turn out, in each month, about sufficient street railway electromotors to fit up all the electric tramcars now running in Great Britain, Mr. Downton, the foreman of apprentices, said: "The engineering apprentices, of whom we have about 150, must be first-class graduates of leading technical schools We start them on trial at 8d. [he said, of course, 16 cents] an hour, and if really bright they may be earning £30 a month with us at the end of eight months. We are always on the look-out for bright men, we co-operate with the professors of colleges to get them. Why, the bosses here are mostly college graduates themselves! There's Mr. Taylor, second vice-president, graduate of Harvard. There's Mr. Osborne, fourth vice-president, graduate of Cornell. There's Mr. McFarlane, acting vice-president; he was educated at Annapolis before he taught at Cornell himself. There's Mr. Scott, chief electrician, graduate of Ohio State University. There's Mr. Lamme, chief engineer, graduate of the same university," and so he went on giving me a long list of the staff and the colleges from which they came.

"Now," he continued, "although we pay our technical apprentices from the first day they join, we are prepared to regard them as learners, not as producers, so that we move them from department to department about every three months."

The following extract from the printed regulations will show how the old apprenticeship system has been brought up to date in America and applied to the technical education of young electrical engineers. As in so many cases, England originated the system, America then adopted and developed it, and it now only remains for Great Britain to reimport it, modernised to suit present developments.

"WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

"*Course for Engineering Apprentices.*

"This course has been arranged for graduates of universities and technical schools.

"The company desires to train a skilled force of engineers, upon whom it can draw for assistance in the various branches of its industry.

"Approved applicants will be given the opportunity of entering the works of the Westinghouse Electric and Manufacturing Company, in order that they may become familiar with the various manufacturing operations and the general construction and working of the apparatus produced. The engineering apprentices will be afforded, in the various departments of the works, actual shop and engineering experience, both mechanical and electrical, and the work of the technical schools will be supplemented by the practical training thus afforded.

"*Compensation.*

"The engineering apprentice will be paid 16 cents per hour during the first 2,808 hours, and 18 cents per hour for the second 2,808 hours. Where called upon to work overtime or holidays, due credit will be given therefor, and the rate will be one and one-half time for such overtime work.

"*Application.*

"Application for admittance as engineering apprentice must be made by letter, in the handwriting of the applicant, stating date of birth; school education and where received; name of university; course pursued; degrees received; reference to professors or others; statement of any practical experience which applicant may have had."

The Westinghouse Company also takes some 80 *non*-technical apprentices, to be trained as machinists, who correspond more with what the English apprentice has become. These start with 5 cents (2½d.) an hour, on trial for 685 hours. If worth keeping, their wage progressively rises to 8, 10, 12, and, lastly, to 15 cents (7½d.) an hour during the fourth year, at the end of which they receive a bonus of £20 and a diploma. If they show particular aptitude during their apprenticeship, they are given special work, and in some cases they become electrical engineers.

Two of the chiefs of the staff visit all the principal universities, colleges, and technical schools throughout the United States every year for the purpose of seeing the students and choosing those who are most suitable to work with the Westinghouse Company. "The Westinghouse works are the product of the colleges of this country," said the chief electrician. "We have come to rely on college men; we are now practically all college-bred men ourselves. And yet when I came to Pittsburg and knocked at the side door of a factory, the fact that I was a college-man counted against me in the mind of the superintendent. Now the same firm sends each year to the technical schools asking for their best men, and sometimes during one yearly visit we take the whole class from a college." This statement was confirmed by what was told me in New York about Prof. Hutton's receiving letters before graduation day engaging 70 of the engineering students at Columbia University.

"Talk to some of our employés yourself," said Mr. Scott—and I did. One was a young Englishman, who, after taking his degree at the Victoria University, became a premium pupil at £150 a year with one of the prominent English electrical companies. But he learnt so little that at the end of the first year his father determined the contract, and the lad then came to Pittsburg. He gave me a long and detailed description of the work that he had done there, and ended with: "The apprenticeship system of the Westinghouse works is simply splendid."

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Another man, an American, now holding a good position in the Westinghouse Company, and as enthusiastic about their methods as the first, gave me a most pathetic account of how, when a lad on the farm, he had been inspired by the country schoolmaster; how to support himself and help his family he had got up morning after morning at 2 a.m. to milk some 30 cows; how he got pay in a machine shop right there in the rocky part of Oregon, then went to the Ohio State University, still getting paid work, cooking and cleaning. And I felt that anyone talking to this man and hearing him explain how "the strenuous work on the farms produces the stock from which springs the American engineer," how "seven out of his eight brothers were now employed in Westinghouse interests," would have realised, if he had not done so before, why the Americans were so successful in their commercial invasion of Europe.

A third man was a former professor of applied mechanics, who described how he had come to the Westinghouse Company's works at Pittsburg, and was engaged there on "a fascinating problem in mechanics connected with the theoretical and practical determination of the economic electric driving of large machine tools," and so on. Example after example I saw of the college and factory going hand in hand.

At the General Electric Company's huge works at Schenectady, hundreds of miles away from Pittsburg, which usually employs some 9,000 to 10,000 men, and is on the same vast scale as the Westinghouse works at Pittsburg, I found the same scheme carried out. The electrical superintendent, Mr. Steinmetz, and the general manager, Mr. Raymond, both spoke of their feeling "the need of technically educated men in all departments"; how they only take for their "365 test students graduates of colleges of high standing"; how "they together visit each year all important colleges as far west as Illinois and Ohio to see the professors, to see the men who contemplate going into practice," so that they may choose some 150 bright college youths every year; how they had met on these annual visits representatives of other large electric works on the same quest; how they all aimed at fostering "a mutual alliance between the factory and the college"; how that, because a student happened to be good at drawing, they did not keep him in their "draughting rooms, but let all students go through department after department so as to learn."

Mr. Raymond told me about his company "paying a good smart fellow 18dol. to 20dol.—*i.e.*, £3. 12*s.* to £4—a week inside his student's course of two years"—one of the half-dozen of my recent students, an Italian, whom I met in the works mentioned that he sometimes made £9 a week with overtime—and how occasionally "they provided a student with a position at 1,500dol.—*i.e.*, £300—a year after being four months with them." Lastly, how on leaving the works at the end of the two years' studentship they got outside positions at from £240 to £700 a year.

At Schenectady there is a college of long standing, called "Union College," at which lectures are given alternately by a member of the faculty and by a member of the General Electric Company's staff. These lectures are open to all whom the faculty considers suitable, but they are attended mainly by the students and draughtsmen of the General Electric Company. I went to one which happened to be given by Mr. Steinmetz himself—it resembled a Royal Society paper, full of original matter, but enthusiastically delivered. "Yes," said the lecturer, when I spoke to him, "we manufacturers here appreciate that theoretical knowledge is of enormous value to the engineer."

The Union College students have the free run of the General Electric Company's factory. Indeed, I was taken over its many large buildings by Mr. Williams, a teacher at the college. He requires no pass to enter the works, he brings his students for a forenoon or for a whole day to the factory—that is, he uses the factory with its 10,000 workmen, with the 6,600 h.p. combined steam turbines and dynamos in construction, etc., as his lecture apparatus.

During the college vacations *any* engineering student, Mr. Steinmetz assured me, "could come into the factory and get a moderate salary in the testing room, armature-winding shop, etc." And to think how my students, failing to induce English firms to let them give their services, their knowledge, and their time *gratuitously* during the vacations, come to me year after year to help them to obtain permission to work for nothing at these times.

"It is universal to loan *modern* apparatus to universities free of charge, or even give it—it is to our mutual advantage—it helps to make a close connection between universities and factories," added he. And my enquiries at colleges regarding the modern apparatus that had been given them by private firms fully confirmed Mr. Steinmetz's statement, and, indeed, they made my mouth water. I saw £600 worth of electric meters that had been presented to one college by one firm, some thousands of pounds' worth of engineering apparatus given by various firms to one university, etc.

"Thirty per cent. of the students of the General Electric Company are British, and within five months the English students drop into step and hustle." I discussed with a group of former City and Guilds Central Technical College men now at Schenectady how the students at their old college could be made to acquire that alertness and go-aheadness that we saw all around us there, and they advised, "Send as many of them as you can to America."

A good example of the advantage gained by college-bred men in the States is seen in the accompanying analysis of the engineering staff engaged in the construction of the Rapid Transit Railroad, the new underground electric railway of New York, costing between five and six million pounds. The men are chosen by examination, and the selected ones get a salary of £20 a month at the start.

ENGINEERING STAFF—EDUCATIONAL STATISTICS.

| | Number. | Columbia. | Harvard. | Cornell. | Cooper Institute. | Rensselaer Poly. | Mass. Tech. | Union. | Lehigh University. | Yale. | New York Univ. | Lafayette Col. | Wash. and Lee Univ. | Univ. of Vermont. | U.S. Naval Acad. | Brooklyn Poly. | Manhattan. | Stevens Inst. | Princeton. | Boston Institute. | Dartmouth Col. | Univ. of Maine. | McGill Univ., Mon. | Col. Univ., D.C. | N.W. Univ. of O. | Ohio State Univ. | Michigan Univ. | Univ. of Virginia. | Virginia Mil'y Inst. | Rutgers. | Bucknell Univ. | Munich. | Pratt's Institute. | Worcester. | Toronto. | Total college. | Non-college. | Per cent. college. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Executive staff. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chief engineer | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 100 |
| Deputy chief engineer | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 100 |
| Division engineers | 7 | 2 | | — | — | 1 | — | — | — | 1 | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 5 | 2 | 71·4 |
| Field. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Assistant engineers | 109 | 24 | 9 | 9 | 5 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 93 | 16 | 85·3 |
| Total engineers | 118 | 27 | 10 | 9 | 5 | 5 | 4 | 4 | 4 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 100 | 18 | 84 7 |

I suggested to Mr. Barclay Parsons, the chief engineer, that perhaps the reason why so large a percentage of college-bred men were chosen, was because the examination questions were such as a college-trained man could better answer than one who had entered on practical life when quite young. But he showed me copies of the questions, and convinced me that they were such as an applicant for an assistant engineership ought to be able to answer, whatever had been his previous training.

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Now, one of the reasons why, in spite of the many places at which electrical engineering is taught in America, the demand for college graduates is still greater than the supply, is because the education which they have received is exactly what the manufacturers desire. It is not given by teachers, the terms of whose appointment divorce them from industry, by men who perhaps even learn to look down upon the manufacturer, the engineer, the manager, and the salesman, although these people are actually occupied in practising that very application of science to industry which the teacher preaches. No, engineering education in America is directed by those who are doing the engineering work of their country.

*To be continued.)*

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

681. Describe, with sketch, the simplest and best method of finding a short in an armature.—T. W.

682. Explain the relative advantages and disadvantages of reverse-current cut-outs and minimum cut-outs when used on continuous currents.—READER.

### ANSWERS.

*Question No.* 673.—The Corporation of A. decided to adopt electric lighting and traction for their town. They have appointed the consulting engineer, who is now ready to proceed with the work; the capacity of the plant to be 5 000 kw. They now require a resident engineer, who is to work under the direction of the consulting engineer to the Corporation, and when all is completed to take over the whole concern and organise a complete staff. (1) What should his qualifications be? (2) How is he to proceed in organising his staff? (3) State the class of men and their qualifications required for the various departments.

*Best Answer to No.* 673 (*awarded* 10*s.*).—As the resident engineer is to work under the direction of the consulting engineer, it is not absolutely necessary that he should possess an intimate knowledge of the work connected with the laying-out of a complete scheme. For the present purpose, it is sufficient that he be thoroughly qualified to run and manage the undertaking when completed. It is now, however, customary to entrust the designing of extensions to the resident engineer, and, even if he is not actually entrusted with the initiation of plans, etc., he should be able to supervise the work for which he will be held responsible after completion. To do this in a satisfactory manner, he must first of all be a practically trained mechanical engineer, and have already held a responsible position in a combined traction and lighting station or system for a period of not less than three years, preferably in a central station of, say, 3,000 kw. capacity with units of 700 kw. or over. In addition to this, he should be a fair draughtsman, and have had some experience in constructional work, well versed in all steam and electrical tests, including mains experience. He will require to be fully alive to the importance of lowering the cost of production, combined with reliability of supply. To this end he must be familiar with the most economical methods of running and upkeep, and untiring in his efforts to improve the station load factor. Above and beyond all, he should be a *man*, resourceful, energetic, devoid of all pedantic assumption and conceit, always willing to feel his way, and not too far removed to take a hint from a subordinate if inwardly convinced of its worth, blessed with unlimited tact, a good student of character, who would consider no exertion too great in getting to understand and infuse enthusiasm into each individual of his staff. There is a right and wrong way of trying to get the best out of every man. His duty is to find the right way. Add to this formidable list of essential qualities a complete technical training in both mechanics and electricity, not forgetting the necessary commercial knowledge, and you have what our modern resident engineer ought to be. Salary, £250 to £300 to start. Occasionally exception might with advantage be made in the matter of mechanical workshop training. A young man may have studied electrical engineering from one or both sides, be a good organiser, and have been closely associated with the running and upkeep of electricity works. He might also be an expert electrician with a natural ability for this kind of work, yet not have passed through the so-called workshop apprenticeship. Such a man in many instances proves a complete success, where a practical engineer with wide and varied experience fails miserably in the selection and management of his staff and in the business side of the concern.

Taking the question broadly, the necessary qualifications to ensure success are not so much the actual practical experience of the individual as the personal *force* and judgment of the man himself.

After our resident engineer has got over the shock and elation resulting from the surprise of his appointment, he will require to engage the following staff (assuming the station to be steam-driven): assistant engineer, mains or distributing engineer, three charge or shift engineers, three switchmen, one draughtsman, book-keeper, storekeeper, three engine-drivers, two or three engine-room attendants or greasers, two fitters, five stokers (one will be sufficient on night shift). The number of trimmers and labourers will depend upon the arrangement of the station, and whether there has been a coal and ash handling plant installed. For the mains and outdoor department the following staff will be required to work under the distributing engineer: installation inspector and tester, motor inspector, cable and road foreman, platelayers, jointers, bricklayers, joiners, lamp trimmers, watchmen, etc.

His assistant engineer should be a man after his own heart, with experience, although not so extended, somewhat similar to his own. The mains engineer should have some considerable experience on both lighting and traction networks, and must be well up in testing, jointing, laying, and inspection of mains on the solid or conduit systems, also rail bonding and testing, and possibly overhead construction. The charge or shift engineers should be qualified engineers with both mechanical and electrical experience, and have had at least two years' service in a combined traction and lighting central station. The draughtsman should also have experience in an electricity department and accustomed to outdoor work, with an intimate knowledge of the general arrangement and extension work connected with a steam-driven central supply station and system. The book-keeper would likewise be selected for his previous knowledge of electricity accounts, central-station book-keeping and costing.—J. C. STEWART.

*Answer to No.* 673 (*awarded* 7*s.* 6*d.*).—In answer to question, "E. C." does not state the system to be adopted, so I presume the resident engineer must be qualified to adapt himself to any. The qualifications of the engineer will be to supervise under the directions of the consulting engineer, therefore he must be well acquainted with the erection and maintenance of electric light and power installations. He must be a good electrical and mechanical engineer, and well accustomed to engines, turbines, pumps, boilers, steam-pipes, condensers, economisers, etc. I will deal with the engineer's qualifications from an electrical point of view. He should first of all be qualified to devise some scheme of supply to meet the demand for light and power, and be able to submit the same to his committee. This is a subject he should be well conversant with, both from a practical and theoretical point of view. The point is to generate power at a cheap rate, for a given amount of fuel, and economise as much as possible. He should be well acquainted with both high and low tension systems,

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and therefore should thoroughly understand not only the erection of but the running and maintenance of generators, exciters, transformers, converters, motors, boosters, balancers, accumulators, switchgear, instruments, mains, meters, etc., and be able to estimate and draw up plans and specifications, the great aim now being to produce the best results at the least cost. As regards the mechanical engineering, he should also be well versed in this matter, and be well associated with the work that his staff will have to carry out, so as to be capable of instructing them, and thoroughly understand the working and drawing up of plans, so as to take full charge just as if there was no consulting engineer present.

The second part of the question refers to how the engineer should proceed to organise his staff. Employés should be advertised for through the medium of some reliable paper; of course, an interview is necessary, and for the most important position should come on trial for at least one month. At the end of that time, if their services have proved satisfactory, they may then be permanently engaged, but it is sometimes found that some of the men on the erection of the plant are suitable for certain positions. The staff he requires will be as follows: station superintendent, chief assistant engineer, junior assistants, shift engineers, mains superintendent, fitter-drivers, switchboard attendants, meter readers and inspectors, installation inspectors and testers, cable jointers, joiners, plumbers, storekeeper, clerks, stokers, and labourers. The main qualifications of the various staff should be as follows: The station superintendent should have a thorough knowledge of all the branches connected with station work, so as to be qualified to take full charge in the resident engineer's absence. The chief assistant engineer should have experience in three-wire continuous current with batteries, high and low tension systems, switchgear, and all the equipment connected with central- and sub- stations, and should be qualified to take full charge of a shift or sub-station. The junior engineer's qualifications should almost be the same as the chief assistant's, so as to be capable of looking after either power or light switchboard, or take charge of a small sub-station or light shift in central station. The shift engineers should have good electrical as well as mechanical knowledge, and be qualified to do any repairs to engines, generators, etc., in case of emergency, and be capable of taking sole charge of shift. The mains superintendent should be well accustomed with the laying and maintenance of all systems of mains, the testing of same, also experience in high-tension street work with transformers, low-tension network, two and three wire system, motor and arc lamp circuits. The fitters and drivers should be men who are capable not only of looking after the running of engines, but to do necessary repairs, and have a little electrical knowledge. The switchboard attendants should be men used to switchgear for high and low tension work, batteries, instruments, the logging of the usual records, and take charge of either power or light switchboard or small sub-station. The installation inspectors and testers should be men accustomed to all classes of installation work, and be capable of examining and testing them, so as to comply with the different requirements, such as the company or the fire insurance rules, etc. The meter readers and inspectors should be acquainted with the different types of meters, demand indicators, etc, and be accustomed with the reading of them, also do any adjusting or repairing that may be required. These men should have a good knowledge of magnetism and electricity. The cable jointers should be qualified to run services and make all necessary connections, accustomed to all classes of cable, fixing street boxes, meters, fuses, and the connecting up of transformers. The arc lamp attendants should be qualified to adjust carbon, and do all necessary repairs to lamps. The joiners should be used to the running of casing, etc., make boards to fix meter, fuses, etc., on, and do necessary repairs in station. The plumbers should be accustomed to iron pipe-work, and be able to wipe joints and do necessary repairs. A good plumber generally makes a good cable jointer. The storekeeper should be a good stock-keeper, and be well acquainted with the stores used. The stokers should be good firemen, attentive and careful men, and take great care to keep the steam well up and regular to suit the demand. As to the clerks, they are required to keep the books, send accounts out up to date, and collect same. They should also be well acquainted with commercial arithmetic. Labourers are regular helpers to anyone that may require them.—J. P. S.

*Answer to No.* 673 (*awarded 7s. 6d.*).—I suppose from the particulars given that the station in question will be of the ordinary type—*i.e.*, three-wire distribution for power and lighting purposes, and the dynamos running compound for traction. If so, there will be no difficulty in getting a good resident engineer and staff with previous experience in stations of this kind. The resident engineer should be a good organiser and manager and possess plenty of tact. A chief possessing these qualities gets good competent men under him and knows how to keep them. He should preferably have had experience in several similar stations, as then he will strive to make his station possess the specially good points of the other stations he has been in without their bad points. In his dealings with his assistant, mains engineer, or shift engineers, he should give his orders to them direct, and not go to their subordinates with orders. If he sees one of the men engaged on some work which he thinks might wait until some more important work was done, the best plan is to go to the person directly in charge of that department and state what he wishes the man to do. This preserves good feeling all round, for if the men find that the orders of their manager are frequently set aside by the chief, then the heads of the departments will find it difficult to maintain order. Mr. Wordingham points out in his book on "Central Stations" how important it is for a chief not to give those under him the idea that he is trying to best them in any way, for if they feel that such is the case, all confidence is destroyed and they cease to do their best.

In choosing his staff he should not select a candidate simply because he has been in a number of stations, and, therefore, apparently should have had good experience, for this fact does not prove he is a smart, capable man. The chief should try and find out if he has kept his eyes open and studied things, for a man of this kind will be able to suggest many little economies in the working of the station. The staff and salaries should be so arranged as to give a good man chances of gradual promotion, otherwise a really first-class man will not stay long at the place, but directly he has got all the experience desirable he will leave for some better appointment. As regards the class of men and their qualifications required for the various departments. Starting first of all with the generating station, this can be divided into two departments, the day men and the shift men. In a station of this size it would be advisable to have a mechanical engineer. He would be responsible for keeping in good repair and working order the engines, boilers, steam and water piping, pumps, economisers, and condensing plant. The day men employed in the station would be under his control. Two good fitters and two or three labourers, to take to pieces any machines requiring repair and execute the repairs in the fitting shop. The fitters should understand the engines thoroughly, and be able to run them if required, so that if one of the engine drivers is away ill or leaves, then no inconvenience is caused in the running of the station. There should be a man in the boiler-house to clean out the boilers when required, replace damaged firebars, repair leaky joints in boiler fittings or pipes, and scrape economiser tubes. If the coal is stored in bunkers and automatically fed into the boilers, most probably the coal will be hoisted up and dropped into the bunkers by an electric crane. A crane man and labourer will, therefore, be required. If the stores are kept in the station one man will be required to act as storekeeper, and might also act as timekeeper if required.

Coming now to the men engaged in running the plant. The three shift engineers are responsible for the whole of the running machinery, for continuity of electrical supply, and for the working of the men under them. They should have had a good all-round central-station training, and, above all, should not lose their head in case of accident or breakdown. This last qualification is a very desirable one for the switchboard attendants and engine drivers also.

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An accident may occur any minute, requiring a cool head and decided action to avert a stoppage of the lights or trams. Anyone getting excited and flurried at this time may cause disaster. A shift engineer should be methodical (for the work is largely routine work) and very observant. By noticing the least indication of anything going wrong, he may to a large extent avoid accidents by prompt attention. Three switchboard attendants will be required to take shift on the lighting and traction switchboards. They also should be very observant, as constant watchfulness is very necessary in the discharge of their duties. One engine driver and between one and three greasers will be required on each shift in the engine-room. The number of greasers depends on whether many small engines or several large ones are installed They should be thoroughly acquainted with their engines, able to do minor repairs if required, and make a practice of going round all the bearings at intervals. The number of stokers and trimmers in the boiler-house depends upon the number of boilers and whether they are hand-fired or automatically fed from bunkers overhead. If the latter, then one stoker and trimmer can manage eight boilers, but if the former they can only manage four boilers. If the boilers are hand-fired and are without moving firebars, thoroughly good stokers must be employed to get economical results.

Leaving the generating station, we come to the mains department. The mains engineer should, of course, be a good manager, having been used to the control of men, and should be well up in the best methods of testing for faults. He should know the best form of manhole or joint-box to use, and be able to carry out extensions of the cable network. There should be two mains assistants, one to look after faults on lighting cables, see that the new consumers are properly connected up so as not to cause an excessive out of balance, and, if the corporation hire out motors, to look after motor breakdowns; the other assistant should attend to the traction feeders and street telephones. There should be two or more jointers with their mates, and one man and boy to test consumers' premises before having them connected on the mains. This man would also attend to reports of consumers' lights out and replace the corporation fuses if necessary. I have assumed that the responsibility of the resident engineer, as far as the traction system is concerned, ends with the feeder boxes in the streets.

To come to the offices, the chief will require an assistant to aid him in his work, and perhaps act as station superintendent or as deputy during the temporary absence of the chief. A draughtsman will be required to draw plans of the mains, get out drawings of any structural alterations or details of machinery in the station; a test-room assistant to test meters, motors, arc and incandescent lamps, and keep the station meters accurate. Two or three clerks and an office boy will complete the staff required.—W. A. T.

*Question No.* 674.—If I have a cable made of four circular conductors, insulated with $\frac{5}{32}$in. of paper around each conductor and $\frac{5}{32}$in. around the bunch, may I supply two towns with single-phase current at 4,000 volts, each pair of conductors being connected to a phase of a two-phase 60-cycle generator? (*a*) Will a varying load at one town affect the voltage at the other town by mutual induction in the cable, the cable being four miles long? (*b*) Would it be permissible to supply these circuits by two separate 60-cycle single-phase generators, the shafts of which are not coupled together?

*Answer to No.* 674 (*awarded* 10*s.*).—With a cable such as is described in the question there would be induction effects between the two phases. The magnitude of these will depend on which of the cores are used for each phase, and also on the protection of the cable. If iron is used as an armouring, there will be a considerable increase in both the self-induction of each circuit and in the mutual induction between them. Without this information a calculation of the drop in each circuit cannot be made. As regards the four cores of the cable, if two adjacent cores form one circuit and the other two cores the other, the conductor can then be considered as two transformer coils placed opposite to each other. The mutual action then tends to reduce the voltage of one phase and to increase that of the other. Any fluctuation of the load on one phase would, of course, be felt in the other circuit. This interchange of voltage, and also of energy, can be largely prevented if the two cores for one phase are diametrically opposite to each other. In this case the four cores represent two coils with their axes at right angles, and hence in a position for minimum mutual induction. The proposal (*b*) to supply the two circuits from two separate single-phase generators would not be advisable, unless the generators were mounted on the same shaft; otherwise, if the two machines were separately driven, they would not produce currents with a constant phase relation to each other. The changes in phase and frequency would then produce beats in the mutual induction effects which would be most objectionable.—P. T.

*Question No.* 675.—Describe in detail, with sketches, how an X-ray apparatus in use in a hospital, and at present worked by accumulators, may be worked from the supply main, which supplies alternate current at 110 volts, 76 periods.

*Best Answer to No.* 675 (*awarded* 10*s.*).—I recently had some experience in working an X-ray apparatus direct from alternating-current supply mains. I used a Nodon's valve to rectify the alternating current, and found it to work very satisfactorily. A full diagram of connections is given in Fig. 1. As the pressure on the mains is only 110 volts,

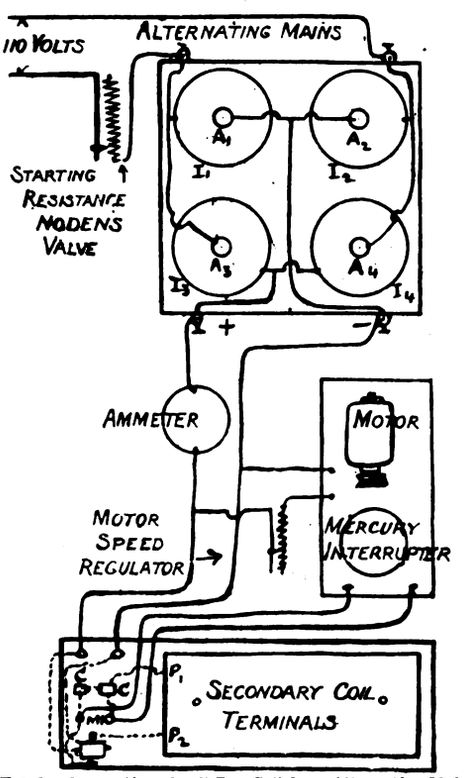


FIG. 1.—Connections for X-Ray Coil from Alternating Mains.

the Nodon valve can be connected directly to them. An adjustable resistance is inserted in circuit in order to start the valve up gradually. The direct-current side of the valve is connected up to two terminals on the induction coil, and it is as well to have an ammeter in circuit. The condenser is connected to the contact breaker and the adjusting screw, C C, and the mercury interrupter (if one is used) to the terminals, M I. The motor for the interrupter is connected direct to the direct-current side of the valve. Now for a brief description of the valves and its working. The coil I used gave a 12in. spark, and I found a valve capable of giving five amperes a suitable size for working it. The valve consists of four iron tubes 4in. in diameter and 1½ft. long (for five-ampere valve), with an aluminium rod inserted in each tube. The tubes are fitted with an indiarubber stopper at one end and filled up with a saturated solution of phosphate of ammonia. A new valve requires careful starting up. On first switching on with all starting resistance in, there will be a rush of about six amperes for a few seconds. In about three minutes this will have died away to zero, and the resistance in circuit can be gradually reduced until it is all out. Keep testing the voltage across the continuous-current terminals until it registers somewhere about 100 volts. The valve is now ready for use. In using the valve it will be noticed that when three or four amperes are taken from the valve, the voltage on the direct-

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current side will fall to 60-70 volts, and remain steady at that. The periodicity of the alternating current does not matter. If the valve is overworked, there will be a white deposit on the aluminium rods. The liquid also will be found to be slightly acid. If a valve is wrong internally, there will be a black deposit on the rods and the liquid will be alkaline. It is advisable to test the liquid occasionally with litmus paper. Never allow the liquid to become alkaline. Either have it neutral or slightly acid. A valve for giving 10 amperes or more is found to get too hot during working, and so is always fitted with hollow rods and a fan to blow air through. If in working the valve the rods are found to have either a white or black deposit on them, the liquid should be drained off and the rods scraped clean.

"X-Rays" is confronted with one difficulty. The primary of his coil will be wound for working with a small number of accumulators, and consequently a low voltage. If he connects his Nodon valve direct on to the alternating mains, he will have 60 to 70 volts on his primary coil, and if the insulation of the coil will stand it all right, the ordinary platinum contact breaker will not. One of the numerous types of mercury interrupters becomes necessary. Another way out of the difficulty, supposing his battery only gives about 30 volts, is to get a transformer to transform down from 110 volts to 40 to 50 volts and connect the secondary to the Nodon valve, which will then give about 30 volts whilst working the coil. A Nodon valve is remarkably simple in construction, and once bought is very little further expense. It can be used for charging accumulators, running small motors, or any work of that description.—W. A. T.

*Answer to No.* 675 (*awarded* 7*s.* 6*d.*).—Any of the following systems may be adapted by "X-Rays." It is, of course, always advisable to keep the accumulators as a stand-by. In method No. 1 they are absolutely necessary with large coils, say over 3in. spark. No. 2 is *the* system for convenience and reliability, although, comparatively speaking, rather expensive to instal. The last two methods are quite different, as the coil itself can be dispensed with.

1. *The Batten Rectifier.*—The apparatus consists of a polarised relay driven by the alternating supply, and thus throwing the top and bottom portions of the curve on to the two outside terminals shown in Fig. 1, the middle

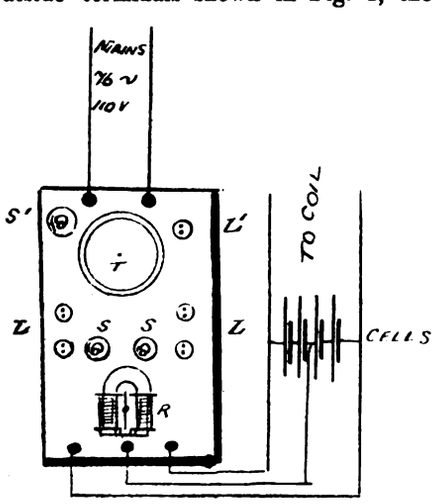


FIG. 1.—L, Resistance Lamps of Rectifier; S, Switches for same Rectifier; L', Driving Lamp of Rectifier; S', Driving Switch of Rectifier; T, Transformer of Rectifier; R, Polarised Relay.

terminal being common to both. Before this takes place the pressure is reduced to about 25 volts. Note the manner in which the cells are arranged, half the total number on each side. This rectifier costs about £10, and should be satisfactory in the hands of an intelligent person who possesses a sense of adjustment.

2. *The Motor-Generator.*—This is a very satisfactory means of working coils. A small alternating-current motor, direct-coupled to continuous-current generator, having a pressure varying according to the length of spark, is required, also a regulating rheostat connected in series with the primary of the coil. About 10 amperes is the limit required in ordinary practice, and, say, nine to 12 volts for 6in. to 10in. sparks. We have here a convenient means of charging accumulators. This is a decided advantage, as sometimes it becomes necessary to take the outfit to a patient's bedside (see Fig. 2).

3. *The Tesla Transformer.*—Here the coil itself is dispensed with, the ordinary supply being transformed up as follows: The town supply is fed through a step-up transformer which raised the potential to approximately 7,000 volts.

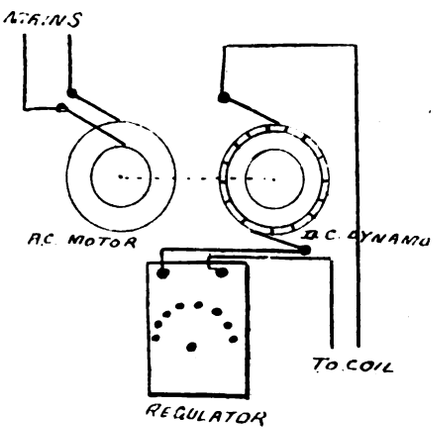


FIG. 2.

The 7,000-volt current is then passed through a primary o very few turns surrounded by a fine-wire secondary, the whole being immersed in oil, as the spark at this stage is rather dangerous. A spark-gap is in series with the primary and a condenser in shunt, as shown at Fig. 3, with the object of raising the frequency by the oscillating spark on the gap. The fluorescent screen glows as steady as an incandescent lamp, owing to the terrific rapidity of the spark. It has, however, an injurious effect, and shortens the life of the tubes.

Wimhurst machines may be used. Although they have a reputation to still make for radiography, with good management and care they give excellent results. It is usual to instal a small electric motor to drive them. The usual troubles are breakage of the plates and non-excitation and unsteadiness These last two are very often caused by moisture and dust.

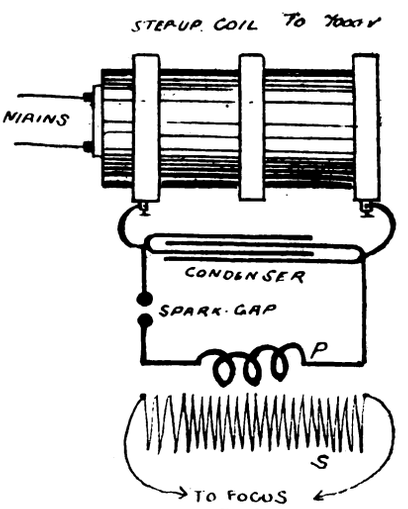


FIG. 3.

To sum up, the writer would be inclined to adopt No. 2 method, still keeping the accumulators on hand and using them occasionally to keep them in condition. Moreover, it is astonishing the number of pleasant acquaintances possessing motorcars and bikes "X-Rays" will make if he decides to instal a motor-generator, particularly if the hospital be in a country district, and surely this should be taken into consideration when deciding!—J. E. H.

*Answer to No.* 675 (*awarded* 7*s.* 6*d.*).—In answer to "X-Rays," he has choice of a number of methods of utilising the alternate-current mains, all good, but differing much in cost. First, he may use double-pole tubes, as Fig. 1, with the ordinary induction coil and rheostat or choking coil. This is very good for screen work and simple

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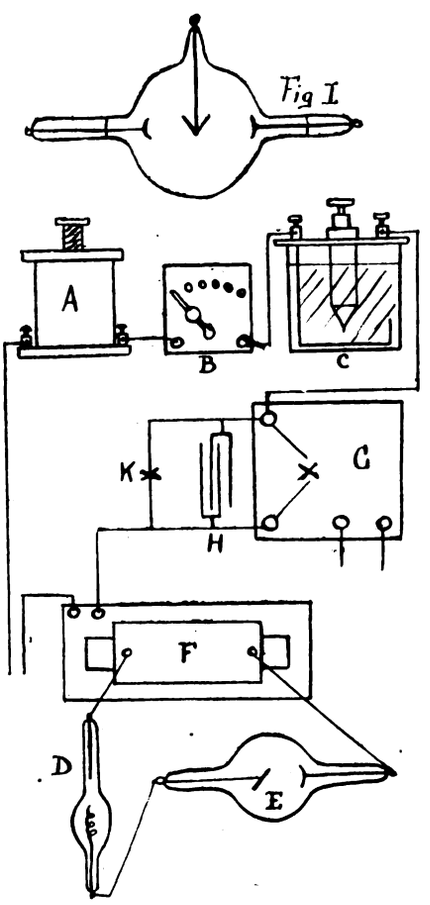
photographic work, but is of no use for soft tissues or accurate localisation work. Secondly, he may use a rotary converter, say six-pole, started up to synchronism by means of a small shunt motor with laminated fields. This gives direct current, and may be used with any of the ordinary dipper brakes and rheostat. Thirdly, an asynchronous motor may be used to drive a dynamo wound for the same voltage as the accumulators that are in use, and thus nothing at present in use is interfered with. Cheaper than (2) and (3), and just as good, is the following arrangement, which the writer recommends for adoption in any case: A is a choking coil to adjust self-induction to best amount; B is a rheostat to regulate current; C is a Wehnelt break, having about a gallon capacity—do not use the trumpery rubbish that has brought this fine brake into disrepute; F is the coil; E the X-ray tube; D is a "soupape" or valve, which may be readily be obtained from Gaiffe of Paris—it is just a vacuum tube with an aluminium spiral, and opposes resistance one way only (it may be replaced by a vacuum tube having mercury for one electrode and aluminium or iron for the other); G is an ordinary dipper brake; H is the




coil condenser; and K short-circuiting switch. The action is as follows: the Wehnelt brake stops almost one-half of the alternate wave, while the "soupape" complete the work; thus the tube gives approximately unidirectional rays The reason for the dipper break being inserted is that the Wehnelt is very sore on tubes, but the dipper break, being in series, gives the tube a rest. When rapid or instantaneous photos are wanted, close the switch, K, and operate the Wehnelt from the rheostat or main switch. One or two practical points: With methods (1) and (4) disconnect the condenser from the hammer break (if that type is used), and in (4) connect condenser across dipper break. With methods (1) and (2) it is likely that the coil will require a new primary unless the accumulator voltage at present is about 70 volts, which I doubt. Have two Wehnelts and two dipper breaks, switching them in alternately. Long experience has shown me that even half a dozen breaks are not too many in hospital practice, unless a qualified electrician is always in charge. Lastly, have a very strongly made and substantial, yet simple, switchboard; use good tumbler switches. I have found that nurses and young medicos draw all other kinds to pieces; with tumblers they don't get a big enough grip. Whatever method is adopted, insist on substantial workmanship—*e.g.*, carbon brushes, proper commutators, well-wound armatures, etc.—or there will always be breakdowns when an important case is on. Clean out dipper breaks every two days, filtering spirit (keep a large filter for the purpose). Save all the mercury oxide and send to the refiners. An ordinary hospital will use £10 in mercury every year which might be saved.—POLYPHASE.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 22.

**Physical Society.**—At 4.30 p.m., council meeting. At 5 p.m., "Calculation of Colours for Colour Sensetometers and the Illumination of Three-Colour Photographic Transparencies by Spectrum Colours," by Sir W. de W. Abney; "On Normal Pileing as connected with Osborne Reynold's Theory of the Universe," by Prof. J. D Everett; and "Note on the Diffraction Theory of the Microscope as applied to the case when the object is in motion," by Dr. R. T. Glazebrook. Exhibition of apparatus by Mr. Peter Hecle.

**Royal Institution.**—At 9 p.m., "Sleeping Sickness in Uganda," by Colonel D. Bruce.

**North-East Coast Institution of Engineers and Shipbuilders.**—At Newcastle, general meeting.

**Institution of Civil Engineers.**—At 8 p.m., students' meeting. Paper: "No. 2 River Pier of the Beckton Gasworks," by Mr. A. Trewby.

**Institution of Electrical Engineers.**—Manchester Students' Section: at 7.30 p.m., "The Equipment and Maintenance of Electric Street Cars," by Mr. C. W. Crosbie.

SATURDAY, APRIL 23.

**Royal Institution.**—At 3 p.m., Mr. Cyril Devonport on "Cameos" (II.).

**Association of Municipal Engineers.**—Grimsby, general meeting.

MONDAY, APRIL 25.

**Society of Arts.**—At 4 30 p.m., Cantor Lecture: "The Majolica and Glazed Earthenware of Tuscany," by Prof. R. Langton Douglas (Lecture I.).

TUESDAY, APRIL 26.

**Royal Institution.**—At 5 p.m., Prof. L. C. Miall on "The Transformations of Animals" (Lecture III.).

**Institution of Civil Engineers.**—At 8 p.m., annual general meeting of corporate members only to receive the report of the council and to elect the council and auditors for the ensuing year.

**Australasian Chamber of Commerce in London.**—At 4 p.m., Visitors' Room, Bank of Adelaide, 11, Leadenhall-street, E.C., the Hon. Henry Copeland on "Proportional Increase of Australian Foreign Trade as compared to Trade with United Kingdom."

WEDNESDAY, APRIL 27.

**Institution of Electrical Engineers.**—At 7.30 p.m., students' meeting. "Insulation and Insulators," by Mr. H. D. Symons.

**Society of Arts.**—At 8 p.m., eighteenth ordinary meeting. "The Need of Duty-Free Spirit," by Mr. Thomas Tyrer.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the Metropolitan Railway Electric Power Station at Neasden.

THURSDAY, APRIL 28.

**Institution of Electrical Engineers.**—At 8 p.m., "Power Station Design," by Mr. C. H. Merz and Mr. W. McLellan.

**Liverpool Engineering Society.**—At 8 p.m., annual general meeting.

**Institution of Civil Engineers.**—Students' visit to Walton and Hampton to inspect the new reservoirs and pumping station of the Southwark and Vauxhall Water Company.

**Royal Institution.**—At 5 p.m., Prof. Dewar on "Dissociation" (Lecture III.).

FRIDAY, APRIL 29.

**Institution of Civil Engineers.**—At 11 a.m., students' visit to the works in progress at the new thoroughfare between Holborn and the Strand.

**Royal Institution.**—At 9 p.m., the Dean of Westminster on "Westminster Abbey in the Early Part of the Seventeenth Century."

SATURDAY, APRIL 30.

**Royal Institution.**—At 3 p.m., Mr. Cyril Davenport, F.S.A., on "Jewellery" (III.).

**Manchester Association of Engineers.**—Visit to Northwich on inspection of the River Weaver mechanical and electrical arrangements. "Inland Navigation," by Mr. Sauer (provisional).

**Institution of Electrical Engineers.**—At 10 a.m., students' visit to the Western Electric Company, North Woolwich.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2. Full programme appears in another column.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Newcastle, May 6 and 7; Buxton, May 20 and 21.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## MUNICIPAL TRAMWAYS.

Another and a very important question in connection with tramways has arisen for settlement, and will have to be discussed and settled upon the broad lines of national utility rather than upon any particular case. The real point is the powers that foreign companies or municipalities shall have for the use of a tramway system. We use "foreign" here to mean the owners of other than one particular system. So long as any tramway system is complete in itself, needs not and has no linking up to any other system, the question of common user does not arise; but when there are two or more systems under different controls, the greatest benefit to any one or all of which and to the community they serve can only be obtained by a service which runs over the whole system, the question becomes crucial. It has been brought into prominence because the House of Lords Committee has granted an outside company running powers and facilities over the Newcastle Corporation's tramway system. At first blush the sanction of these powers seems a step in the wrong direction, and to handicap one authority heavily and disadvantageously. Take a simple case that may easily arise. A corporation controlling a large and populous area embarks a huge capital in a tramway system. A company has a small system and a small capital embarked at some small place outside but near the area controlled by the corporation. The business and traffic of the small place is principally with the centre of population. Of course these assumed positions may be reversed, but in any case we have a small concern almost absolutely dependent upon the large concern. The cost per mile of track in the centre of a town is many times more than when the track is laid in country districts, and the earning power is correspondingly different. In a particular case like the one assumed, it is the capital of the large concern that provides the dividends of the small concern, and it would be extremely difficult to apportion justly the distribution of earnings. The general case, however, is far different, and we trust the committee's decision will be reversed in order to have the subject fully investigated. If tramways or light railways are to be used to the utmost advantage, it is evident that in populous centres like Manchester, Liverpool, Newcastle, Birmingham, Glasgow, etc., the systems must ramify outwards and pass through districts under the control of different authorities, and thus there must be some method devised either to place the whole system under one authority for working purposes, or to adjust receipts upon an equitable basis. It seems to us that divided management is almost an impossibility, for, as the Newcastle people say, their service would be absolutely dislocated by interference with from an outside authority. A single manager may with comparative ease prepare a running schedule, but two managers would have great difficulty, as each must fight for his own hand, and a combination of three managers would form a fighting triumvirate that, to succeed, would land two of them into oblivion. A conference of municipal authorities was held on Monday last at the Westminster Hotel to consider the Lords' decision, and a motion was unanimously carried, "That in the opinion of this conference the granting by Parliament of running powers and compulsory traffic facilities over municipal tramways will be fraught with grave and undesirable consequences, and will be detrimental to the working of a large central tramway system." It has been justly pointed out in various quarters that, having these powers, the value of a subsidiary concern would be enormously increased, and this artificial value would obtain from no inherent properties of its own, so that if, as is usually the case, some authority decided to buy, the amount to be paid

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would be difficult to ascertain, the intrinsic value being one thing, the artificial value, which would be the real value to the holders, being quite another thing. If the question is not altogether new, it is new to practical politics, and we quite agree with the conclusion arrived at by the conference that the clause is to be strenuously opposed in the Commons

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### STEWART ARC LAMP.

SIR,—Our attention has been called to a notice in your columns in regard to the name "Stewart," which we have reason to believe has misled many of your readers and caused obstruction to our business. We should, therefore, be obliged if you would allow us to state explicitly the actual facts, on which we think that comment is superfluous.

The Stewart Electrical Syndicate, Limited, sold certain arc lamps as "Stewart" arc lamps under an agency agreement, and to the best of our knowledge sold nothing else under the name "Stewart." The agency of the company for these lamps was determined, and with it the company's right to apply to arc lamps the word "Stewart," which denotes solely those lamps for which their agency had ceased. The business of the Stewart arc lamp was acquired by us.

The only right which the Stewart Electrical Syndicate, Limited, retained in the use of the word "Stewart" was to apply it to electrical goods other than arc lamps; and in connection with such goods the name was unknown in the trade, and had no commercial value.

The Stewart Syndicate went into liquidation, and its manager obtained employment with another company, whose advertisement is in question. This company thereafter purchased what remained of the "goodwill" of the Stewart Syndicate business for £95, and began inserting advertisements to the effect that they had acquired the right which the Stewart Syndicate possessed to the use of the word "Stewart" in connection with the sale of electrical goods.

It will be seen from the above statement that the company has not acquired the right to sell its arc lamps as Stewart lamps, or to restrain the makers of the Stewart lamps from selling theirs under that name, and that Stewart arc lamps can be obtained only from ourselves, our agents, and our customers.—Yours, etc.,

J. DEFRIES AND SONS, Limited.

London, E.C., April 20, 1904.

## SOME REMARKS UPON THE CAUSES OF BREAKDOWN IN ELECTRIC MOTOR INSTALLATIONS.

BY A. H. M.

That accidents will happen and repairs from time to time become necessary to all classes of machinery is beyond dispute, but as far as the direct-current motor is concerned, the trouble might frequently be avoided by the exercise of a little extra foresight with regard to the *details* of the installation. How much depends upon mere details, both with reference to the construction of the motors themselves and also the accessories, will probably be made painfully manifest when the machinery has been running for a short period under working conditions. By the expiration of a few months an employé will certainly have found an opportunity of getting a spanner or other equally undesirable article firmly jammed between the armature and pole-piece of the open-type motor which has so far given no trouble, and this expensive mishap will bring out the advantages of the protected ventilated type with considerable distinctness.

Then, again, those shunt windings (the writer has seen many such) merely insulated from the pole-piece by a few turns of paper and cotton cloth will suddenly develop an earth to the framework, and as a result the field coils must be entirely removed. This points with no uncertain finger to the necessity of a bobbin of hard fibre or similar suitable material for winding the coils upon. With regard to these bobbins, it is highly important that the end discs and connecting sleeve shall be in one piece, or at any rate shall be so joined that oil or moisture cannot find an entrance, as damage to the coils will often make a start at this point if moisture finds its way in. The last few outside layers of wire should also be saturated with a highly insulating and waterproof varnish, forming practically a damp-proof skin over the whole. The above remarks with regard to insulation will also apply in some cases to the armature, the writer being conversant with several machines in which the insulation between the armature discs and the winding is quite insufficient to stand the test of time, although a really fabulous voltage may have been employed in testing previous to leaving the maker's works.

Or, again, trouble may arise because for some reason the armature of motor No. 3 refuses to revolve, even when encouraged by the application of a current immensely in excess of the carrying capacity of the windings, and when by steadily reinforcing the conveniently handy fuses the attendant at last succeeds in burning out the armature, the machine will be overhauled and the alarming discovery made that the nut provided to hold the commutator in position has worked loose and jammed back against the framework. An additional thin lock nut or even sunk set screw would have saved all this damage. Many a disaster amongst electric motors has been caused by the accidental dragging out of the shunt lead from its terminal. This is one of the most inexcusable of accidents, and is directly attributable to the use of ordinary set-screw terminals. Set screws have a habit of working loose in time, especially when subjected to the constant vibration attendant upon the running of an electric motor. Even when firmly screwed down the grip is of a poor mechanical character, and for this reason the shunt lead should not be less in section than $^{7}/_{20}$ S.W.G., and the end should be thoroughly soldered into a thimble and loop, and the loop fitted over an upright threaded terminal, and held firmly by means of a spring washer and a winged nut. It may be added that a large winged nut and a hard bronze spring washer fitted to an upright threaded brass stud, form a most excellent terminal for the main current leads as well as the shunt.

The running parts of motors are often unduly strained, especially where a direct drive by toothed gearing is employed, by allowing too large a starting torque with the starting switch arm on the first contact. This is, of course, due to the fact that the total resistance of the rheostat is too low. Probably, in the majority of cases, the starting current required exceeds the full-load current by about 50 per cent., but that is no legitimate reason why such a rush of current should pass through the armature all at once. A properly designed rheostat should have its resistance so graduated that about half of full-load current will pass with the starting arm on the first contact, full-load current on the second, and then, providing that the motor has not started, the current should rise to about 50 per cent. excess on the third contact. Even when the motor does not start with the first two sections of resistance cut out work is being done, as the current passing through the armature is *tending* to move it, and the next rise of current will start the motor without undue shock or strain.

The original cost of an installation is often unduly increased by the employment of motors of the totally enclosed class, owing to the low efficiency of such machines from overheating. There are, of course, cases in which it is necessary to use the totally enclosed type, but the protected ventilated motor would often be equally as suitable for the work and far more economical. Improper connections between the starting switch and the motor are sometimes responsible for damage, especially if the shunt wiring is not properly connected. The writer has seen several instances in which the shunt lead is taken direct from the double-pole switch to the motor terminals. This is quite wrong, as upon opening the double-pole switch the shunt circuit is suddenly opened, and a great strain thrown upon the insulation. The lead for the shunt terminal of the motor should always be taken from the first contact of

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the armature starting resistance, and upon breaking circuit the shunt discharge will expend itself in discharging through the main resistance. The type of starting switch selected for use in the installation will exercise an immense influence upon the satisfactory, or otherwise, working of the plant.

Starting switches are generally described in makers' lists as a given horse-power and a given voltage. It would be far better if a further sub-division were made classing the switches for heavy and for light duty. A certain starting switch may satisfactorily start a motor of given horse-power and voltage, but may at the same time be utterly unsuitable for continuous and heavy starting work such as starting apparatus is called upon to perform in large engineering works. When the motor is to be frequently stopped and started, and the starting load uncertain, and likely to reach a large excess current, it is absolutely imperative that the carrying capacity of the resistance shall be ample to meet emergencies, otherwise continual expense and annoyance will follow. For the above heavy duty it is necessary to provide contacts of the renewable segment type, and the contact maker should be of ample area.

One other point, which cannot be too frequently driven home, is the *absolute necessity* of providing reliable fuses in each motor circuit. They are a perfect safeguard, and, where omitted, a heavy bill for repairs and stoppages will mount up swiftly and surely.

The extent to which electric driving has been adopted during the last five years is ample evidence in establishing its superiority over the older forms, and it would, indeed, be a pity to hinder its further rapid progress by lack of attention to small matters, which may amount to a great deal in the formation of the user's opinion of his installation at the end of the year.

## VISIT OF THE STUDENTS' SECTION OF THE I.E.E. TO BIRMINGHAM.

BY D. S. PAXTON.

It has become an annual event in the history of the Students' Section of the Institution of Electrical Engineers to devote the second week of the Easter vacation to a series of visits to important works in some large engineering centre. This year the district chosen was that surrounding Birmingham, and on the afternoon of Monday, April 11, a party of about 40 students from all parts of the country assembled at the Rugby works of Messrs. Willans and Robinson, and were shown round them by members of the staff. The pattern shop is being brought right up to date by the installation of a complete system of compressed-air tools, many other labour-saving machines being already in operation. In the machine shops many engines in various stages of completion were seen, their destinations including Chelsea, Bradford, Northampton, Santiago, Stoke-on-Trent, and Tokio. It was noticed that, in place of the wood lagging which was formerly used on Willans engines, a metallic lagging is now in use, being filled with a special composition. One of the new vertical gas-engines of 150 h.p. was on test in one of the workshops; it is coupled to a Siemens 110-kw. dynamo, and runs at a speed of 250 revolutions per minute. Another engine that excited interest was a waste-heat engine, designed to utilise the waste heat in the exhaust steam from steam-engines. The method of working is to vaporise sulphur dioxide by means of the steam, and to drive the engine, which is similar to an ordinary gas-engine, by the sulphur dioxide, which is then condensed and used again. After leaving these works the party completed their journey to Birmingham.

On Tuesday morning the Witton works of the General Electric Company were visited, the manufacture of arc lamp carbons being followed with special interest. Briefly stated, the process is as follows: Graphite is ground up and mixed with tar, the mixture is then reground, rammed into cylinders, and passed through a hydraulic press, out of which it comes in the shape of a long rod of the required section; this rod is cut into lengths of about 4½ft., which are dried and baked in gas ovens of special construction for about eight days at a temperature of 2,500deg. F.; the carbons are then cut to standard sizes, and the cored ones filled with a special composition by small hydraulic presses. In the engineering works large numbers of continuous-current and polyphase motors and generators were seen in course of construction.

The afternoon was spent at Ocker Hill, where the generating station of the Midland Electric Power Company has recently been completed. The plant at present installed consists of one 1,500-kw. two-phase Ferranti alternator driven at 100 revolutions per minute by a Yates and Thom engine, and two 800-kw. two-phase Ferranti alternators driven by Ferranti engines at 150 revolutions per minute; in each case the exciters are rope-driven from the shaft. A motor-driven Hunt coal-conveyer, capable of dealing with 20 tons per hour, carries the coal from barges to hoppers over the boilers, of which there are 16 by Babcock and Wilcox, stoked by chain-grate mechanical stokers. The generating voltage is 7,000, which is transformed down to 2,700 at the sub-stations, and again to 200 in street transformers at the various points of supply. The Wednesbury Corporation has within the last few weeks started taking a 200-volt supply from the Wednesbury sub-station of the company, which was also visited. The high-tension and extra high-tension switchboards are by Ferranti, and the low-tension by Kelvin and James White.

The party journeyed to Wolverhampton on Wednesday morning, and proceeded to the works of the Electric Construction Company. A 1,500-kw. two-phase generator for Leeds, a 750-kw. traction generator for Halifax, and a balancer for Johannesburg, were among the machines seen in the various shops, which are all electrically driven, some by continuous-current motors and some by three-phase motors, so that prospective customers may see either system at work.

The Wolverhampton Corporation electricity works were visited in the afternoon. Here the generating pressure originally in use was 1,800 volts, continuous current, which was transformed down to 110 volts in the sub-stations; this has now been entirely done away with, and the system in use is a three-wire supply with 440 volts between the outers. The sets at present in running order are one 200-kw. Willans-Parker set, two 500-kw Willans-E.C.C. sets, and one 500-kw. Davey-Paxman-E C C. set; to these, two new sets, probably of 500 kw. each, will soon be added. The boiler-house equipment consists of two Paxman boilers and six Lancashire boilers by Thompson, of Wolverhampton, each of the latter being fitted with a superheater. The feed water is heated by means of a Berryman feed-water heater and a Green's economiser, the feed pumps being by Weir. A coal conveyor will shortly be erected to carry the coal from the canal to bunkers over the boilers. There are two batteries of Tudor cells, one of 1,200 ampere-hours capacity for lighting, and the other of 1,000 ampere-hours capacity for traction; the battery regulating switches are not on the main switchboard, but the contacts are moved by small motors which are operated from the main switchboard, thus saving a long run of cables.

After leaving the generating station, the car-sheds were visited, and here the Lorain surface-contact system was explained in detail.

On Thursday morning the visitors divided into two parties, one going to Messrs. W. and J. Player's works, and the other to those of the Lanchester Engine Company. The speciality of the former firm is the manufacture of belt or motor driven power hammers, designed to take the place of steam hammers. At the latter works the manufacture of Lanchester automobiles was followed with interest, the chief points remarked upon being the compact design of the engines, the change-speed gear, and the patent Lanchester magneto-ignition. Originally the cylinders of the motors made by the firm were air-cooled by means of fans, but, as some people prefer water-cooling, either method is now fitted according to customers' preference. An 18-h.p. engine of specially light construction has been brought out this year, in addition to the original 12-h.p. size.

The self-lubricating engines of Messrs. Belliss and Morcom, whose works were visited on Thursday afternoon, are too well known to require any special mention here, so

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it will suffice to say that the works are electrically driven throughout from generating sets in their power-house.

Electricity supply meters in all stages of manufacture were seen at the works of Messrs. Chamberlain and Hookham on Friday morning. Everything connected with the meters is made on the premises, including the counters, which in most makes of meters are purchased ready made from Germany. A special feature of the works is the excellent work done by turret lathes, of which there are a large number, and the highly specialised nature of each man's work. During the last year the manufacture of both continuous and alternating current prepayment meters was commenced, and large orders are now in course of fulfilment; in fact, it is anticipated that the turn-out of prepayment meters alone will soon reach 250 per week. Contracts in hand for this year for the various types of meter manufactured by the firm include 750 for Glasgow, 500 for Liverpool, 500 for Manchester, and 2,000 for the Edmundson's Electricity Corporation, Limited. It is intended that special attention shall be given to the manufacture of highly-finished ampere-hour and watt-hour meters for switchboard work.

On Friday afternoon the party again divided into two sections, one section journeying to the factory of the Birmingham Small-Arms Company at Small Heath, where the manufacture of all types of small arms and the celebrated B.S.A. fittings were seen, and the other to the tube works of Messrs. Stewarts and Lloyds at Halesowen, which are devoted to the manufacture of steel pipes and all sorts of joints and fittings for use with them. The greater part of the works has been converted to electric driving, and the remainder soon will be. Three methods of welding were seen in operation: (1) by means of rollers—for this method, which is used in the manufacture of all the smaller sizes of pipe, the pipes are raised to the required temperature in Siemens furnaces, which are heated by producer gas made in the works; (2) gas welding, which is used for large pipes up to 4ft. in diameter; and (3) electric welding, which is used for welding on flanges and all sorts of special work. The visit was brought to a conclusion by the turn-out of the fire brigade, which was accomplished in a very short time, a good jet of water being obtained in a few minutes.

A dinner was held at the Midland Hotel on Friday evening, with Mr. H. D. Symons, formerly hon. secretary of the Students' Section, in the chair, and Mr. Vaudrey, the chairman of the Birmingham Local Section, as the guest of the evening. The toast list, which was interspersed with songs and recitations, included the President and Institution, Mr. Vaudrey, Mr. Symons, and Mr. A. G. Ellis, the present hon. secretary, to whom the success of the visit has been chiefly due.

The Water-street generating station of the Corporation electricity supply department was visited on Saturday morning. There are two engine-rooms, one on each side of the boiler-house. The smaller contains seven Belliss engines coupled to four Crompton and three E.C.C. dynamos, each of 180 kw., and the other contains four 500-kw. Mather and Platt dynamos coupled to Willans engines. In this room there are also rotary transformers, generating at 1,200 volts, for the supply to the Edgbaston district. The system in use is a three-wire continuous-current supply with 440 volts between the outers. The boiler-house equipment consists of 14 Lancashire boilers stoked by mechanical stokers, the flues leading into a 200ft. stack through two batteries of Green's economisers. Wheeler surface condensers are used, the water being air cooled in a cooling tower. A new boiler-house, containing two Babcock and Wilcox boilers, has recently been put down, mainly for use at the peak of the load. After leaving the generating station, a special car conveyed the party, including Mr. Vaudrey, who kindly explained all points of interest, to the new university buildings, which are sufficiently advanced towards completion to afford some idea of their ultimate magnificence. The power-house is already in working order, and contains a 120-h.p. Premier gas-engine driving a Westinghouse dynamo through a spring coupling, a 375-kw. Westinghouse dynamo driven by a Westinghouse three-cylinder gas engine, a Maclaren marine engine driving a 75-kw. three-phase Westinghouse alternator, a 75-kw. Willans-Siemens set, a 20-kw. De Laval turbine driving a Greenwood and Batley dynamo through a reduction gearing, and a 100-h.p. Belliss engine coupled to a Bruce Peebles generator. There is also a 37·5-kw. Westinghouse rotary converter, and the switchboard, which is divided into 13 panels, is by the same firm. Three-phase motors are used to drive the fan on the cooling tower, the coal conveyer, and coal washer.

Saturday afternoon brought an end to a very successful and enjoyable visit, and, farewells having been said, the party dispersed.

## MANCHESTER SECTION ANNUAL MEETING.

Another function of the double-event type was carried out on the 12th inst., when the annual gathering for the re-election of officers, etc., was made more interesting than usual by the happy idea of an exhibition of local manufacturers' specialities. The proceedings commenced with a digest report of the work of the session, mention being made of the increase in membership from 472 to 549, and of the newly-formed students' section being already 250 strong. There was no discussion this year, the feeling of the meeting evidently being that it was best to let superlative wellness severely alone.

Mr. C. D. TAITE, in proposing a vote of thanks to the retiring chairman, Mr. E. W. Cowan, referred to his universal urbanity, and to the good work that he had done both in Manchester and on the General Committee of the Institution in London. He was also mainly responsible for the students' section formation. Dr. BOWMAN, in seconding, thought Mr. Cowan had carried on the high traditions of the section in a most successful manner, and the vote was carried by acclamation.

A further vote of thanks was passed to Mr. P. A. Ramage for his labours as hon. secretary, Dr. RHODES quoting the Lancashire proverb, "If tha' does owt for nowt, do it for thysel'," as evidently being unknown to Mr. Ramage.

The next event on the programme was the rather novel one of exhibitors' representatives being called on separately to describe to the meeting (somewhat in the guise of showman) their specialities, and the following firms took advantage of this in connection with the exhibits mentioned: the British Westinghouse Electric and Manufacturing Company, Limited, model of magnetic track brake, "Cooper Hewitt" mercury vapour lamps; Cowans, Limited, "Carbone" arc lamp; General Electric Company, Limited, circuit breakers, etc.; W. T. Glover and Co., Limited, cables, joint-boxes, etc.; Key Engineering Company, Limited, Stanley magnetic suspension meter, reverse-current cut-out apparatus; Dr. Rhodes, track brake; Royce, Limited, controllers; Mr. Bertram Thomas, circuit breakers and starting switches; Verity's, Limited, circuit breaker.

Among the exhibits the new Carbone arc lamp might be specially mentioned as being open-type at 80 volts. It is noiseless and shadowless, both carbons being above the arc. The Cooper Hewitt lamp will evidently need to exercise all its valuable qualities to overcome feminine prejudices in the matter of complexion tinting. A working model of Mr. Leonard Andrews's magnum opus, the reverse-current cut-out, was the centre of attraction, and alternating station engineers who estimate the advantages of sound sleep at its proper value should look into the question of adopting this device on their boards.

The qualities of Glover's fireproof cables were tested by leaving a sample piece over a Bunsen burner for about an hour in full view of the meeting, until the volatilising of the rubber insulation caused it (though otherwise undamaged) to be forcibly removed out of pity to the audience. A kinematograph display illustrated a test actually made upon this class of cable, when, after enduring the pangs of a short-circuit involving 100 kw. for about five minutes, on switching off the current no vestige of resultant fire was to be seen on the afflicted cable.

The large number of circuit breakers shown appear to

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indicate that we are following the universal American practice mentioned by Mr. Eustace Thomas in the course of his oration upon his own particular pet. And Mr. Cowan's instance of one breaker having had occasion to work in practice 80 times in 20 minutes corroborates the necessity for these devices.

At the close of the meeting the result of the voting for officials for the ensuing year was disclosed as follows: chairman—C. D. Taite, Esq.; vice-chairman—A. S. Giles, Esq.; hon. secretary—P. A. Ramage, Esq.; committee—Dr. Bowman, Dr. Rhodes, Dr. Schuster, Mr. Cortez Leigh, Mr. A. A. Day, Mr. M. B. Mountain, Mr. A. H. Gibbings, Mr. A. Bromley Holmes, Mr. G. F. Metzger, Mr. T. L. Miller, Mr. S. L. Pearce, Mr. L. Andrews.

MANCHESTER SECTION STUDENTS.

A party of about 100 inspected the works of Messrs. W. T. Glover and Co., Limited, Trafford Park, on the 9th inst., being shown the various cable-making processes in detail. Pressure tests on extra-high-tension cables, and experiments on fireproof insulation were also demonstrated. The hon. secretary, Mr. John Roberts, jun., is to be congratulated on the progress of this young society, which although still in its teens (as to weeks of experience) has already discussed three papers read before it and paid two visits to prominent works. This section undoubtedly fulfils a useful mission in the Manchester district. It is questionable if any other district could show a like result.

## HIGH-TENSION TRANSMISSION IN SPAIN.

The Siemens-Schuckert Company have, we learn, completed the equipment of a power station to the order of the Società Hidro-Electrica Iberica in Bilbao. This station is situated at Quintana Martingalindez, about 48½ miles from Bilbao, and has been designed for an output of 4,000 h.p, turbo-alternators of 1,000 h.p. each at 375 revolutions per minute being installed. The primary current at 3,000 volts pressure is transformed up to 30,000 volts for transmission to Bilbao. Later on it is intended to work this plant in conjunction with another of 6,000 h.p. capacity which is being erected at Puentelarra, about 43½ miles from Bilbao. The 30,000-volt transmission lines from these two stations terminate at a sub-station in Bilbao, where the pressure is reduced to 3,000 volts. In view of future extension of the primary plants, this sub-station has been designed for an ultimate output of 15,000 h.p. There is a considerable demand for current from the ironworks and other industrial establishments in Bilbao, besides for the town's lighting. A third generating station, to be equipped with plant aggregating 4,000 h.p., is in course of erection for the same company at Leizaran, distant 62 miles from Bilbao and 11 miles from San Sebastian. It is interesting to note that transmission in this case will also be at 30,000 volts, a large part of the output being destined for Bilbao, which will thus receive its electricity supply from three waterfalls, each situated at a considerable distance.

## THE FARADAY SOCIETY.

An ordinary meeting of the Faraday Society was held on April 13 at the Institution of Electrical Engineers, Mr. J. Swinburne, vice-president, in the chair.

Mr. ARTHUR J. HIORNS read an abstract of his paper on "Alloys of Copper and Arsenic," illustrating his remarks by a series of interesting and beautiful lantern slides. The object of the author's investigations was to ascertain the exact relation between copper and arsenic in binary alloys, and the limit of proportion of arsenic that can be retained in copper in the cold solid state. The addition of arsenic lowers the melting point of copper uniformly down to about 14 per cent., when a steep fall in the freezing-point curve occurs, reaching its lowest point at 685deg. C. This alloy contains 19·2 per cent. of arsenic, which corresponds to the formula $Cu_5As_2$. The alloy with 22 per cent. of arsenic freezes at 708deg., and the temperature gradually rises until the alloy with 28·34 is reached at 747deg. This is the compound $Cu_3As$. At 810deg. another chemical compound freezes, having the chemical formula $Cu_5As_2$; it contains 32·2 per cent. of arsenic. Beyond this point the temperature gradually falls again to a minimum at the alloy with about 35 per cent. of arsenic. The curve then rises to another summit at 740deg., forming the compound $Cu_2As$, with 37·24 per cent. of arsenic. From this position the curve descends to 702deg. with the alloy containing 41 per cent. of arsenic. This is nearly the practical limit of the direct combination of copper and arsenic. The top surfaces of many of the alloys were photographed. The types of pattern visible on the etched surface depend upon the position of the freezing point on the curve. For alloys whose freezing point is on or near the summit of a curve, the whole of the section is composed of one substance, generally made up of crystal grains having fine boundaries. When, by addition of copper or arsenic, a summit of a curve is left, the lines between the crystal grains widen and become filled with a network of matter differing from that of the crystals and generally showing a more or less striated appearance, so characteristic of eutectics. As the bottom of a curve leading from a summit is reached the eutectic occupies the whole surface. It is noticeable that the alloy of minimum fusion of copper-arsenic alloys has an extremely fine striated structure. Any deviation in composition from the eutectic proportion causes the breaking up of this striated pattern, and grains of one of the constituents appear in the eutectic matrix. A microscopic examination was also made of polished sections of the various alloys. These, when viewed in daylight, are all copper-coloured in those with little arsenic, and gradually get paler as the arsenic is increased. When the alloy with 19·2 per cent. is reached, the surface appears of a pale-blue colour, and this is continued up to the compound $Cu_5As$, containing 28·34 per cent., which is of a deeper blue colour. The alloys between 19·2 and 28·3 per cent. have a paler blue tint because the blue constituent is associated with a constituent richer in copper, forming an eutectic mixture. The alloy with 30·0 per cent. is of a light purple colour, and when the compound $Cu_5As_2$ is reached, containing 32·2 per cent., a full reddish purple is obtained. This purple colour maintains up to the limit of these experiments with 45 per cent. of arsenic, but gets gradually paler. The paper concludes with a detailed description of the various alloys, fully illustrated by excellent photomicrographs.

Mr. SWINBURNE, referring to the melting point of arsenic, which the author thought could only be obtained by experiments made under great pressure, observed that the effect of pressure on the melting point of solids is very small, and that probably at ordinary pressures the melting point of arsenic was very close to its volatilising point.

Dr. PERKIN hoped that the author would supplement his researches by making conductivity measurements of the series of alloys.

Dr. C. H. DESCH made some interesting comparisons between the results obtained by the author and those published by other investigators in the case of the analogous series of copper-antimony alloys.

Mr. E. G. P. BOUSFIELD contributed a paper on "Experiments with a New Primary Cell." The cell consists of an inner porous pot containing nitric acid and a carbon pole, and an outer vessel containing sodium hydrate solution and a metal pole, preferably zinc—*i.e.*, a solution of from 12 to 15 per cent. Using solutions of maximum conductivity with zinc and carbon poles on open circuit, an E.M.F. of 2·6 volts may be obtained, Not only does the cell possess this comparatively high E.M.F., but it may be short-circuited far longer than most cells before it runs down. A cell short-circuited through a total resistance of 0·61 ohm gave a current of 4·18 amperes, which fell to 2·61 in an hour, 2·38 in 2¼ hours, and 1·75 in six hours. A smaller cell gave a fairly constant current of about 0·8 ampere for 20 or 25 hours. Discharge curves are given in the paper. Acids other than nitrate were experimented with. Some of them gave higher E.M.F.'s than nitric acid, but no other acid possessed the same "lasting powers." The effect of using various metals instead of zinc was also tried; some of these gave higher E.M.F.'s than the zinc, but the high readings were quite transitory. Using two carbon poles the E.M.F. was about 1·35 volts. The cell is then similar to Becquerel's platinum cell, in which the plates are immersed in acid and caustic potash respectively.

Mr. W. R. COOPER referred to the disadvantages of both nitric acid and caustic soda as electrolytes. The high E.M.F. of the cell was only apparent, because it rapidly fell to a working value of 1·8 or 1·9. He would like to have seen comparative tests made, say, with a bichromate cell.

Mr. J. SWINBURNE mentioned a suggestion made by Dr. Swan, that the cell would be improved if it were converted into a three-fluid cell, with a neutral electrolyte—*e.g.*, $NaNO_3$—in the mid compartment.

Mr. BOUSFIELD also contributed a "Note on Determining Accurately the Percentage of Ozone in Gases not dissociated by Moderate Heat." Difficulty was found in determining accurately the quantities of ozone formed in different electrolytic reactions. The potassium iodide test is sufficiently accurate for most purposes, but for very accurate work it is not satisfactory, as

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an error of 5 per cent. or more is often obtained with a slightly alkaline solution, and an error of as much as 1 or 2 per cent. with an acid solution. Estimating the ozone by weight, using glass globes for that purpose, was also found to be somewhat uncertain, due to the condensation of moisture on the glass. The method recommended by the author is a measurement by volume. A certain quantity of gas containing ozone is measured. This gas is then passed over some substance, such as heated platinised asbestos, which is capable of converting ozone into ordinary oxygen. On again measuring the gases, an increase of volume due to the breaking down of $O_3$ molecules into $O_2$ molecules is found. From this increase of volume the quantity and percentage of ozone originally present is readily calculated. A description of the simple apparatus required for the measurements is given in the paper.

## TRADE NOTICES AND NOVELTIES.

### Combination Tumbler Switch and Wall Connection.

We have received from Mr. A. P. Lundberg, Pioneer Electrical Works, 477 to 487, Liverpool-road, Islington, N., a sample of his "Pivot" combination tumbler switch and wall connection for 2½ amperes and 200 volts. The construction of the switch movement is identical with that of the Lundberg "Pivot" tumbler switch, and depends upon a variable spring leverage for its action, the contact arm being locked in its "on" position. Four substantial terminals are provided, with large wire holes for looping in. The two additional terminals allow the article to be adapted for a number of purposes, the connecting strap being so arranged that it can be easily removed to accomplish these adaptations. For example: (1) The switch movement may be arranged to control the plug circuit. (2) The plug circuit arranged independently of the switch move-

Combined Tumbler Switch and Wall Connection.

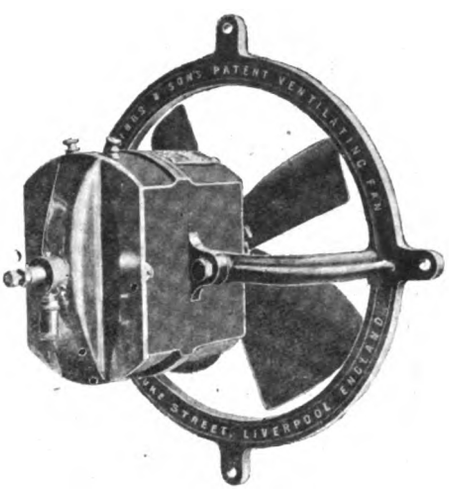
ment, the latter controlling a different circuit. (3) The switch movement arranged to control the plug circuit and an additional one. (4) The switch and wall plug circuits can be connected to separate pairs of mains, should the necessity arise, and control separate lamps. (5) A motorcar cell connected in the plug circuit may be conveniently charged in series with a lamp. (6) A suspension pear switch connected with the plug part, and the circuit so arranged that both switches (*a*) control the same circuit together; (*b*) control the same circuit independently; (*c*) control quite distinct circuits. (7) The contacts of the plug part can be specially arranged to supply current for Nernst lamps and for similar cases where any change of polarity must be guarded against. The sample before us is constructed to suit the Lundberg "Dot" gauge of two-pin plug, but, we understand, a pattern will shortly be introduced to suit the larger gauge of plug also—viz., the "Universal." It is of excellent finish. Quite apart from their convenience, the use of such combination fittings results in considerably economy in material and labour cost, and we are pleased to note that Mr. Lundberg is reaping the reward of his untiring enterprise in a large demand.

### G.E.C. Progress Sheet.

The progress sheet issued by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., for March deals with several new items from the firm's different departments. The "Pedestal" type of cut-out in cast-iron case, shown on p. 1, has been specially designed to meet the demand that has arisen for a high-voltage main cut-out. Cut-outs of this type can be supplied with either plain or spring clip terminals, the latter to take a "Mordey" fuse. The terminals are mounted on porcelain insulators, which are fixed to the inside of the base of the box; a porcelain bushing is also supplied to the leading-in holes. Two new designs of radiators are shown on p. 2, one, the "Dolphin" pattern, being most artistic. A very handy form of lamp-testing ammeter is shown on p. 4.

### A Completely Enclosed and Protected Motor Fan.

The need for a first-class, lasting, and, at the same, cheap and reliable ventilating motor fan has long been felt. Small apartments, such as lavatories, ships' staterooms, and the like, are difficult to keep in an efficient state of ventilation without some mechanical means, but the machine illustrated below seems to be exceptionally well adapted for this purpose. As will be seen at a glance, this fan is neat in design and appearance. It is of a pattern recently introduced by Messrs. John Gibbs and Son, 72-76, Duke-street, Liverpool. The magnets of these fans are built entirely of sheet-iron laminations, and are of the enclosed, double-circuit type. The pole-tips are so shaped that the hum common in small fan motors is elimidated. The armatures are of the slotted type and are carefully wound, and insulated entirely by mica. The commutators are of ample section, and are sufficiently deep to permit of turning up when required. The brush-holders have been carefully designed to require a minimum of attention. They are fitted with square carbon brushes, and are insulated from the cast-metal rocker by ebonite and mica. The bearings are brass bushed, and are fitted with a special form of steel ball thrust so that the propeller action of the fan blades creates no friction. Solid grease lubricators are fitted so that the fans can be run at any angle, either vertically or horizontally. The whole motor is encased in an entirely enclosed cast-metal case either of iron, brass, or aluminium, which can be electroplated if required. This casing protects the motor from all injury, dust, etc., and is practically watertight, whilst the back is instantly removable if required for renewing brushes and inspection purposes. The fan blades themselves are of the open type, which Messrs. John Gibbs and Son have found, after a series




New Pattern Ventilating Motor Fan.

of experiments, to be the most efficient form for propelling air with a maximum efficiency, using a minimum of power. They are built into Messrs. John Gibbs and Son's patent fan boss, which consists of two halves of cast metal, locked with flanges in such a manner as to perfectly grip the blades which are inserted between them, and even at a very high speed are perfectly safe from centrifugal action. This is an important matter, and cannot be too strongly impressed upon all purchasers of fans, as many are imperfectly secured to the boss. It will be seen by the illustration how easily the fan and motor can be transferred to another ring and fitted elsewhere. This is effected by means of two bolts and wing nuts, and is especially useful when the machines are for use on board ship. The power consumed by the fans is so small that they can easily be worked with an adaptable plug off the lighting circuit, no starting switch being necessary. It may be added that this pattern of fan is intended by Messrs. John Gibbs and Son to supply the demand for a really first-class machine at a price within the reach of all who require such.

### Regina Arc Lamps.

We understand that Mr. G. Braulik, 217 and 218, Upper Thames-street, London, has been appointed sole agent in this country for Regina long-burning enclosed arc lamps. These lamps offer a great advantage, in that those of large type will burn no less than 200 hours with one set of carbons, while the miniature type will burn 25 hours without recarboning.

### Catalogues.

W. H. Willcox and Co., Limited, general engineers' stores and lubricating oil merchants, Southwark-street, S.E.—Motor requisites, lubricating oils, pumps, injectors (Penberthy patent), water raisers, hose, tools, etc.

W. N. Brunton and Son, Wire Mills, Musselburgh.—The third edition of the firm's resistance material catalogue includes details of new specialities manufactured by them for the electrical trade, as well as resistance material—such as

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cable clips, arc lamp rope, etc. Revised tables are added giving resistance, carrying capacity, etc., of "Beason" high-resistance wires. We are informed that our readers may obtain a copy on forwarding to the firm four penny stamps to pay for postage and printing.

## MANCHESTER.

The accounts of the electricity department, submitted on Wednesday, show considerable progress. Last year the committee anticipated a deficit of £9,450, estimating expenditure at £242,450, and income at £233,000. The approximate expenditure for the year just ended amounts to £261,850, which balances with the approximate income, but it includes £25,000 which has been transferred to renewals suspense account. For the current year the committee estimate an expenditure of £287,600, inclusive of another £25,000 to suspense renewals account, and that the income will be fully equal to the demand. They hope to receive from sales of current, meter and motor rentals, £179,700; from the tramways department, for current, £106,900; and from the city fund, for street-lighting, £350; £50 is also expected by way of rent from cottages; and £600 may be expected in the shape of interest on money invested. The committee ask from the rates this year £1,000 to cover the cost of street-lighting, an increase of £500. The committee intend to spend on capital account £10,600 on buildings and machinery at Dickinson-street, £4,300 at Bloom-street, £82,000 at Stuart-street (on building, machinery, railway, etc.), and £42,700 on buildings, transformers, etc., at the distributing stations; £45,000 is to be provided for mains, £5,000 for meters, and £3,500 for motors, making a total capital expenditure of £193,100. The estimate for the year ended March 31 on this account was £350,600, and the approximate expenditure came to £333,710. The estimate of ordinary expenditure for the current year includes £54,000 for sinking fund, £66,500 for interest on mortgage debt, £19,130 for rents, rates, and taxes; £23,430 for repairs, maintenance, and renewals of buildings, machinery, and mains; £40,950 for coal; £8 020 for oil, waste, water, engine-room stores, etc.; £14,700 for wages and salaries for generation, £13,400 for distribution, and £6,650 for management.

The committee report on the accounts and estimates as follows: The total expenditure for the year just closed amounts to £261,850. Dividing this, as usual, into (1) running charges and (2) fixed charges, it will be found that the former show marked economies and the latter heavy increases. Running charges amount to £53,196 for an output of 28.953,459 units, as compared with the previous year's total of £48,489 for 17,400,223 units, or ·44d., as against ·67d. per unit. This saving is mainly due to a reduced consumption of coal, oil, waste, water, etc., and to the plant requiring less for maintenance. Fixed charges amount to £208,654, which, divided by the aggregate of consumers' maximum demands (measured at the generating stations), equals £12. 1s. per kilowatt. For the previous year the corresponding total was £140,365, equalling £10. 19s. per kilowatt. The additions here are principally as follows: (*a*) distribution wages from £7,525 to £12,448, caused by the 20 new sub-stations being fully manned and used during the whole year, whereas in the previous year these places were more or less in course of construction; (*b*) rents, rates, and taxes from £12,172 to £15,419, caused chiefly by additional assessments for local rates; (*c*) interest and sinking fund payments from £76,538 to £107,727, these, of course, being governed mainly by the capital expenditure; (*d*) the provision of £25,000 for future renewals. With regard to this, it will be obvious, when the extent and nature of the undertaking are considered, that the recent method of meeting actual renewals as they arise out of the current year's revenue is altogether inadequate. During the earlier years of the department a renewals suspense fund was built up to the extent of £17,578, but was exhausted by March, 1900. In the case of management expenses, which also come under the heading of fixed charges, these show a substantial reduction—from £14,615 to £11,766.

The income during the past year from lighting and traction sales again shows steady growth, as will be apparent from the following analysis, which shows the income from lighting at 5½d. per unit, lighting at 1¾d. per unit plus fixed charge, and traction respectively:

| | | | |
|---|---|---|---|
| During 1903-4 ..... | £70 484 | ..... £75,973 | ..... £100.000 |
| During 1902-3 ..... | 61,937 | ..... 63,885 | ..... 52,463 |
| Increase ..... | £8,547 | ..... £12,088 | ..... £47,537 |
| Increase per cent ... | 14 | ..... ... 19 | ..... 90 |

From power sales the income is £13 830, being £1,766 less than last year, notwithstanding the increase of 766,511 units in the quantity sold. This is explained by the reduction in price. The estimates for the year have been calculated with every care. The increased sales of current are anticipated as follows: on lighting sales at 5½d. per unit, 8 per cent.; on lighting sales at 1¾d. and fixed charge, 12 per cent.; on power sales, 35 per cent.; on traction sales, 7 per cent. Many of the items on the expenditure side are dependent on output, and are reckoned accordingly. It is expected that a further sum of £25,000 will be available for transfer to the renewal suspense account. The amounts shown for sinking fund charges and instalments of loans to be repaid are definite figures. Interest charges cannot differ much from those now estimated. The remaining items on revenue account do not call for comment, except that the item of £5,000 for expenses *re* vibration and explosion is merely for rent, counsel's fees, and damages *re* explosion, and does not cover the cost of any prospective attempts to remove vibration. With regard to the estimates on capital account, nothing has been included beyond what has been brought before the committee from time to time. The total is made up of: (1) a proportion of the expenditure as scheduled in the present application to the Local Government Board for further borrowing powers; and (2) further payments on account of balances owing on schemes sanctioned for Bloom-street, Stuart-street, etc.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on April 14 the following candidates were elected:

*Associate Members.*—T. M. Blackman, 5, Sea-view, Tulketh road, Ashton-on-Ribble, Lancs.; J. H. Carrick, New Laithes, Horsforth, near Leeds; F. W. Cawthorn, 38, York-place, Edinburgh; W. Crawter, Gun Carriage Factory, Jubbulpore, India; R. Hotz, care of Messrs. Brown, Boveri, and Co., Baden, Switzerland; A. P. Hudson, Fairview, 107, Woodvale, Forest Hill, S.E.; J. G. Leeson, 39, Tyrwhitt-road, St. John's, S.E.; E. F. Long, 47, Hartington street, Barrow-in-Furness; B. Longbottom, Electromotors, Limited, Openshaw, Manchester; J. C. Macfarlane, 36, London-road, Chelmsford; A. Murdoch, 21, Rycroft-street, Fulham; E. G. Symons, 31A, Cremorne-mansions, Chelsea; A. J. Todd, Hobart Gas and Electric Light and Power Company, Hobart, Tasmania; C. Vernier, 49, Lovaine-place, Newcastle-on-Tyne.

*Associates.*—G. W. M. Boycott, Cleveland Bridge Company, Gateshead; H. F. E. Deane, 40, Redcliffe-square, South Kensington; W. Dingle, 10, Barrington-road, Brixton; E. Edwards, 92, Lee-road, Blackheath; J. S. Gardiner, P.O. Box 6 511, Johannesburg, South Africa; F. P. Griffith, B.A., Rathmines Castle, Dublin; W. Harrison, 89, Pensbury-street, Darlington; R. Lindsay, Laboratory, 75, Waterloo-street, Glasgow; G. S. Long, The Cottage, Milford, Stafford; H. S. Pursey, 64, Gauden-road, Clapham, S.W.; W. B. Pye, 9, York-terrace, Manchester-road, Southport; T. F. Waugh, 201, Mount-road, Madras, India.

*Students.*—J. Curtis, 4, Hawthorne-bank, Lower Broughton-road, Manchester; W. H. Glaser, 34, Moreton-avenue, Stretford, Manchester; H. R. Lloyd, 34, Moreton-avenue, Stretford, Manchester; J. A. Lloyd, Castle Rock House, Peveril-drive, The Park, Nottingham; H. R. Mills, 5, Imperial-buildings, London-road, Forest Hill; J. G. P. Thomas, Bwlch-y-Cibau Vicarage, Oswestry; G. W. Turner, Redcliffe House, Barton-on-Irwell, Manchester.

## PERSONAL.

Mr. John W. Hame, of Wigan, has been appointed assistant electrical engineer under the York Corporation.

The Lowestoft Town Council have fixed the accountant's salary at £400 per annum, this to include tramways, electric lighting, and education work.

It is proposed that a honorarium of £2,000 be paid to the widow and children of Mr. John Cooper, late burgh engineer, Edinburgh, in respect of his services in connection with the cabling of the tramways.

Mr. Fred Williams, of Maidstone, has been appointed assistant electrical engineer to the Leek Urban District Council.

Mr. Wm. Johnson Galloway, M.P., has been elected chairman of the board of directors of Galloways, Limited, Manchester, in the place of Mr. Charles J. Galloway (deceased).

Mr. W. L. Vitty, of the Dudley Corporation electricity works, has been appointed the switchboard attendant at Farnworth.

The late chief assistant engineer, Mr. A. J. Beckett, York, was on Wednesday presented with a handsome smoking cabinet by the staff and workmen of the electricity department on the occasion of his departure from the city to take up the position of borough electrical engineer to the Bridlington Corporation.

## APPOINTMENTS VACANT.

**Assistant Electrical Engineer,** Aldershot. Commencing salary, £80 per annum. Applications by May 2 to Mr. W. E. Foster, Council Offices. See advertisement.

**Shift Engineer,** Exeter. Salary, £2. 2s. per week. Applications by May 4 to Mr. Geo. R. Shorto, town clerk. See advertisement.

**Traveller,** electric lighting goods. Apply, T. T. C., 92, Queen Victoria-street, London, E.C. See advertisement.

**Foreman,** India, Government telegraph workshops, Alipore, Calcutta. Age not to exceed 30 years. Engagement for three years, with option of extension, if approved by Government. Salary, Rs.300 per mensem, rising by annual increments of Rs.25 to Rs 450 per mensem. A second-class passage provided from and to England at the expiration of three years. Applicant should be a man thoroughly conversant with light machine shop and tool-making work (the class of manufacture being electrical instruments), able to design and supervise the making of tools for special purposes, and set up automatic machines for screw-cutting, etc. A good knowledge of milling machines is also essential. Form of application and further particulars can be obtained by applying, in writing to the Director-General of Stores, India Office, London, S.W., by May 10.

**Assistant Engineer,** Bolton tramways. Commencing salary, £150 per annum. Applications to Mr. R. G. Hinnell, town clerk, Town Hall, Bolton, by 25th inst.

**Gas Engineer and Manager and Electrical Engineer,** Malvern. Salary, £400 per annum. Applications to Mr. H. L. Whatley, Council Offices, Malvern, by April 23. See advertisement in former issue.

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# LEGAL INTELLIGENCE.

## QUESTION OF LOWERING HEAVY TACKLE.

At the Brompton County Court on Monday, before Judge Stonor and a jury, Ernest G S. Burr, a fitter's mate, brought an action under the Employers' Liability Act against the Underground Electric Railways Company of London, Limited, claiming damages in respect of personal injuries alleged to have been sustained owing to negligence on the part of the defendants or their servants. The claim was set down at £261. 6s.

**Mr. Wildey Wright** stated that on Jan. 4 last, the plaintiff, who was in the employ of the defendants, was working at the defendants' new generating station. The man was told by the foreman on the job to assist in unhooking and lowering a heavy block and fall, which was suspended from an iron girder. The men had to stand upon two 9in. boards, and it was contended that no proper appliance was provided for releasing the tackle. The men had to raise the whole weight by their hands, while another man, by means of a rope turned twice round one of the girders, pulled in "the slack." Suddenly the rope slipped, and plaintiff's left hand was caught and terribly crushed by the chain as the falling weight made it taut.

**Mr. William Robert Pether,** civil and consulting engineer, maintained that the block and fall on the occasion in question was lowered in an unsafe way. They should have been raised and then lowered by means of a rope slung over something above, so that the men did not have the whole weight on their hands.

**Mr. Edgar Shan,** engineer, agreed with the last witness.

For the defence, the **Company's Foreman** stated that he had had considerable experience in the trade, and never knew of any method being adopted for lowering tackle than that used in the present case. After the accident the plaintiff admitted that it was his own fault.

**Mr. Charles Fredk. Fuller,** mechanical engineer, maintained that the method adopted by the defendants on the occasion of the accident was a safe and proper one.

The jury found that the plaintiff met with his injuries through a "pure accident," which represented a verdict for the defendants, in whose favour his Honour gave judgment, with costs.

The plaintiff, however, still had a claim under the Workmen's Compensation Act, and was awarded half the amount of his usual wages from a fortnight after the accident till the present time, and as he was now partially incapacitated, 10s. a week from date until recovery.

# COMPANIES' MEETINGS AND REPORTS

## SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

The second annual meeting of this Company was held at Treforest on Saturday. Mr. Robert Forrest, the chairman of the Company, presided.

The report stated that for the short time it had been at work the Bridgend station had shown good results, and the business of the Company in that district was constantly increasing. The stations at Pontypridd and Cwmbran were now ready to deliver current, and the buildings at the Neath station had been completed. The plant at Neath was in course of construction, and the directors hoped that the station would be at work in about three months.

The **Chairman,** in moving the adoption of the report and statement of accounts, stated that the meeting was called at the works in order to give the shareholders an opportunity of seeing the largest station of their undertaking and making themselves conversant with a part of the Company's business. They would be glad to learn that for the last two or three days the Treforest station had been delivering current to a customer for sale, and that other customers would as soon as possible take their supply from the Company. At Cwmbran the conditions were practically the same, although that station was a few days later in commencing to deliver current. The shareholders would, no doubt, like to hear what were the directors' views in regard to the prospects of the Company. The only fear they had at any time was that the use of electricity in works, and especially in collieries, being something of a novelty in England and Wales, a considerable time would elapse before a large supply of current would be required. They anticipated that the prospective users would require to be more or less educated in the use of electricity. So far as the Company had gone, however, this difficulty had been most satisfactorily solved, and what the directors now feared was that they would not be in a position to supply the demand which would come upon them. Already the customers secured, and those who were in negotiation with the Company, were more than sufficient to absorb the whole of the power which could be generated at that station. The same obtained at Cwmbran and Bridgend, and a like set of circumstances would certainly arise later at Neath. At Treforest and at each of the other stations increased power must, in the opinion of the directors, be provided in the near future. He remarked that the advantages of electric over steam power for coal-winding were now being recognised, which would mean a large increase of business. The little Rhondda were going to take their supply of current from the Company, and motors were now going in. The great Rhondda was in practically the same position, with the exception of two collieries, with the proprietors of which negotiations were now proceeding. The chairman alluded to the use of electricity on the North-Eastern and the Lancashire and Yorkshire Railways, and said that it was pretty well certain that in the near future some of the many railways in South Wales would require to use electricity for the cheap propulsion of their trains, and from whom would they be able to obtain it so readily and so cheaply as from this, the pioneer company, who were already on the ground and were supplying a considerable portion of the area?

**Lieutenant-General Sir R. H. Sankey** seconded the motion.

The report and statement of accounts were then adopted, and Sir W. T. Lewis and Messrs. W. W. Hood and W. S. B. M'Laren re-elected directors.

**Mr. H Holloway** proposed that the remuneration of the directors be the same as last year, and alluded to the responsibilities which had rested upon the Board during the construction of the works. He prophesied that as soon as coalowners and other recognised what they could save by using electricity there would be a great rush for power. As one who had had experience of putting down a generating plant, he strongly advocated the taking of supplies from public companies. At 1½d. per unit the current would be at least 25 per cent. cheaper than any industrial company could generate it, and another disadvantage was that there was no responsibility. The current was switched on or off as required, and there was an end of it.

The motion was carried unanimously.

## DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The twenty-second ordinary general meeting was held in London on the 19th inst., Mr. J. A. Lycett, the managing director, presiding. Particulars of the report appeared in our last issue

In the course of his remarks, the **Chairman** stated that during the past year they had expended considerable sums and capital on the improvement and further development of the undertaking. In connection with the reconstruction of the old line they had expended £4,790, mainly in improving the present passing places, and in some instances putting an increased number, so as to facilitate the traffic. The Kinver light railway had received particular attention during the past year. They had realised that in order to get the fullest advantage from that undertaking, it was essential that they should be able to run through cars from any part of the whole undertaking. This they were debarred from doing by reason of the rails existing on this line, so that they had taken away that type of rail and substituted throughout the grooved rail, which had very much enhanced the business. The total increase of capital which was occasioned during the year was £14,699. In regard to the small item of £44 cash in hand, Mr. Lycett explained that at the end of their last financial year they had on deposit and current account £8 491, which had been appropriated to meet some of the capital expenditure. In addition they had incurred an overdraft on the bankers, but this was only a temporary matter. The traffic receipts were considerably enhanced owing to the relaying of the Kinver lines. The Kinver traffic had been particularly gratifying during the year. The results led the directors to believe that with increased facilities the line would become a most remunerative one, and they were considering the advisability of doubling the track. Referring to the amalgamation of the Company with the Birmingham and Midland Tramways Company, he said that the object was to effect a joint and combined working of the companies and lines under the control of the British Electric Traction Company in the Midlands, thus increasing the intercommunication and traffic, and giving greater facilities to the travelling public, and at the same time making a reduction in the working cost by concentration in the management. The details had not yet been worked out, but he assured the shareholders that should the proposals involve any change which might materially affect their interests, they would be consulted. He moved the adoption of the accounts and report as presented.

**Mr. A. C. Miles** having seconded the resolution, it was carried unanimously.

## LIVERPOOL DISTRICT LIGHTING.

The annual meeting of the Liverpool and District Lighting Company was held at the Exchange Station Hotel, Mr. Holbrook Gaskell presiding.

The **Chairman** moved the adoption of the report and accounts and the declaration of a dividend at the rate of 3 per cent. for the half-year. After careful consideration the directors had reduced their charge for the electric light in Waterloo from 6d. to 5d.—compared with 3½d. in Liverpool. The reduction in price of current already had the effect of increasing their customers and their business generally. The increase in consumption of the first two months of this year compared with the same period of last year was at the rate of 36 per cent., and if this continued the dividend would soon again be 5 per cent. Personally he thought 5d. per unit still too high, and while they could not be expected to compete with the Liverpool Corporation (whose charge was 3¾d.), they might have to reduce their charge even below 5d. to, say, 4½d., which with the increase of business which would be brought about would be beneficial to the Company. The directors had debated whether they should, after reducing the price, make up for the loss by reducing the depreciation account or the dividend, and they had decided to pay a smaller dividend, because depreciation took place whether it was allowed for or not. The fact that their business increased in spite of the reduction showed that the policy was good. In conclusion, he mentioned that Mr. Cookson, a member of the Waterloo Council, had accepted a seat on the Board.

**Mr. Naylor** seconded, and the resolution was carried.

Messrs. H. Gaskell, jun., and J. Naylor were re-elected directors, and Mr. W. L. Jackson as auditor.

## BIRMINGHAM AND MIDLAND TRAMWAYS.

The twentieth ordinary general meeting of this Company was held on the 14th inst. at the offices, Central House, New-street, Mr. C. S. B. Hilton presiding.

In moving the adoption of the report and accounts (which have been published), the **Chairman** dealt with the advantages that would

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result from the harmonious working of the Birmingham tramways. To-day there were 94 miles of tramways and light railways, the bulk of them worked on the overhead system. At present all the companies in the district were worked by separate organisations, and their policy was to bring about a working arrangement with all those companies The Company had acquired an electric lighting order for Smethwick. They had also negotiated with the authorities at Oldbury, but so far the negotiations had not been completed. The Rowley Regis line, when completed, would be leased to the Company for 21 years. After that it would be a very useful feeder to their system. The premiums paid for third-party insurances had given them a great deal of consideration during the year, and they had had such a tendency to increase that most of the associated companies with the British Electric Traction Company had entered into what amounted to a mutual scheme, and if, after looking into it, they found that it was satisfactory, he believed the Company would join the other companies in the scheme.

**Sir Ernest Spencer** seconded the motion, and expressed the hope that in the future they would be able to give the public a very good service, that they would be able to increase the comfort of the trams, and that intercommunication between the districts, which was so necessary in the present day, would be soon made possible.

**Mr. J. A. Lycett**, the retiring director, was unanimously re-elected, and Messrs. Carter and Co., of Birmingham, and Messrs. Abbott, Deeley, Hill, and Co., of Birmingham and London, were appointed auditors.

## BARNSLEY AND DISTRICT ELECTRIC TRACTION.

The third ordinary general meeting of the Barnsley and District Electric Traction Company, Limited, was held on the 8th inst. at Donington House, Norfolk-street, Strand, London, W.C., Lieut.-Colonel Sir Thomas Pilkington, Bart. (chairman of the Company), presiding. The report stated that the total revenue for the year amounted to £9,737, and the net profit is £2,388, which, with £532 brought forward from the previous account, gives a total of £2,920. A dividend was paid in July last at the rate of 6 per cent. per annum on the cumulative preference shares, which absorbed £420, and after deducting this there is an available balance of £2,500. The directors propose: amount to be placed to depreciation and reserve fund, £500; balance of preference dividend to Dec. 31, 1903, £500; to the payment of a dividend on the ordinary shares at the rate of 4½ per cent. per annum, £693; amount to be carried forward, £806—£2,500. The expenditure during the year amounted to £15,634, making the total £63,721 on this account. The extension to Hoyland Nether has not yet been proceeded with, as the difficulties in regard to crossing the railway on the level at Worsborough have still to be overcome. The directors do not feel justified in advising the building of a bridge owing to the heavy capital outlay this would entail. The Board are, however, considering the advisability of extensions in other parts of Barnsley.

## MERTHYR ELECTRIC TRACTION AND LIGHTING.

The seventh ordinary general meeting was held on the 8th inst. at the registered offices, Donington House, Norfolk-street, Strand, London, W.C. Mr. Wm. L. Madgen (chairman of the Company), presided.

The **Chairman**, in moving the adoption of the report and statement of accounts, said that the Company was making progress, though the increase in actual receipts was not very marked, but it had been possible to effect some considerable reduction in working expenses. The Company had paid the debenture interest and the full dividend on the preference shares; and, in addition, the directors recommend a dividend at the rate of 2½ per cent. on the ordinary shares. Under average trade and weather conditions, both the tramways and the electric supply department should yield better results in the near future. Perhaps greater expansion is to be expected from the development of the power and lighting business than from the tramway traffic.

**Mr. G. R. Hulme** seconded the motion, which was carried unanimously.

The retiring director, Mr. G. R. Hulme, was re-elected. The auditors, Messrs. Walter J. Kershaw and Co., were reappointed at a fee of 30 guineas.

## POTTERIES ELECTRIC TRACTION.

The sixth ordinary general meeting was held on the 8th inst. at Hamilton House, Victoria-embankment, Mr. G. F. M. Cornwallis-West presiding.

In moving the adoption of the report (particulars of which appeared in our issue of the 8th inst.) and the payment of the dividends therein recommended, the **Chairman** said that in spite of bad weather, decrease in trade in the district, and increase in the rates, they were able to recommend the payment of the same dividend as in the preceding year, placing a similar amount to depreciation, and carrying forward only £84 less. Owing to the wet weather, which delayed the work considerably, the reconstruction of the Fenton section was only completed last November. The improved service which was now possible had resulted in increased traffic on that portion of the line, and the results had fully justified the expenditure. The new route between Stoke and Newcastle, which had only been completed within the last six weeks, supplied a long-felt want, and the traffic receipts were steadily increasing. The directors had every confidence that it would prove a sound, commercial addition to the Company's system. There were several light railways authorised which were not yet constructed. It was possible that one small piece of line might be constructed shortly if their finances would allow of it, but the directors were anxious to keep all capital expenditure within the narrowest possible limits. The total increased expenditure of the Company for the past year amounted to £2,081, but the proportion of expenses to receipts had not increased; it remained at the same figure as last year—namely, 59 per cent. The general increase in the gross receipts was satisfactory, the turnover of the Company last year being £97,700, as against £92,343 the preceding year. They had carried 492,000 more passengers. The directors intended to put on a service of motor-omnibuses in certain districts, there being many roads along which it would not pay to lay down an expensive tramway.

**Mr. Emile Garcke** seconded the motion, which was adopted.

## ELECTRO-PEAT COAL SYNDICATE.

The general meeting of the Electro-Peat Coal Syndicate, Limited, was held on the 8th inst. at Cannon-street Hotel, Mr. Rowe (the chairman of the Company) presiding.

The **Chairman** remarked that no expense had been spared in putting up a trial plant, which had been acknowledged by experts to have demonstrated beyond doubt the commercial advantages and utility of Mr. Bessey's electrical process. He ventured to say that those demonstrations had proved an unqualified success for the process. A very large quantity of raw peat from different bogs, including some from the Continent, had been brought to the works in its natural state, and with practically no manual labour it was converted by this patented electrical process into an electro-peat coal. The parent company for the United Kingdom would be shortly issued, under most favourable auspices, and an initial plant set up within the next two or three months for dealing in very large quantities of material. The consumer at large would be able to purchase that material at such a price that the output would be only limited by the means at the disposal of the parent and subsidiary companies for producing the manufactured material. One of the novelties and important factors in the process was that the application of an electric current to the mass of peat set up a chemical action between the natural constituents of the peat itself, and the result of that chemical action was not only the expelling of moisture from the material, but the natural consolidation of the peat into a hard solid block of fuel. The great authority on patents, Mr. Fletcher Moulton, K.C., M.P., stated in his report that the invention was one of substantial practical utility; that the letters patent were good and valid; that the specification and claims were in proper form. The Company claimed that electro-peat could be produced at the works at 5s. per ton.

**Mr. Burns** (Belfast) stated that he had been personally watching the working out of Mr. Bessey's process for the past nine months, and attended the demonstrations. He was entirely convinced that the claims could be achieved, and that the future of the enterprise had far-reaching benefits for the world at large, and for Ireland in particular, where it would open up a great national industry, and convert the peat in the almost 3,000,000 acres of bog land, which were now practically a waste, into an article of great commercial value.

## ANGUS ELECTRIC LIGHT AND POWER.

The directors in their report for the year ending Dec. 31, 1903, state that the Company has made satisfactory progress during the year. The lamp connections have been increased in Montrose from 6,422 to 11,670 equivalent 8-c.p. lamps, and in Brechin from 5,725 to 7,359, and up to the present time 1,500 additional lamps have been applied for in Montrose and 2,000 in Brechin, making a total of 22,529 in the two towns. Including the balance of £418. 10s. 9d. brought forward from last year's account, the result of the year's working shows a profit of £2,152. 16s. 2d., and after paying interest, which amounts to £918. 3s., there remains a balance of £1,234. 13s. 2d. available for distribution. The directors recommend that a dividend be declared at the rate of 2½ per cent., which will absorb £265, and that £500 be placed to reserve and renewal fund account, leaving a balance of £469. 13s. 2d. to be carried to the next account.

## BABCOCK AND WILCOX.

The fifth ordinary general meeting of the shareholders of Babcock and Wilcox, Limited, was held recently at the Cannon-street Hotel, E.C.

The **Chairman** (Mr. John Dewrance) moved the adoption of the report and accounts, and said the profits of the year had amounted to £180,042, against £171,832 last year; this, with the balance brought forward, gave a total of £197,92[illegible] to be dealt with. The interim dividend paid accounted for £40,100, and the directors now recommended the payment of 3 per cent. on the preference shares (less income tax), 8 per cent. on the ordinary shares (free of income tax), a bonus of 2 per cent. on the ordinary shares, the placing to the reserve fund of £50 000 and to the dividend equalisation fund £25,000, leaving £26,820 to be carried forward. The profit had been earned in the face of the keenest competition and greatest depression of trade known in the history of the Company. They had been able to make their profits, by reason of their strong financial and superior organisation and machinery, at prices which a few years ago would have been considered ruinous.

The motion was seconded by **Sir William Arrol, M.P.**, and carried unanimously.

## ORIENTAL TELEPHONE AND ELECTRIC.

In their report for the year ended Dec. 31, 1903, the directors state that, including £1,954. 18s. 9d. brought forward at Dec. 31, 1902, and deducting £5,379. 7s. 10d., the interim dividend of 3 per cent. paid Nov. 1 last on the ordinary shares, the amount to be dealt with is £10,523. 9s. 7d. The directors propose to apportion this sum as follows—viz., the payment of a dividend to Dec. 31 at the rate of 6 per cent. per annum, less income tax, on the preference shares issued, £1,010. 7s. 10d.; the payment of a final dividend of 3½ per

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cent. on the ordinary shares issued, free of income tax, making 6½ per cent. for the year, as against 6 per cent. for the year 1902, £6,275. 19s. 1d.; to reserve account, £1,500; leaving a balance to be carried forward of £1,737. 2s. 8d. In accordance with the resolution passed by the shareholders at the extraordinary general meeting held in June last, the nominal capital of the Company was increased by the creation of 100,000 6 per cent. cumulative preference shares of £1 each, 50,000 of which were issued in July. The Telephone Company of Egypt continues to extend its operations; it has entered into further contracts with the Government of H.H. the Khedive for a considerable extension of the telephone system, connecting the chief villages in the provinces of Lower Egypt, and negotiations are now in progress by which it is hoped the Company's interests in that country may be further consolidated. In order to provide that company with necessary funds, your directors have taken over during the year 4,900 of its preferred shares of £5 each, and 50 debentures of £100 each. The exchanges worked directly by the Company continue to expand, and this has been particularly noticeable at the Singapore branch, at which place the directors are pleased to be able to inform the shareholders they have secured an extension of the Company's license for a period of 31 years. The Indian local companies have brought increased revenues into their accounts for the year under review, and the Bombay Company has paid its usual dividend of 6 per cent., but the Bengal Company, to strengthen its resources in view of cabling expenses, has reduced its usual dividend by 1 per cent.—viz., to 5 per cent. In order to make a commencement with the underground cabling in India, in accordance with the conditions imposed in the new licenses obtained from the Government of India, referred to in last report, the services of a special telephone engineer were engaged to lay out plans for this cabling, and to advise the Board as to the best system to adopt in that country. He has completed the surveys of Calcutta and Rangoon, and is now on his way to Singapore for the same object. It has been deemed advisable by the directors that the Company, in places where long leases are unobtainable, should secure its own freehold premises, so as to avoid any possibility of having to remove its exchanges after cables have been installed. In Rangoon, premises and land have already been purchased, and the Company is now in occupation. The Bombay Company has recently also acquired land on a 99 years' lease on which to build suitable premises, whilst negotiations for a like purpose are now in progress at Singapore. The China and Japan Telephone Company's exchange at Hong Kong has made substantial progress during the year, and it is hoped that the negotiations now being carried on with the Colonial Government there will shortly result in an extended license being granted to it. The electrical branch of the Company shows a considerable increase in the volume of business transacted over that of 1902.

## WYCOMBE ELECTRIC LIGHT AND POWER.

This Company held its annual meeting recently, and it was announced that the result of the year's trading, including a balance of £22. 11s. 7d. brought forward from the previous year, shows a profit to the credit of the net revenue account of £3,329. 11s. 5d., and after paying interest on loans and debentures amounting to £1,536. 5s. 9d., there is a surplus of £1,793. 5s. 8d.

## NEW COMPANIES REGISTERED.

**Walker Bros. (Wigan), Limited.**—Capital, £100,000. Object: to acquire the business of engineers and ironfounders, electrical engineers, etc., carried on at the Pagefield Ironworks, Wigan, by J. S. Walker, T. A. Walker, and E. R. Walker as Walker Bros. Registered office: Pagefield Ironworks, Wigan.

**Hitchon Gear and Automobile Company, Limited.**—Capital, £10,000. Objects: to adopt an agreement with A. Hitchon for the working of Patent No. 18,460 of 1901, for improvements in transmission appliances in connection with automobiles, and to carry on the business of mechanical, gas, and electrical engineers, etc. Registered office: Moscow Mill, St. Oswaldtwistle, near Accrington, Lancashire.

**Tunks (1904), Limited.**—Capital, £3,000. Objects: to acquire the business of Bessie Tunks, trading as Tunks and Co., at 39, Penarth-road and 156, Colum-road, Cardiff, and to carry on the business of mechanical, bakers', and electrical engineers, etc.

**Automobile Engineering Company, Limited.**—Capital, £15,000. Objects: to adopt an agreement with Corders' Trust, Limited, and to carry on the business of manufacturers of and dealers in motorcars, motors, and their accessories, etc. Registered office: 34, Leadenhall-street, E.C.

**Traction and Power Agency, Limited.**—Capital, £500. Object: to carry on the business of omnibus, carriage, vehicle, and boat builders, carriers, tramway and railway proprietors, cycle and motor manufacturers and dealers, electrical and general engineers, etc. Registered office: 92, Victoria-street, S.W.

**Miniature Arc Lamps, Limited.**—Capital, £2,000. Objects: to adopt an agreement with A. E. Parker and P. E. V. G. Plater to manufacture and deal in lamps, dynamos, cables, insulating materials, accumulators, telephones, and other apparatus, and to carry on the business of electricians, engineers, suppliers of electricity for light, heat, motive power, or otherwise, etc.

### Liens Registered.

**Northern Counties Electricity Supply Company, Limited, Newcastle-upon-Tyne.**—Lien for £10,000 5 per cent. debentures, part of £100,000 authorised. Holders: T. E. Hodgkin and J. W. B. Pease, of Collingwood-street, Newcastle-upon-Tyne. Charged on the undertaking and all the property, including the uncalled or unpaid capital.

**Kent Electric Power Syndicate, Limited, London, E.C.**—Charge for £1,000 to the Hon. J. B. Lubbock and G. C. Curtis, bankers, 15, Lombard-street, E.C. Secured on all the assets, including any uncalled or unpaid capital.

**Scottish House-to-House Electricity Company, Limited, London, E.C.**—Supplemental lien to a bond and disposition in security (in Scotch form) dated Aug. 18, 1903, for securing £75,718 and 6 per cent. interest. Holder: County of London and Brush Provincial Electric Lighting Company, Limited. Charged on the undertaking and all the property, including the Coatbridge and Airdrie undertakings.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tender for rails and other material.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Tynemouth.**—The Corporation invite tenders for the supply of service fuses. Specification may be obtained from the Electrical Engineer. Tenders by 30th inst.

**Cleckheaton.**—The Urban District Council invite tenders for one 350-kw. steam generator. Specifications may be obtained from the Electrical Engineer. Tenders by May 2.

**Royton and Crompton.**—The Urban District Council invite tenders for Section A of tramways—permanent way. Tenders by April 30. See advertisement in last issue.

**Talavera de la Reina.**—The Municipality require tenders for electric lighting of the town—430 incandescent and a number of arc lamps are required for street lighting. Tenders by April 24.

**Brora (N.B.).**—The Committee invite offers for a complete installation to light the village with a minimum of 18 lamps. Length of overhead wiring 2,310 yards. Offers to Mr. John Ross, secretary.

**Aberdeen.**—The Electric Lighting Committee invite tenders for the supply and erection of surface-condensing plant, air-pump, and piping. Tenders by April 30. See advertisement in last issue.

**Edinburgh.**—The Council invite tenders for extension switchboard panel and steam and exhaust pipework. Specifications, etc., may be obtained from the Resident Electrical Engineer. Tenders by April 23.

**Wigan.**—The Corporation invite tenders for steel framework for construction of electric tramway car-sheds. Specifications may be obtained from the Tramways Engineer. Tenders by 12 noon on 23rd inst.

**Glasgow.**—The Corporation invite tenders for four sets of 800-kw. dynamo panels. Specifications, etc., may be obtained from Mr. W. A. Chamen, 75, Waterloo-street, Glasgow. Tenders by May 9. See advertisement.

**Hackney.**—The Council invite tenders for electricity supply mains (feeders and distributors). Specifications, etc., may be obtained from Mr. R. Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by May 26. See advertisement.

**The Hague.**—Tenders are required by the Municipal Authorities (bourgmestre et échevins) for the electric lighting of the Royal Theatre by April 25. Particulars may be obtained from the Secrétariat de l'Hotel de Ville, The Hague.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant: excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc. Tenders by May 17. See advertisement.

**Birmingham.**—The Public Works Committee invite tenders for 1,000 tons of 7in. tramway rails, British standard section No. 4, with all necessary fishplates. Specifications, etc., may be obtained at the City Surveyor's Office. Tenders by April 25.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required for their steamer and ferries, including electric globes and carbons. Particulars from the Manager's Office, Egremont Ferry, Cheshire. Tenders by May 9.

**Poplar.**—The Council invite tenders for supply of cables and supply and erection of battery. Specifications, etc., may be obtained from the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders before 9 a.m. on May 7. See advertisement.

**Heckmondwike.**—The Electric Lighting Committee invite tenders for the supply and erection of feed pump and pipework, steam traction generator, water-tube boiler, main switchboard panels, induced-draught apparatus, and underground feeders. Tenders by April 26. See advertisement.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required at the electricity supply works, including meters, cable and junction boxes, switches, and cut-outs. Particulars from the Electrical Engineer. Tenders by 27th inst.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Govan (Scotland).**—The Town Council invite tenders for 12 months' supply of various material from May 15, 1904, including meters, house fuse boxes, iron castings, and arc lamp carbons. Particulars may be obtained from the Burgh Electrical Engineer, Helen-street, Govan. Tenders by 26th inst.

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**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Dublin.**—The Guardians invite tenders for supply and erection of two large Lancashire boilers laundry steam plant, drying horses, hydros, with hot and cold fittings, etc., necessary for the full equipment of their new laundry at the workhouse, North Brunswick-street. Tenders by 12 noon on 27th inst.

**Bray (Ireland).**—The Urban District Council invite tenders for 12 months' supply of goods required at the electric light works, including cables, carbons, house wires, switches, lamps, holders, incandescent lamps, etc. Specifications, etc., may be obtained from the Town Clerk. Tenders by May 2.

**Hammersmith.**—The Borough Council invite tenders for the supply of two 1,500-kw. steam turbines or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters, capable of evaporating a total of 40,000lb. of steam per hour. Tenders by May 18. See advertisement in last issue.

**London County Council.**—The Council invite tenders for erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Specifications, etc., may be obtained at the Architect's Department (Highways Section), Trafalgar House, 13, Charing-cross, S.W. Tenders by 10 a.m. on April 26.

**Wallasey.**—The Urban District Council invite tenders for one independent counter-current jet condensing apparatus, with air and water lifting pumps, to treat 40,000lb. of steam per hour, and to give a vacuum of not less than 27in. Specifications, etc., may be obtained from the Engineer's Office, Seaview-road, Liscard, Cheshire. Tenders by May 7.

**Mexico.**—Tenders are invited by the Municipality of Sans Luis Potosi, Mexico, for the electric lighting of that city by not less than 150 arc lights. The system is to be established by the end of this year, the contract to be concluded for 15 years. The selected contractor will be required to deposit 5 000dol. Mexican as caution money. Tenders will be received up to May 15.

**Ayr (Scotland).**—The District Lunacy Board invite tenders for the following plant: (Section 1) boiler, pump, feed-water heater, piping, etc.; (2) building, chimney, flues, foundations, and iron roofing: (3) engines, dynamos, and main switchboard; (4) electric wiring and mains, etc. Specifications, etc., may be obtained from Mr. W Maxwell Stewart, 55, West Regent-street, Glasgow. Tenders by May 20.

**Park Royal.**—The Directors of the Great Western Railway invite tenders for motor-generators, natural-draught cooling towers, electrically-driven and hand-driven overhead travelling cranes and runways, conveyors, etc. Specifications, etc., can be obtained at the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, London, S.W. Tenders by April 26. See advertisement in former issue.

**Burslem.**—The Corporation invite tenders for water-tube boilers, steam-piping, pumps, water-softener, etc., engines, dynamos, balancer, and boosters, switchboard, cables (including laying), arc lamps, accumulators, and refuse destructor plant. Specifications, etc., may be obtained from Mr. A. Bremner, A.M.I.E.E., Market-buildings, Burslem, after 25th inst. Tenders by 12 noon on May 14. See advertisement.

**Dublin.**—The Lighting Committee invite tenders for the supply and erection of a steam generating three-phase extra-high pressure set of plant, consisting of Belliss engine and condensing plant, combined with alternators of the make of either Dick-Kerr Electric Construction, Oerlikon, or Westinghouse, size 1,000 kw., 1 250 kw., or 1,500 kw., whichever can be delivered most quickly, steam and exhaust piping, and extension to switchboard. Tenders by May 9. See advertisement.

**Antwerp.**—The Board of Trade have received through the Foreign Office from H.M. Consul-General at Antwerp, a dispatch stating that the Municipality of Antwerp will proceed on 26th inst. to the public adjudication of the tenders submitted for the electric lighting of the Flemish Theatre in that town. The deposit payable on each tender is £200. A copy of specification, enclosed with the dispatch, may be seen on application at the Commercial Intelligence Branch of the Board of Trade any day between 10 a.m. and 5 p.m., and on Saturdays 10 a.m. and 1 p.m.

**London County Council Tramways.**—The London County Council invite tenders for the following switchgear—namely: (*a*) one extra-high-tension three-phase board, with operating table and instrument board; (*b*) one low-tension combined direct-current and three-phase board; (*c*) one combined extra high-tension and low-tension sub-station board: and (*d*) one extra high-tension and low-tension transformer board; and for the erection and connecting-up of the same at the Council's electricity generating station, Greenwich. Tenders by May 17. See advertisement in last issue.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Manchester.**—The Waterworks Committee invite tenders for the supply, delivery, and erection at their Longdendale works of the following plant: (Section 1) one 90-b.h.p. water turbine, with direct-coupled dynamo, switch, and distribution boards, sluice and regulating valves, etc.; (2) four electric motors, with starting switches, lead-covered feeders, junction boxes, etc.; (3) overhead equipment of existing railway track, rail bonds, electric locomotive, etc.; (4) switch and distribution boards, conductors, incandescent lamps, etc. Specifications, etc., may be obtained on application to the Secretary, Waterworks Offices, Town Hall, Manchester. Tenders by 28 h inst.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Genoa.**—A dispatch has been received at the Board of Trade from H.M. Consul-General at Genoa forwarding translations of notices calling for tenders for the supply to the Italian Navy of indiarubber goods and fittings to the estimated total value of 40,000 lire (about £1,600), and of electrical material to the estimated value of 20,159 lire (about £806), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, Taranto, and Castellamare as required. Tenders will be opened at 11 a.m. on April 13 for the indiarubber goods, and at 11 a.m. on 26th inst. for the electrical materials. The special conditions of contract may be seen at the Ministry of Marine (Contracts Office), Rome, at the General Directorates of the Royal Arsenals at Spezia, Naples, Venice, and Taranto, at the Technical Office of the Navy at Genoa, and at the principal Chambers of Commerce in Italy.

## RESULTS OF TENDERS.

**Belfast.**—The tender of W. Coates and Son, Limited, has been accepted for electric wiring the new city hall.

**Tiverton.**—The tender of J. Grater and Sons, at £1,546, for the erection of buildings for the electric light works has been proposed for acceptance.

**South Africa.**—The East Rand Proprietary Mines have placed an order with Bruce Peebles and Co., Limited, for a 250-kw. direct-coupled set.

**Hammersmith.**—The Borough Council have accepted the tender of Cowans and Co., at £124. 10s., for Andrews's discriminating transformer and switchgear.

**Salford.**—The tender of the Lancashire Dynamo and Motor Company, Trafford Park, Manchester, has been accepted for motors of 5 h.p. and upwards for the ensuing year.

**Warrington.**—The Electricity Committee have accepted the tender of Johnson and Phillips, Old Charlton, Kent, at £225. 10s. 8d., for 12 months' supply of paper-insulated cables.

**Pumpherston Oilworks, Scotland.**—Messrs. Bruce Peebles and Co. have sublet to Willans and Robinson, Rugby, the order for two 750 kw. engines for direct coupling to Peebles alternators.

**Burton-on-Trent.**—The Corporation have placed an order with Bruce Peebles and Co., Limited, for a 500 kw. single-phase alternator direct coupled to a Willans and Robinson central-valve engine.

**Ilford.**—The Urban District Council have accepted the tender of the British Thomson-Houston Company, Rugby, for 12 months' supply of B.T.H.-Edison incandescent electric lamps, and O.H. ampere-hour wattmeters.

**Waterloo Hospital.**—The tender of the Private Wire and Telephone Company has been accepted for fitting a telephone installation throughout the new premises of the Royal Waterloo Hospital, Waterloo Bridge-road, S.E.

**Aberdeen.**—The British Westinghouse Electric Manufacturing Company, have sublet to Willans and Robinson, Rugby, the order from the Aberdeen Corporation for one 750-kw. engine for direct coupling to a Westinghouse dynamo.

**Hereford.**—The Asylum Board have accepted the following tenders for electrical installation: W. J. Fryer and Co., rewiring, £2,187; Custodis Chimney Construction Company, chimney shaft, £229; E. Danks and Co., boiler, £252. 10s.

**Handsworth.**—The Handsworth District Council have accepted the tender of G. Holloway, of Wolverhampton, amounting to £9,945, for the construction and re-equipment of the line between New Inns, Handsworth, and West Bromwich boundary.

**Hanley.**—The Town Council have accepted the following tenders: British Westinghouse Company, 500-kw. steam alternating engine, £3,162; Bertrams, Limited, Edinburgh, condensing plant, £495; A. Bolton and Co., Manchester, superheaters, £388.

**Pontypridd.**—The Council have accepted the following tenders for free wiring in connection with the installation of the electric light tenders of the South Wales Electrical Company: Agar and Sons, Newport; Arnold and Co., Newport; and Bedford and Gray, Cardiff.

**Brighton.**—The Telephones Committee recommend for acceptance the following tenders for the supply of telephone cable and cast-iron pipes: British Insulated and Helsby Cables, Limited, cables, £2,613. 5s. 6d.; W. C. Yuille and Co., 867 lengths of cast-iron pipes, £205. 18s. 3d.

**Gravesend.**—The Town Council have accepted the following tenders: Reason Manufacturing Company, indicators; Ferranti Limited, meters: Electrical Company, lamp stores; T. Stone and Co., F. Bird, and W. H. Wilcox and Co., engine stores; W. Gray and Co., and T. Stone and Co., oil; W. Cory and Son, coal.

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**Baker-street and Waterloo Railway.**—The Rhodes Electrical Manufacturing Company, Limited, have secured from Messrs. Heenan and Froude, Limited, a contract for the supply of the first lot of motors for coupling up to their ventilating fans in connection with the Underground Electric Railways Company of London, Limited, for the ventilating of the Baker-street and Waterloo Railway.

**Aberdeen.**—The Electric Lighting Committee have received the following tenders for two water-tube boilers and accessories: Babcock and Wilcox, 21, St. Vincent-place, Glasgow (accepted); Richardson, Westgarth, and Co., Hartlepool Engine Works, Hartlepool; Stirling Boiler Company, 2, St. Andrew-square Edinburgh; Stirling Company, 53, Deansgate arcade, Manchester; Willans and Robinson, Ferry Works, Queenstown, S.O., Flintshire.

**Loughborough.**—The Town Council have received the following tenders for the battery required for the electricity undertaking:

| | | A. |
|---|---|---|
| Electrical Power Storage Company, Limited | £1,114 0 0 | £80 0 0 |
| Sanders, Rehders, and Co. | 972 2 0 | 75 18 0 |
| Chloride Electrical Storage Company | 1,000 0 0 | 120 0 0 |
| Hart Accumulator Company, Limited | 1,030 15 0 | 81 10 0 |
| Watkin Bros., Limited | 1,510 0 0 | 90 0 0 |
| British Accumulator Company, Limited | 917 13 0 | 49 12 6 |
| S.P. Battery Company, Limited | 1,140 0 0 | * |
| A. Kramer | 966 0 0 | 80 0 0 |
| Pritchetts and Gold, Limited (accepted) | 1,100 0 0 | 65 0 0 |
| W. O Roper and Co. | 1,208 0 0 | 120 0 0 |
| Tudor Accumulator Company, Limited | 1,174 0 0 | 70 0 0 |
| A.B.P. Accumulator Company, Limited | 1,320 13 0 | 131 0 0 |
| Chloride Electrical Storage Syndicate, Limited | 1,090 0 0 | 120 0 0 |

A. Annual maintenance. * 5 to 8 per cent, on tender, or free guarantee for two or three years.

**Leavesden (near Watford).**—The Metropolitan Asylums Board have received the following tenders for installation of fire-alarms and telephones at the asylum:

| | |
|---|---|
| Mason, Cash, and Co., Woodville Electrical Works, Burton-on-Trent (accepted) | £294 0 0 |
| Donnison, Sillem, and Co., 116, Great Portland-street, W. | 310 0 0 |
| F. Hodgson and Co., 24, Queen Victoria-street, E.C. | 359 0 0 |
| Lea, Son, and Co., Pengwerne Works, Shrewsbury | 361 0 0 |
| Cox-Walkers, Darlington | 368 0 0 |
| D. Firth and Son, 14, Cannon-street, Manchester | 376 0 0 |
| P. Dewhirst, 24, Birley-street, Blackpool | 421 10 0 |
| Gent and Hurley, 44, Belvoir-street, Leicester | 429 19 0 |
| Watford Engineering Works, Watford | 450 0 0 |
| J. T. Mayfield and Co., 63 and 63A, Cannon-street, E.C. | 454 0 0 |
| A. V. Gifkins and Co., 68, Victoria-street, Westminster, S.W. | 457 0 0 |
| Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, S.W. | 457 19 0 |
| W. J. Furse, Traffic-street, Nottingham | 470 0 0 |
| Willey and Co., Limited, St. Thomas, Exeter | 475 0 0 |
| Watkins Bros., Limited, West Bridge Works, Northampton | 479 8 0 |
| Jackson Bros., The Broadway, Plaistow, E. | 545 0 0 |
| W. S. Wilson, 18, Derby-road, Watford | 549 0 0 |
| Tamplin and Makovski, Limited, 15B, James-street, Haymarket | 568 0 0 |
| F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W. | 587 10 0 |
| Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C. | 638 0 0 |
| P. J. Driscoll, 12 Soho street, W.C. | 715 0 0 |
| S. E. Haward and Co., Limited | 774 0 0 |
| National Telephone Company, Cheapside-chambers, Luton | 960 0 0 |

# BUSINESS NOTES.

## TRACTION.

**Darlington.**—The Corporation trams are expected to run by Whitsuntide.

**Charing Cross and Hampstead Tube Bill.**—This Bill has been read a third time.

**Reading.**—The Corporation are to advertise for the supply of an electrically-driven water-cart to be used on the tramway.

**Aberdeen.**—The Aberdeen Suburban Tramway Company has decided to borrow £8,000 on mortgage on its undertaking.

**Leicester.**—Preliminary trials have been made on the new electric tramway, and it is expected that the line will be opened in about a month.

**Leeds.**—The tramways are to be extended to Horsforth, and an application is being considered to extend them still further afield to Guiseley.

**Morecambe.**—The suggested electrification of the trams was raised again at the last meeting of the Town Council. No decision has yet been come to.

**Dudley.**—The fine weather will probably enable the tramway track from Coventry-street to Dean's-road, Moseley village, to be ready for traffic on the 25th inst.

**Dundee.**—The Dundee, Broughty Ferry, and District Tramways Bill has been passed as complying with the general orders applicable to Scotch provisional orders.

**Belfast.**—The company have, subject to confirmation by the shareholders, agreed to the terms suggested by the Corporation for the purchase of the company's tramways.

**Brighton.**—The Tramways Committee have resolved that the laying of the tramways in North-road and Queen's-road is to be commenced as soon as the Dyke-road route is completed.

**Liverpool and Southport.**—The electric trains on this line have been working regularly since Sunday. The luggage cars are highly appreciated by the tradespeople in the district.

**Derby.**—Delay has been caused in the electric tramway development owing to a Belgian contract being countermanded and arrangements having to be made with an English firm for fishplates and other material.

**Nottingham.**—In addition to the cheap workmen's fares in the early morning, it is now proposed to issue workmen's return tickets which will be available for return after 11 o'clock in the morning and until 9 o'clock at night.

**Tramways and Light Railways Association.**—The annual dinner of this association was held on the 13th inst. at Princes Restaurant. Mr. Alfred Baker, the president, was in the chair, and the guests numbered nearly 120.

**Radford.**—The District Council have arranged with the Bury Corporation to lay an electric tramway in their area, and to provide a quarter of an hour's service. There will be direct connection to Manchester, Bolton, and Bury.

**Bradford.**—The Tramway Committee recommend the extension of the tramlines from Thackley so as to join the Shipley system at Windhill, and then there will be a complete circuit from Bradford through Thackley and back by way of Shipley.

**Camberwell and Dulwich.**—Evidence has been taken before a Select Committee of the House of Commons on the London, Camberwell, and Dulwich Tramways Bill, promoted by a company. The County Council and the Camberwell Borough Council are opposing.

**Ilford.**—The first year's working of the electric trams at Ilford has been most successful. With a population of 50,000, the number of passengers carried in the year was slightly over five millions. The average daily number of passengers was 14,407, and the takings £60. 12s. 5d.

**Proposed Light Railway.**—The Gloucestershire County Council has appointed representatives to confer with those of the Worcestershire County Council upon the advisability of establishing light railways to meet the convenience of people trading at Upton-on-Severn and Newent markets.

**London County Council.**—The work on the tramway extension through Brixton is proceeding with great rapidity. Operations were begun at the cable station near Kennington Gate a week ago, and the vanguard of the road-breakers is now more than a mile away in the direction of Brixton-hill.

**Swansea.**—The work in connection with the Corporation new tramways in Oxford-street and Walter-road has been stopped owing to the gas company having pointed out that the track will be carried in places over the gas-mains, and the Corporation must either divert the tramways or the gas-mains.

**Bury, Rochdale, and Oldham.**—The arbitration of the purchase of the Bury, Rochdale, and Oldham Company's undertaking by local authorities is to commence at the Surveyors' Institute on May 31. Mr. Graham Harris is the arbitrator. The reconstruction of the system has already been commenced, and a manager is shortly to be appointed.

**London United Tramways.**—The Board of Trade suggest that the by-law in regard to distance between cars should be adopted in the following form: the driver of every car shall so drive the same that it shall not follow the preceding car at a less distance than 50 yards, excepting in cases of emergency, when the driver shall comply with the direction given by the authority controlling the traffic at the spot.

**Walsall.**—The report of the working of the tramways for the past two months shows respectively the receipts per car mile of 7·89d. and 8·87d. The system of collecting mails on the tramcar is being extended, the price charged per annum being £2. 10s. per mail-bag from Walsall to Bloxwich. A mail letter-box is to be attached to the 7.30 car from Walsall to Walsall Wood, for which a payment of £4 per annum is to be made.

**Chester.**—At Wednesday's meeting of the Corporation the Tramways Committee recommended that the tramways No. 4 and 5 be made and equipped for working on the overhead trolley system, and that the committee be authorised to complete the necessary plans and specifications, and submit them to the Board of Trade for approval, and afterwards obtain tenders. The first year's working has yielded a slight profit.

**Snowdon New Railway.**—Substantial progress was made during the past month with the extension of the North Wales narrow-gauge railway from Rhyd-ddu or Snowdon Station to Beddgelert, 4½ miles away. The workmen have advanced as far as Pitt's Head, a distance of a mile. Under the project the railway will be continued on to Portmadoc, and will also fork towards Gwynant and Bettws-y-Coed. The electricity is to be generated from the water impounded from the lakes of Snowdon.

**Stirling.**—At the last meeting of the Town Council it was agreed to have a report upon the electrification of the entire stretch from Bridge of Allan to Bannockburn. Correspondence with the local authorities interested and with the tramway company was submitted The County Council desire a conference. It seems that the local tramway company asked for £21,000 for their undertaking, which one of the councillors considered would be a quite unremunerative load on the undertaking, as the present tramways would not be of service.

**Newcastle.**—The tramway extension to Fisher Hill, Walker, a distance of half a mile from the Colliery Wagon Way, has been opened. There is still a small portion of line to be completed. The following is the traffic return of the Newcastle tramways for the week ended

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April 16: passengers carried, 758,366; miles run, 80,758; receipts, £3,395. 12s. 10d.; average receipts per car mile, 10·09. Corresponding week of last year—710,766, 74,858. £3,296. 15s. 3½d., and 10 56; and in the preceding week—815,983, 84,780, £3,791. 5s. 7½d., and 10·73 respectively.

**Pontypridd.**—At a meeting last week of the Electrical and Tramways Committee of the Urban District Council, a letter was read from Messrs. Blackwell, contractors, intimating they were now prepared to lay tramlines in the narrow part of Taff-street, Pontypridd, and the clerk was instructed to see to the diversion of the traffic, acting in conjunction with the police. It was reported that no date had yet been fixed for the arbitration between the Council and the British Electric Traction Company. It was decided to ask the referee to sit at Pontypridd, if possible, at the earliest possible opportunity.

**Farnworth.**—When the Council's lines are connected with those of the Salford Corporation and the South Lancashire Tramways Company the takings per mile, which now average 7·4d. per mile, will be increased. The total number of passengers carried was 1,532,293, and the average receipt per passenger amounted to 1 17d.; 317,126 units were used for the cars and the cars travelled 242,524 car miles, which works out at 1·3 units per car mile. The total receipts were £7,485, or 7·4d. per car mile. The total expenditure was £9,266, or 9·17d. per car mile, leaving a deficiency of 1·77d. per car mile.

**Baker-street and Waterloo Railway Bill.**—In the Commons last week a new clause was moved requiring the company to construct subways for foot passengers near the Elephant and Castle. It was contended that the original promoters of the undertaking had agreed to build the subways, and that their successors in title ought to be compelled to carry out the scheme. The chairman of the committee, however, pointed out that the word in the clause was "may." He expressed the opinion that the borough of Southwark and the company should agree to share the expense of making the subways. The clause was negatived by 143 votes against 133.

**North-Eastern Railway.**—The question of wages to be paid to the drivers of the new electric service on the North-Eastern Railway has been a matter of discussion between the company and the men. Mr. B. Bell, on behalf of the men, now states that the following terms have been arranged after three interviews with the company: (1) that the work of motormen should be retained in the locomotive department; (2) that engine-drivers who felt disposed to apply for transfer from steam-engines to the motors should be accepted and paid the maximum rate for motormen; (3) that the terms of pay be 32s. for the first year, 34s. second year, 36s. third year, and 39s. for fourth year; uniform supplied, a 10 hours' day, and time and a quarter for overtime. These have been adopted by the men concerned.

**Innovation in Railway Conveyance.**—The North-Eastern Railway Company, who intend shortly to introduce a number of petrol electric autocars between the Hartlepools and on other sections of their systems, conducted last Sunday a series of important experimental runs in the neighbourhood of Darlington with a newly completed electric autocoach, propelled by a Wolseley petrol motor coupled direct to an electric generator which is installed at one end of the coach. The trials are stated to have been eminently satisfactory, the coach, which has accommodation for 50 passengers, on one stretch of line attaining a speed of 40 miles per hour. The petrol system is claimed to be more conveniently and more economically operated than steam-propelled coaches, as no time is lost in getting up steam.

**Municipal and Private Lines.**—At the conference of municipal authorities held at the Westminster Palace Hotel on Tuesday, the following resolutions were adopted: (1) "That in the opinion of this conference the grant by Parliament of compulsory running powers and compulsory traffic facilities over municipal tramways will be fraught with grave and undesirable consequences, and prove detrimental to the working of large central railway systems; and (2) that an executive committee, consisting of the representatives of the Corporations of Birmingham, Liverpool, Manchester, Glasgow, Leeds, Cardiff, Sheffield, Newcastle-on-Tyne, and the London County Council, with power to add to their number, be appointed to take such steps as they may deem necessary in relation to the matter."

**Kingston.**—At a special meeting of the Town Council Mr. J. Clifton Robinson promised to proceed with the construction of the line in the Kingston area as soon as the plans for widening were passed. He explained that the delay in carrying out the work was largely accounted for by the impracticability of running trams over Kingston and Hampton Court Bridges until they have been widened or rebuilt, a work which the Surrey and Middlesex County Councils are not prepared to take in hand. Mr. Robinson intimated that the company would not wait for these alterations, but would proceed to lay the lines and make the necessary widenings as soon as the plans were passed. It is understood that the Kingston Council will receive £12,000, with the option of purchase upon advantageous terms at the expiration of 25 years.

**Worcester.**—At its last meeting the Corporation approved a report of the Finance Committee embodying the terms upon which the questions in dispute between the Corporation and the tramways company have been amicably settled. The company agree to pay £1,500 of £1,650 claimed by the Corporation for current which should have been taken from the Hylton-road station, and to commence within a week work on the Bath-road tramways, and complete before June 17, in consideration of which the Council agree to a two years' extension for all uncompleted lines, to the abandonment of any lines the company do not desire to construct at the expiration of that time, and waive all penalties. There has also been an arrangement whereby the company may use the current supplied for traction purposes for lighting their premises under certain restrictions.

**Londonderry and Moville Electric Railway.**—A Judicial Committee of the Privy Council heard last week the application of the promoters for the construction of the above light railway between the city of Londonderry and the town of Moville. It seems that the construction of the line will cost about £122,000. After considerable argument on the question of the line crossing an existing railway, the committee decided to recommend the construction of the line, subject to written agreements embodying the settlements that had been come to between the County Councils and the Harbour Commissioners being handed in, and other amendments made in the draft order. The promoters agreed to eliminate the clause asking for compensation for disturbance of their traffic in the event of the Lough Swilly Company at any time deciding to build a bridge to carry the public road over their railway.

**Wolverhampton.**—In regard to the Wednesfield-road tram route some delay has arisen. Preparations were made to continue the double line across the canal bridge, but a property owner objected. He protested that he had been given no notice of the work, and pointed out that not only was the work seriously interfering with the traffic from his yard, but that a double line would deprive him of sufficient space to enable entrance and exit of vehicles to his works. The committee had only provided a 2ft. 6in. instead of a 9ft. 6in. space. The borough surveyor agreed with Mr. Shelton's contention, and the work for a double line was countermanded, and the single track is now being proceeded with. The Corporation had also omitted to notify the Midland Railway Company and the canal company of their intentions with the crossing to the goods station and the lines over the bridge, and the work at these two places has been suspended until a satisfactory understanding has been arrived at.

**Manchester.**—The Tramways Committee calculate that the traffic revenue this year will amount to £635,583, and that the miscellaneous revenue, including payments from Salford, will reach £5,082, making a total income of £640 665. It is estimated that this year's expenditure will be £434,903, the principal items being: power expenses, £110,563; traffic expenses, £211,021; rent of tramways, £21,390; repairs and maintenance, £51,054; general expenses, £39,875. It is proposed to appropriate the balance of £205,762 as follows: interest on loans, etc., £50 033; sinking fund and instalment on loans, £34,822; renewals fund (permanent way), £51 600; depreciation and reserve fund, £19,307; leaving a surplus available for city fund, £46,000; infirmary purchase, interest, etc., £4,000. For the year just closed the estimated outlay was £184,820, and the approximate expenditure was £191,880. 17s. 9d., while £50,000, as estimated, was handed over to the city fund. On capital account the estimated expenditure is £124,000, against an approximate expenditure last year of £356,493. The main items are: land and buildings, £4,400; cars and car equipments, £67,000; permanent way, etc., £7,500.

**Southport.**—In reference to a rumour current in the town, and accentuated by the trials on each other's lines described in our last issue, that negotiations are taking place between the Corporation and the company with a view to securing one control, Councillor Travis, interviewed on the subject, said it was a question whether the Corporation should buy out the tramways company, whether the company should lease the Corporation's remaining lines, or whether some joint arrangement should be arrived at. There was "nothing in it" up to the present time, except that the Corporation had always recognised that it would be better for the whole of the tramways to be worked as one undertaking. If the amalgamation with Birkdale had been granted, the Corporation would, if the company had asked a proper price, have purchased the company's undertaking. At the last meeting of the Tramways Committee an approximate idea was given of the state of their finances at the close of the year ending March 31 last. The gross receipts amount to about £18,000, while the working expenses come to about £11,000, showing a surplus on the working of about £7,000. There has, however, to be deducted the usual payments for sinking fund and interest, which will amount to £7,500 or £7,600, thus leaving a total deficit of £500 or £600. Last year the gross income was only £16,387, and the working expenses £11,231. The amount set aside for sinking fund was £2,884, and for interest £3,493, or a total of £6,378. There was thus a deficit on the year of £1,222. In 1902 there was a deficit of £41, and in 1901 a small balance of £81.

**Liverpool.**—We extract the following further points from the general manager's annual report: In regard to the question of laying lines in Everton-road from the Necropolis to Fitzclarence-street, the general manager pointed out that if lines are to be laid in Everton-road, the only proposition he could make with any hope of a remunerative result would be to merge them into a new north and south route, passing through the eastern centre of the town. This report was approved by the Tramways Committee and the Council. The electrification of the Litherland lines had been delayed owing to the Urban District Council suggesting terms which the Tramways Committee could not accept; but on April 6, 1903, following a deputation from the Litherland Council, there was a general acceptance of the terms of the Corporation, and the work was ordered to be proceeded with, the lines being opened for electric traction on Dec. 11. On April 17 an agreement in connection with the through running of cars for passenger traffic over the South Lancashire and Liverpool Corporation tramways systems was approved by the Tramways Committee, and trial cars were taken from the pierhead to Bolton on Monday, March 30. Through running commenced on May 18, 1903, with a half-hourly service in both directions. The returns indicate that there is a very substantial through traffic, especially during the summer months, and this is likely to be largely increased as a result of an arrangement for reduced through fares. The Board of Trade extended the speed limitation as follows, in equivalent miles of single track: 14 miles per hour, 9 miles 400 yards—10 per cent; 12 miles per hour, 51 miles 1,081 yards—54 per cent; 10 miles per hour, 25 miles 150 yards—26 per cent; 8 miles per hour, 9 miles 1,460 yards—10 per cent. The chapter on lost property discloses that 15,516 articles, varying from legal documents to artificial teeth, were lost on the cars during the year. This represents an increase in the number of 22·74 per cent. over last year, and 53·56 per cent. over

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1901. The number of articles unclaimed amounted to 10,109, or 65 per cent. The following is a summary of the principal figures applicable to the tramways for the years 1903 and 1902 respectively: capital expenditure to Dec. 31, £1,863,485. 1s. 5d. (1902, £1,832,977. 9s. 11d.); total revenue, £531,483. 14s. 10d. (£517,935. 5s.); operating costs, £341,463. 9s. 10d. (£339,810. 19s. 8d.); percentage of operating costs to total revenue 64·247 per cent. (65 per cent.); gross profits, £203,256. 18s. 9d. (£178,124. 5s. 4d.); percentage of gross profits to capital expenditure, 10·90 per cent. (9·7 per cent.); interest and sinking fund, £107,014. 0s. 10d. (£102,627. 0s. 2d.); balance, £96,242. 17s. 11d. (£75,497. 5s. 2d.), divided as follows—reserve, renewal, and depreciation, £64,161. 18s. 7d. (£50,341. 10s. 2d.); transferred to general rate account, £32,080. 19s. 4d. (£25,165. 15s.); total operating costs per car mile, 6·983d. (6·884d.); interest and sinking fund per car mile, 2·188d. (2·089d.); total charges, 9·171d (8·973d.); car mile earnings, 10·733d. (10·34d.); average fare per passenger, 1·113d. (1·111d.); average length of penny stage, 2½ miles (2½ miles); length of track, 103 miles (101 miles).

## LIGHTING AND GENERAL.

**Ipswich.**—Electric light is to be installed in the Guardians' Board-room.

**Keighley.**—Extensions of cables, estimated at £415, have been authorised.

**Middlesbrough.**—The town hall is to be lighted by electricity at cost of £300.

**Bristol.**—The telephone extension to Highbridge has been practically completed.

**East London Electric Power Bill.**—The scheme has failed to pass the committee stage.

**Taunton.**—The lamp connections during the past quarter were equivalent to 481-8-c.p. lamps.

**Angus Electric Light and Power Co.**—A dividend of 2½ per cent. has been declared for the past year.

**Burton-on-Trent.**—Sanction has been obtained to the borrowing of £15,655 for increasing the electrical plant.

**Whitehaven.**—The Lighting Committee are getting out estimates for laying a public lighting main to Lonsdale-place.

**Hanley.**—The Town Council have decided to purchase six transformers for use at the electricity works at a cost of £245.

**Llandilo.**—The Urban District Council are raising £1,300 for the purpose of providing the additional electric lighting plant.

**Gloucester.**—In connection with the electric lighting of the shire hall, it is suggested to include the law courts in the scheme.

**Seebpore.**—The Lieutenant-Governor of Bengal recently presided at the opening of an electrical power installation at the C. E. College, Seebpore.

**Saffron Walden.**—Plans, specification, and detailed estimate of the electric lighting scheme have been sent to Messrs. Preece and Cardew for report.

**Blairgowrie.**—Mr. Weir has been successful in getting 33 subscribers for the proposed telephones in Blairgowrie and seven in Coupar Angus.

**West Bromwich.**—An enquiry has been held into an application by the Town Council for sanction to borrow £2,998 for purposes of their electricity undertaking.

**Liversedge.**—The District Council have instructed Messrs. C. H. Gott and Sons to advise them in the negotiations with the Yorkshire Electric Power Company, Limited.

**Newquay.**—The Urban District Council are considering an amended draft of the provisional order to be applied for by the Southern Counties Electricity Corporation.

**Bridlington Electric Lighting Scheme.**—On Monday the first sod was turned in connection with the Bridlington electric lighting scheme. The scheme will cost about £26,000.

**Doncaster.**—The preamble in the Corporation's Bill relating to the extension of the limits of the electric supply to outside areas has passed the committee stage of the House of Commons.

**Stoke Newington.**—The Council have arranged a scale of fees with Messrs. Talbot and Stevenson for advising as to what has been and may be required upon electric lighting schemes.

**Lighthouse Communication.**—Trinity House is corresponding with the Board of Trade in regard to the connection of lighthouses and lightships with the shore by telegraph or telephone.

**Surbiton.**—The electric lighting works at Tolworth were officially inspected by members of the District Council on Wednesday, and the works will be open to the general public on Friday and Saturday.

**Finchley.**—An exhibition of fittings, etc., appertaining to the electrical department is to be opened in the central hall of Christ's College upon the 20th proximo, and continued daily until the 28th proximo.

**Hindley.**—The Council are asking the South Lancashire Tramways Company if they have obtained the consent of the Lancashire Electric Power Company to supply electricity, and also to the supply of additional lighting.

**Greenock.**—In his report on Wednesday Mr. James A. Robertson, electrical engineer, stated that during the past month there were 117,697 units generated, as compared with 99,257 in the corresponding month of last year.

**Westbury-on-Trym.**—The terms agreed upon between the Bristol Corporation and the Westbury Parish Council, included in the Boundaries Extension Bill, provides for the laying of the electric light mains in Stoke Bishop.

**Cardiff.**—In a report presented to the Electric Lighting Committee on Tuesday, Mr. Ellis estimated that the profits for the past 12 months would amount approximately to £2,500, an increase of 41 per cent. as compared with last year.

**Newcastle.**—The Guardians have decided that electric light be installed in the aged and infirm wards and the hospital and in the new buildings, and that the supply be taken from the Newcastle and District Electric Supply Company.

**Willans and Robinson, Limited.**—A special meeting of this company will be held on Wednesday next at 2.45 p.m. to elect two new directors. These gentlemen are, as announced last week, Messrs. G. W. Anderson and J. C. Peache.

**Milngavie.**—The Clyde Valley Electrical Company have agreed to reduce their maximum from 7d. to 6d., and to insert a clause that the burgh will have the benefit of all the conditions regarding the rates that the county will have at the present time.

**Coatbridge.**—The electricity company during last year spent a large amount on mains and plant for supplying the tramways with current. No revenue can as yet be expected from this source. The actual net profit was £514, an increase of £60 on last year.

**Dunfermline.**—Mr. James A. Bell, Corporation electrical engineer, Aberdeen, has been requested by the Town Council to give the benefit of his services as expert adviser of the Corporation in the matter of the proposed introduction of electric lighting for the burgh.

**Ramsgate.**—The Board of Trade have now granted the Ramsgate electric lighting order, which authorises the supply of electricity for public and private purposes by the Ramsgate and District Electric Supply Company, Limited, to the borough of Ramsgate.

**Dorking.**—A letter from the Dorking Electricity Supply Company, stating that, understanding that the contract for street-lighting expired in September, they hoped they would be allowed to tender for such lighting, is before a committee of the Urban District Council.

**Hetton-le-Hole.**—A meeting is to take place to-day at the office of the Board of Trade in regard to the application of the Houghton-le-Spring Electrical Company, seeking lighting powers for the district, for leave to dispense with the Hetton Urban District Council's consent.

**Darlington.**—The Electric Lighting and Tramways Committee have appointed a sub-committee to go into the question of the supply of motors for power purposes to small manufacturers, etc., a proposal to wire free for electric lighting private houses, and several other questions.

**North-Western Electricity and Power Gas Bill.**—Requisitions on behalf of the London and North-Western Railway Company and the Great Western Railway Company for leave to withdraw their opposition to this Bill have been deposited in the Private Bill Office of the House of Commons.

**Louth.**—The tender of the National Electric Construction Company, Limited, for introducing the electric light and power into Louth has been accepted, subject to the consent of the Local Government Board being obtained to borrow a sum not exceeding £17,000 for carrying out the work.

**Carnarvon.**—An enquiry has been held into an application of the Corporation for sanction to borrow £17,000 for the purpose of an electric lighting scheme, for the carrying out of which the Corporation entered into a provisional agreement with the National Construction Company several months ago.

**Proposed Telephone Conference.**—The Common Council on Thursday authorised the Streets Committee to arrange for a conference of local authorities in the London telephone area for the purpose of considering the proposed purchase by the Government of the National Telephone Company's undertaking.

**Devizes.**—The Council will proceed with their electric lighting provisional order in view of the outlay of £19,000 which the scheme is estimated to cost. A committee has been authorised to open negotiations with any outside company who might desire to lease the powers under the order for a number of years.

**Calcutta Electric Supply Co.**—The directors have decided, subject to audit, to recommend to the shareholders, at the meeting which will be held on May 6, the payment of a dividend for the half-year ended Dec. 31 last at and after the rate of 8 per cent. per annum, making, with the interim dividend, 7 per cent. for the year.

**Stratford-on-Avon.**—The Board of Trade have agreed to defer consideration of revoking the Council's electric lighting order for 12 months from Feb 21. The Southern District Electricity Corporation's proposal to form a company to acquire the Council's provisional order and to carry out the necessary work is under consideration.

**Bury.**—The electrical lighting system in general is reported as thoroughly satisfactory. There were 172 consumers at the end of March, 1904, 31 more than at a corresponding period of 1903, 68 more than at a like time in 1902, and 107 more than at a similar period of 1901. There has also been a marked progress in units sold.

**Lowestoft.**—The resident electrical engineer in his report for the past month says that 21 new consumers were connected to the mains, representing 677 8 c.p. lamps. There are now connected to the mains 485 consumers representing 23,896 8-c.p. lamps. An extension of the electric lighting main is to be made at a cost of about £105.

**Graham, Morton, and Co.**—Some time ago we referred to the rapid construction and completion of up-to-date engineering works by this firm at Hunslet, Leeds, and have now seen a letter of the 29th ult., in which H.R.H. the Prince of Wales in appreciative terms congratulates the firm on the great rapidity with which the undertaking was carried out.

**Grimsby.**—Mr. Vignoles, electrical engineer, in his last report, stated that during the past month there had been an increase of 5,118 units of power for traction as compared with the same period of last

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month, 256 units for public lighting, and 9,418 units for private consumers. The totals for the month were 84,170 units, showing an increase of 14,792.

**Aberfeldy.**—The Town Council on Monday considered letters from Messrs. Cumming and Duff, S.S.C., Edinburgh, the same firm who are dealing with Benachally scheme, offering to "electrify" the railway to Ballinluig and light the town, etc., if the Council would support them. It was agreed to take no action regarding the letter, but make enquiries individually as to electric schemes.

**Branch Office.**—We are informed by the New Brotherton Tube Company, Limited (head office and works, Commercial-road, Wolverhampton), that their late agent, Mr. James Gray, has ceased to represent them, and that enquiries should be addressed to 3, Cadogan-street, Glasgow; telegrams, "Accumulator, Glasgow"; telephones, National 22Y Argyle, Corporation 3,858.

**Worcester.**—It has been decided to substitute an iron platform and staircase for woodwork for the switchboard at the Powick generating station at a cost of £90. The contract has been entrusted to the Nevile Engineering Company. The Council have approved an arrangement with the Electromotors Limited, Manchester, for the hire of motors in the city to customers on the two years' hire-purchase system.

**Alternating-Current Motors.**—We understand that the Rhodes Electrical Manufacturing Company have extended their factory and have laid down a quantity of additional plant and tools in order to cope with the increase in business. The firm have already secured a number of orders for alternating-current motors, and state that they are now in a position to quote for any sizes up to 20 h.p., single or polyphase.

**The Britannia Colony.**—The *Daily Chronicle* correspondent at Winnipeg telegraphs that the Britannia colony at Lloydminster, North-West Territories, was yesterday connected by wire with the outside world for the first time, the Government telegraph extension from Fort Pitt being completed. The colony has wintered well, and is in good condition for the summer. There have been already many new arrivals.

**Floating Workshop.**—In connection with a floating dock they are constructing Messrs. Swan, Hunter, and Wigham Richardson recently launched a floating workshop, built to the order of the Natal Government, containing many various kinds of machinery, all of which is driven by electric motive power. The workshop is also lighted by electricity. The vessel is equipped with an electrically-driven crane capable of lifting a weight of 15 tons.

**Walsall.**—The Electricity Committee's last report shows that the total number of consumers supplied on March 31 last was 337. During the past month the total units generated at the station were 141,439. The total output from the main generators was 135,921 units. The total units from the transformers were 105.932 (estimated). The total units registered on the meters were 83,761. The machinery was run for 708 hours. The wages paid amounted to £127.

**Crewe.**—The Electric Lighting Committee have fixed the charges for current for power purposes at the following figures: for the first 100 units per quarter, 3d. per unit; next 100, 2½d. per unit; 300 units per quarter, 2d. per unit; and all over 500 units per quarter, 1½d. per unit. The electrical engineer has been asked to report what the difference in revenue would be on the rebate system if the charges were reduced from 6d. and 3d. to 6d. and 2½d. per unit.

**Stourbridge.**—At an enquiry into an application of the Council for sanction to borrow a loan of £16,000 for the purpose of laying down a municipal electric lighting and power plant on Thursday week, an offer from the Midland Electric Corporation for Power Distribution, Limited, was referred to, and the inspector said he should, he thought, tell his Board that the Council ought to know more about this offer. It is understood that a further enquiry will have to take place.

**Pontypridd.**—At the recent Board of Trade enquiry into the question of the right of the Council to lay mains over the Taff Vale Railway bridge, Gelliwastad, Pontypridd, Mr. Beasley, manager of the company, offered to compromise by allowing the Council to take the mains under the railway lines. The committee, after a long discussion, decided to reject this proposition and ask the Hon. W. Pelham, the arbitrator, to give his decision on the evidence taken.

**North Wales Electric Power Bill.**—The examiners having reported that the Standing Orders had not in all respects been complied with in regard to this Bill, the matter was considered on Tuesday by the Standing Orders Committee of the House of Commons, Mr. Halsey in the chair. After deliberating in private the parties interested were admitted, and Mr. Halsey announced that the committee had decided to allow the Standing Orders to be dispensed with. The Bill will accordingly be allowed to proceed in the usual course.

**Watford.**—The Board of Trade have issued a provisional order to the Urban District Council, authorising them to supply electrical energy for public and private purposes within so much of the urban district of Watford as constituted at the commencement of the order as is not included in the area of supply mentioned in the first schedule to the Watford Electric Lighting Order, 1897. The expert report of Major Cardew on the electric light scheme has been received, and was considered at a special meeting of the Electric Lighting Committee on Tuesday.

**Typewriting Telephone.**—We are informed that successful experiments have been made by the Typewriting Telephone Company, 92, Queen Victoria-street, with a view to adopt the Stelljes instrument to submarine telephony. We have seen an excellently printed message which was delivered over 50 km. during the recent R.E. manœuvres in Spain, and completely satisfactory messages have passed between Milan and Rome, a circuit of 1,600 km. The Italian Press, both technical and daily, recently devoted considerable space to this English production.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day and to grant a quotation to Charing Cross and Strand Electricity Supply Corporation's further issue of 10 000 ordinary shares of £5 each fully paid, Nos. 70 001 to 80.000, and 10,000 4½ per cent. cumulative preference shares of £5 each fully paid, Nos. 70 001 to 80,000; and to allow Underground Electric Railways Company of London's £3,599,268 5 per cent. profit-sharing secured notes (fully-paid provisional certificates) to be quoted in the official list.

**City of London.**—An arrangement is to be made with the City of London Electric Lighting Company for the supply of current for the ensuing year to the Guildhall, the art gallery, the Guildhall justice-room, the new offices (Aldermanbury), the south court, and 9 and 10, Great Tower-street, at 3d. per Board of Trade unit, with 2d. per unit for motive power, at the existing pressure of 104 volts. A proposal to undertake a systematic rewiring, commencing with the art gallery, and to expend a sum not exceeding £200 on the latter work, is before the Coal and Corn and Finance Committee for consideration.

**St. Marylebone.**—The St. Marylebone Electric Lighting Bill having passed its third reading in the House of Commons, as modified in Select Committee in several respects, the Council's Electric Supply Committee report that as the present measure now stands the London County Council will advance £1,365,000 for the completion of the purchase, raising the amount temporarily by the issue of bills, the temporary loan to be replaced by the issue of stock "so soon as the financial conditions are sufficiently favourable." The period of 38 years has been allowed for the repayment of the £1,365,000.

**Northwich Electric Supply and the Power Gas Company.**—At an extraordinary general meeting on Saturday a resolution was passed empowering the directors to enter into a contract with the Cheshire Electricity and Power Gas Company to transfer the business and undertaking of the Northwich Electric Supply Company, Limited, to the Cheshire Electricity and Power Gas Company, or the promoters thereof. The terms of the transfer are: the repayment of the capital invested in the Northwich Electric Company, with an additional sum to make up the dividends paid (7½ per cent. per annum), a further 5 per cent. on the ascertained value.

**Hampstead.**—During the existence of the Council the electric lighting undertaking of the borough has doubled. Four years ago the capital expenditure on the undertaking was £160,000, now it is £350,000. Then the number of consumers was 1,671, now it is 3,600. Reduced charges have been agreed to for current for electric motors during the hours when the plant at the electric station is not much engaged for lighting purposes, in conjunction with a scheme for hiring out motors through third parties. The charge at present for current for motive power is 2d. per unit, that in future it will be 2d. per unit for the first 80 units, 1½d. for the next 80, 1½d. for the next 140, and 1½d. for any units above 140.

**King's Lynn.**—The electrical engineer in his last report stated that applications from private consumers were received during the month for 309 additional lamps of 8 c.p., making a total of 18,717 lamps and 456 consumers. He also submitted the following statement for February, 1904: units generated, 15,898 (1903, 38 317); units sold to private consumers (light and power), 23 340 (17,952); units sold at power rates, 7.329 (3,614); cost of fuel, stores, repairs, and wages at station, £127. 1s. 3d. (£100. 6s. 3d.); cost of units generated, 0·6644d. (0·6283d.); wages of lamplighters and outside staff £18. 14s. 7d. (£16. 14s. 6d.). The following statement of estimated expenditure for street-lighting for the year ending March 31, 1905, has been approved: 477 lamps at £3. 10s., £1,699. 10s.; 18 arc lamps at £16, £288—total, £1,957. 10s.

**Hornsey.**—The Electricity Supply Committee have appointed Mr. J. R. Farquharson chairman of the committee for the current year. The borough electrical engineer in his last report states: "Number of consumers connected to date, 443; number of consumers at date of last report, 411—increase 32; total number of lamps connected to date, 25 861; total number of lamps connected at date of last report, 24,419—increase 1,442. Mains extension.—To ensure the cable-laying being carried out at a minimum cost, it is necessary that a gang should be kept steadily at work rather than intermittently as at present. With this end in view, I would suggest that the following roads scheduled be cabled as opportunity occurs: Queen's-avenue, King's-avenue, Prince's-avenue, Fortis Green-road, Crescent-road, and Christchurch-road. No doubt the question of laying cable in other roads will be raised at the conference with builders, and any likely ones might be added to the list." Sanction has been received to the borrowing of £37,333 for purposes of electric lighting.

**Cheshire Electricity and Power Gas Bill.**—This Bill is now before a committee of the House of Commons presided over by Mr. Cawley. The capital of the company proposed to be incorporated is £1,000,000, with borrowing powers up to £330,000. The area of supply is the county of Cheshire, comprising 59 local authorities. Of these 25 are in favour of the scheme and 24 are neutral. The principal opponent is the borough of Stockport. The Bill provides for the supply of electrical energy only to authorised undertakers and to persons requiring it for power. It is contended that the company cannot supply to authorised undertakers unless they demanded it, and that, therefore, they are not competing with them. There is a provision in the Bill that persons requiring electricity for power could not use more than 30 per cent. of the supply for lighting. Except in the case of railways, waterworks, and canals, the consent of the authorised distributors must be obtained before a supply could be given by the company, and, if any question arose as to whether that consent was unreasonably withheld, the matter was referred for decision to the Board of Trade. A requisition on behalf of the Corporation of Liverpool for leave to withdraw their opposition to the Cheshire Electricity and Power Gas Bill has been deposited in the Private Bill Office of the House of Commons.

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**Leek.**—The Urban Council, having decided not to undertake the wiring of consumers' premises for electric light, have entered into an agreement with Mr. John Richards, 60, St. Edward-street, on a deferred payment system, as follows: For each "point" wired for one incandescent light up to 32 c.p., including suitable fittings, an annual charge of 2s. 6d. will be made, and an additional sum of 9d. will be charged for each extra lamp wired from the same point. This amount will be included in the consumers' quarterly electric lighting account, and collected by the Council. At the expiration of 10 years, payments having been regularly made, the installation becomes the property of the consumer absolutely. The consumer is also at liberty to purchase outright the installation at any time, by arrangement with the contractor, full consideration being made for instalments already collected.

**Farnworth.**—The accounts of the electricity and tramway undertakings of the Urban District Council for the year ending March, 1904, show a capital expenditure of the electricity department amounting to £36,064. That of the tramways was £43,695. The electricity department supplied 628,032 units during the year, 317,126 of which were debited to the tramways at the low price of ½d. per unit in order to relieve the undertaking of loss occasioned by bad weather during the year, and also owing to poorness of trade in the cotton district, which it is estimated has made a difference of £1,500 in the receipts. The electricity department generated 680,168 units at a total expenditure of £3,763, the receipts amounted to £3,795, leaving a profit of £32 after paying £1,278 for interest and sinking fund. The progress of the undertaking is indicated by the fact that during the year motors taking current equivalent to 3,563 8-c.p. lamps were connected, besides radiators equal to 99 8-c.p. and lamps equal to 2,639. The total connections up to date aggregate 18,345 8-c.p., and applications equivalent to 1,524 8-c.p. have been received.

**Glasgow Telephones.**—With regard to a notice of motion to the effect that the Telephone Committee ask the Corporation to consider whether the several departments of the Corporation, other than the fire brigade and police offices, requiring telephones for the public service should not take such telephones from the telephone department of the Corporation only, a letter has been received by the Town Council and the members of the committee containing the following paragraph: "In plain English, all ratepayers who do not take the Corporation telephone, but only the National telephone, are to be cut off from telephoning to the gas, water, health, town clerk's office, and all other Corporation departments, excepting fire and police. It is an undignified proposal to boycott. It means that ratepayers who use the National telephone shall be rendered unable to telephone the sanitary department in the case of small-pox or fever, or to the water department regarding a burst water-main, or to the gas department regarding a gas explosion, etc. I am asked by my directors to point out that the ratepayers ought not to be subjected to any such annoyance, inconvenience, and even danger, simply because an unfortunate rivalry exists between the two public telephone services in the city. Surely such a resolution will unhesitatingly be negatived as prejudicial to the interests of the citizens."

**Swansea.**—The Municipal Telephone Committee on Monday discussed the question of doubling the capabilities of the telephone exchange to meet the extraordinary demands made by the public, the subscribers already exceeding the number originally provided for. The borough accountant (Mr. Holton) submitted a statement showing that the total revenue for one year's rentals was £4,004; the numbers of lines in operation, say, 1,000; the estimated cost per line, £2. 4s. 5d. The capital outlay in providing these lines was £20 300. The result, therefore, will be: credit—estimated revenue, £4,004; debtor—1,000 lines at £2. 4s. 5d. per line, £2,220. 16s. 8d.; interest at 3½ per cent. on capital outlay, £710. 10s.; sinking fund at 3 per cent., £519. 13s. 7d.—total, £3,451. 0s. 3d., leaving a surplus of £458. 19s 9d., less royalties and income tax, £310; surplus, £242. 19s. 9d. General satisfaction was expressed at the probability of a surplus in the first year. The question of intercommunication again came up, the assistant solicitor saying that at present a deadlock prevailed. Mr. Bennett, (the consulting engineer), in reply to a question, said the only other borough which had applied for intercommunication was Hull, which was in an exceptionally strong position with regard to underground wayleave, and was consequently able to force the company to agree from the beginning. He added that the company was only independent of the Corporation so long as the Corporation allowed it its underground wayleaves, which could, however, be withdrawn. After discussion, it was decided to complete the laying of the cable that would connect the two central exchanges before invoking the aid of the law.

**Nernst Lamps.**—Dartford (Kent) was probably the first town to adopt Nernst lamps entirely for street-lighting. The following results of tests with lamps supplied by the Electrical Company, Limited, Charing Cross-road, in March, 1903, since when the burners have been considerably improved, will be of interest. It may be noted that in March, 1904, with 200 street lamps, the renewals averaged only 15 a week. Taking last year from Jan. 1 to Dec. 31, the renewals on 188 posts cost 8s. per post. This figure includes the cost of some extensive renewals due to several faults which occurred on the mains during the excessive heavy rains experienced last summer, and it compares very favourably with the cost of ordinary incandescent lamps, which for effective street-lighting should be renewed at least every 500 hours, as an ordinary post fitted with two 16-c.p. incandescents costing, say, 10d. each lamp, renewed every 500 hours, would show a cost per post of about 11s. 8d. per annum for 3,500 hours. The lighting hours in Dartford amount to 3,870 per annum. The engineer, Mr. A. J. C. Waterland, reckons to have made a considerable saving by adopting the Nernst lamps, to say nothing of the lamps giving a better light. The results of the tests taken on Jan. 1, 1903, were as follows: one-ampere Nernst burners—one, 169 hours; one, 13 hours; one, 564 hours; one, 564 hours; one, 504 hours; one, 576 hours; one, 588 hours; one, 550 hours; one, 231 hours; one, 385 hours; one, 264 hours. Half-ampere Nernst burners—one, 385 hours; one, 195 hours; one, 299 hours; one, 420 hours; one, 450 hours; one, 806 hours; one, 12 hours; one, 25 hours; one, 340 hours; one, 400 hours; one, 590 hours; one, 400 hours; one, 375 hours; one, 225 hours; one, 575 hours; one, 308 hours; one, 100 hours; one, 1,092 hours; one, 220 hours. One of the half-ampere was put out on Nov. 21, 1903, and brought in on April 5, 1904, in good condition after a run of about 1,700 hours. The other was put out on Dec. 12 1903, and brought in on March 31 1904, about 1,300 hours. Of the two quarter-ampere burners, one was put on Nov. 29, 1903, and brought in March 28, about 1,500 hours. The other was put out Dec. 6, 1903, and brought in March 28, 1904, about 1,400 hours. Both these burners were in good condition when brought in.

**London Gazette.**—The first meeting in the estate of the Electric Seasoning and Preservation Company, Limited, 65 and 66, Chancery-lane, London, will be held at 11.30 a.m. on April 29, at 33, Carey-street, Lincoln's-inn, London, W.C. The creditors of the British Electric Separating Company, Limited, are required to send particulars of debts or claims to Richard Phillips Pike, 35 and 36, Wind-street, Swansea, by May 31. The Argentina Electric Traction Company, Limited, will be wound up voluntarily. Alfred Clements, 83, Cannon-street, London, has been appointed liquidator. A general meeting of the Yorkshire Electric Power Syndicate, Limited (in liquidation), will be held on May 17, at 2 p.m., at 4, South-parade, Leeds, to have the liquidator's accounts, showing the manner in which the winding-up has been conducted and the property of the company disposed of laid before them, and to determine the manner in which the documents of the company shall be disposed of. The partnership between Harry Thorpe and Harry John Salter, carrying on business as electrical and mechanical engineers, 235, High Holborn, W.C., and St. George's Works, Eden-grove, Holloway, N., under the style or firm of "Thorpe and Salter," has been dissolved by mutual consent. The creditors of Robert Colston, 13, Connaught-street, Paddington, London, electrician, are required to send particulars of debts or claims to William George Blakemore, 6, Old Jewry, London, E.C., by May 5. A petition for winding-up of the National Electric Traction Company, Limited, will be heard at the Royal Courts of Justice, Strand, London, on May 3. Any person intending to appear must send notice to Hargreaves and Joblin, solicitors, by 6 p.m. on May 2. Mr. R. J. Ward has been released from trusteeship in the estate of Harry South, electrical engineer, 43, Rathbone-place, Oxford-street, late of 10 and 12, Garrick-street, Covent Garden, London. The last day for receiving proofs in the estate of Thomas Hymon, hardware dealer, gas and electric light fitter and plumber, 139, Fawcett-road, Southsea, is May 4. E. H. Hawkins, official receiver, 3, Barbican, E.C. The first meeting in the estate of Charles Aubery Smith (trading as C. J. Smith), electrician, residing at 6, Garnard-road, Wandsworth Common, and trading at 22, King's-street, Regent-street, London, will be held at 12 noon on April 28, at Bankruptcy-buildings, Carey-street, London. A receiving order has been made out in the estate of Charles Manners Downie, electrical engineer, 4, Bloomsbury-street, London, and 28, Heathville-road, Crouch-hill, Middlesex.

**Hammersmith.**—The following report of the Electricity and Lighting Committee was submitted at Wednesday's Council meeting on the proposed extensions to generating plant. The borough electrical engineer has made the following report in continuation of that submitted at the previous meeting: "With further reference to my report dated Dec. 4 last, in which I drew your attention to the fact that the present plant was only intended to meet a maximum demand of 50,000 8-c.p lamps alight at one time, and to the practical certainty of this maximum demand being exceeded during the coming winter, I have pleasure in submitting for your consideration what I consider to be the necessary extensions of the generating plant to meet this increased demand. Considering the fact that our present consumers are but a small percentage of the number we hope to ultimately obtain, I think it would be wise to plan the completed scheme before proceeding with any portion of this work, so that the present and each future extension will form a portion of one large station capable of generating current in the most economical manner possible. The time is rapidly approaching when it will be cheaper to abandon the use of some of our smaller engines and boilers and trust entirely to the larger generating machines, and these in turn may have to be abandoned for still larger sets if economical working is to be obtained, so that in future we shall have to depend more and more upon the extensions now contemplated. My suggestion is to build an entirely new boiler-house running at right angles to and at the east end of No. 2 boiler-house, containing 12 boilers, with economisers, forced-draught apparatus, feed pumps, air and water heaters, etc. These boilers to be operated with forced hot-air draught, so that only a short cheap chimney would be needed, and the boilers would deliver superheated steam into an engine-room built at the north end of this boiler-house, and forming a continuation of the present engine-room, where the new generating machinery will be fixed. There would ultimately be one chimney in the centre of this boiler-house for all these boilers. There will be room for another boiler-house between this and the railway, and a further extension of the engine-room would form the completed generating station so far as the present site would allow. This is upon the assumption that the turbine generating sets are found to be satisfactory, in which case this arrangement would, I think, enable us to instal machinery having a total capacity of 17,000 kw. when completed. In my estimation a higher ratio of increase must be allowed for in coming years, owing to the lower rate at which current will be supplied inducing a greater demand. The present Nos. 2, 3, and 4 generating sets will not be required after next year, as they are not so economical as the larger sets, so the space occupied by these machines could be set apart as a high-tension switchroom and distributing station with a specially-designed switchboard, so that the danger of interrupted supply through fire or other causes would be

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reduced to a minimum. This is the ultimate scheme, and I consider it necessary to commence carrying out the following section at once. This section comprises two boilers capable of supplying a total of 40,000lb. of steam per hour, with the necessary forced-draught apparatus, feed pumps, economisers, air and feed water heaters, steam-piping, etc. In order to avoid spending money on a new chimney stack, I would propose turning the gases into the present chimney until it is loaded up to its full capacity under forced draught. In the vacant space at the end of the present engine-room I find it is possible to instal two generating sets giving an output of 1,500 kw. each under normal load. These sets can easily be installed if it is decided to have steam-turbines instead of slow-speed reciprocating engines, but if the turbine manufacturers are unable to offer any advantages over slow-speed engine builders, and it is decided to adopt a duplication of the present sets, then it would be necessary to extend the present engine-room in order to accommodate two sets of this size. It must be remembered that these two sets would more than double the present capacity of the station, but in view of the increased economy of generating by means of large sets I do not think we are looking too far ahead in putting down plant of this size instead of a multiplicity of small machines, with their attendant high capital cost, big repair bill, and low steam economy. My proposals also include the provision of a small booster-room behind the present high-tension distributing board, with a battery-room overhead to supply the current for the separate excitation of the alternators in order to give a steadier pressure now that we are dealing with a big power load, and also work the automatic switch-gear which it may be necessary to instal. I would also suggest extending the present rectifier-house so as to form a repair shop adjacent to the engine-room, and move the rectifiers into one end of this if it is found advisable to retain them, and above this shop build a more convenient messroom away from the dust and dirt of the present room adjoining the boiler-house. It is impossible to prepare any detailed plans of the new buildings required until the type of machine has been definitely decided upon, but it is proposed that for the boiler-house a steel building with overhead system of coal storage and elevator and conveyor plant be adopted. I estimate the probable cost of the immediate requirements will be as follows: two boilers, including brickwork, feed-water heater, economisers, forced-draught plant, feed pumps, piping, etc., £12,100; two 1,500-kw. steam-turbines, £20,000; ash conveyor, hopper, feed-water reserve tank, battery, boosters, foundations, steel chimney, flues, extensions to condensing main, etc., £5,900; contingencies, £2,000—total, £40,000. With reference to the new plant required, it will be necessary to prepare specification, and I suggest that the specification should be an open one in order to allow contractors to quote for various types of plant under strict guarantees, and the committee could afterwards examine the various proposals and decide which is the most satisfactory for the purpose when they have definite tenders and guarantees before them." The committee recommended (*a*) that the works be at once put in hand. Advertisements have already been issued inviting tenders for the plant immediately required. In a further report the committee asked for powers to negotiate special agreements for the supply of electricity in bulk to large consumers, for power purposes, upon the following terms: (*a*) The supply to be given at a uniform rate of 1d. per unit, both summer and winter alike, for a minimum period of five years, upon the understanding that the whole of the consumer's power supply shall be taken from the Council, the minimum amount of current consumed to be 200,000 units per annum, of which the consumption for lighting purposes must not exceed 10 per cent. (*b*) In order to induce present consumers to continue increasing their demand for electricity for power purposes at the existing price of 1½d. per unit, the following discounts to be allowed off the accounts—viz.: (1) 5 per cent. discount when the account for both power and lighting reach £250 per annum; (2) 10 per cent., £500; (3) 15 per cent., £750; (4) 20 per cent., £1,000; (5) 25 per cent., £1,250; (6) 33⅓ per cent., £1,500 per annum; each year to be considered separately, and no agreement to be made for more than one year.

## PROVISIONAL PATENTS, 1904.

APRIL 11.

**3620a/03. Improvements in or relating to dynamos.** James Finney McElroy, 19, Holborn-viaduct, London. (Date applied for under Patents Rule 9, Feb. 16, 1903.)

**8245. The continuous-action lifeguard for electric tramcars.** Alfred Edward Robens, 4, Royle-street, Egerton-road, Withington, Manchester.

**8258. Improvements in and relating to apparatus for the control of electrical circuit breakers and like devices.** Leonard Andrews, 14, College-land, Deansgate, Manchester.

**8262. Improvements in and relating to telephones for use in dictating correspondence, for exchange call-room, for personal use, and for other like uses.** Samuel James Port, Cobden-buildings, Corporation-street, Birmingham.

**8269. Improvements in electrically-illuminated letters and signs for advertising and the like.** George Henry Chard, 5, Budge-row, London.

**8277. Improvements in or relating to means of charging storage batteries.** Malcolm Sutherland and Elias Marcuson, Montpelier Works, Twickenham.

**8294. Improvements in electrical induction machines, motors, and transformers.** Hans Bernhard Lippelt, 23, Southampton-buildings, Chancery-lane, London.

**8297. Improvements in systems of electrical distribution.** Peter Cooper Hewitt, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 25, 1903, being date of application in United States.) (Complete specification.)

**8312. Improvements in and relating to electrically-driven rotary hair brushes.** John George Lemon, 53, Chancery-lane, London.

**8316. Improvements in or relating to electric machine tools.** Joseph Sinclair Fairfax, Sunview, Faconberg-road, Chiswick, London.

**8321. Improvements in receiving apparatus for use in wireless telegraphy.** Georg Möller, 325, High Holborn, London. (Complete specification.)

**8323. Improvements in automatic electric switches.** Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, Surrey.

APRIL 12.

**8347. Improvements relating to the fittings for electric conduit both for lighting and power.** Thomas Taylor, Parkfield, Somerville-road, Sutton Coldfield.

**8358. Electromagnetic device for controlling the position of a switch tongue from an electric car or truck.** Ernest Larmuth, 24, Edge Hill-road, Nether Edge, Sheffield.

**8365. Storage batteries or accumulators.** Wallace Fairweather, 65, Chancery-lane, London. (Vesta Storage Battery Company, United States.) (Complete specification.)

**8378. An arrangement whereby ordinary house electric bells can be used for electro-medical purposes.** Alfred Page, 100, Wellington-street, Glasgow.

**8394. Improved apparatus for automatically operating electric switches, gas-cocks, or other like controlling devices.** Charles Russ, 321, High Holborn, London.

**8398. Improvements in and connected with electrically-energised pendulum clocks.** George Daniel Granger, *Invention* Office, Mitre-court, Fleet-street, London.

**8399. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8400. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States).

**8401. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8402. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8403. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8404. Improvements in and relating to alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8444. Improvements in safety devices for electric railways.** George Gibbs, 46, Lincoln's-inn-fields, London.

APRIL 13.

**8454. Variable-speed electrical haulage engine.** William Cubitt, Christopher Mathias James, and Denys Leighton Selby Bigge, Lloyd's Bank-buildings, Bristol.

**8477. Improvements in incandescent electric lamp holders.** Rees Evan Rees, 55, Chancery-lane, London.

**8501. Improvements in controllers for the motors of electrically-propelled vehicles.** Mark Cummins, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

**8514. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8515. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8540. Improvements in printing-telegraph receivers.** Frederic J. Swift, 28, New Bridge-street, London. (Complete specification.)

APRIL 14.

**8549. Electric ships' telegraph.** John Houston and James Erskine, junior, 5, Hunter-street, Scotstoun, Glasgow.

**8555. Improvements in electric stop motions for drawing, slubbing, and other similar machines for preparing and spinning cotton and other fibrous materials.** Edmund Tweedale, Samuel Tweedale, and Joseph Smalley, Globe Works, Castleton, Lancs.

**8556. Improvements in call receivers and repeaters for telegraph stations.** Konrad Wolf, 112, Potsdamerstrasse, Berlin W., Germany. (Complete specification.)

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**8575. Improved electrical device for shifting type carriers, as well as paper carriers, for typewriters, type telegraphs, and the like.** Wilhelm Benick and Heinrich Westerbeck, 72, Cannon-street, London. (Complete specification.)

**8590. Improvements in brush-holders for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8591. Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83 Cannon street, London. (The General Electric Company, United States.)

**8608. Improvements in commutators for dynamo-electric machines.** Frederick William Young, 22, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 22, 1903, being date of application in United States.) (Complete specification.)

**8612. Improvements in or relating to the transmission of electrical impulses.** John Stanley Richmond, 111, Hatton-garden, London. (Complete specification.)

**8620. Improvements in and relating to electric motors.** Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

**8621. Improvements in and connected with rails for electric tramways, and for like purposes.** Alexander Fowler, 18, Southampton-buildings, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 5, 1904.*

1903.

**8048. Phase-measuring instruments for electric currents.** Heap.

**8256. Controlling systems for electric motors.** Westinghouse.

**8279. Electric switches.** von Zweigbergk.

**8280. Electric switches.** von Zweigbergk.

**8343. Electric reversing switch.** Heywood and Heywood.

**8550. Controlling of electric tramcars and other vehicles.** James and Bryan.

**8607. Accumulator plates.** Gondrand and Celestre.

**8669. Training mechanism for searchlight projectors.** Carolan. (General Electric Company.)

**8791. Electrostatic voltmeters.** Ferguson and Kelvin and James White, Limited.

**8860. Interlocking electric switches and cut-outs, or the like circuit breakers, suitable for use in mines or the like situations.** Eckstein and Krause.

**8826. Apparatus for playing a game of skill and administering electricity to the successful player.** Rose.

**9131. Plug and socket connections and switches for electrical purposes.** Sellick.

**9535. Electric time relay switches.** Lackie, Calderwood, and MacEwen.

**10504. Electric switches for railway point and signal mechanism.** Sykes.

**10702. Electric advertising devices and street indicators.** Lampson.

**11473. Electric cables.** Whalley.

**11725. Switching mechanism for controlling alternating-current electric motors.** Carolan. (General Electric Company.)

**11727. Recording instruments.** Carolan. (General Electric Company.)

**12837. Electric motors.** Carolan. (General Electric Company.)

**12954. Magnetic brakes.** Carolan. (General Electric Company.)

**13009. Trolley heads for electrically-propelled vehicles.** Major.

**13153. Shade holders for electric lamps.** Chisholm.

**14539. Armature coils for dynamo-electric machines.** British Westinghouse Electric and Manufacturing Company, Limited. (Westinghouse Electric and Manufacturing Company.)

**14814. Electrical resistances or rheostats applicable as a regulator, motor-starting switch, or the like.** Brounger and Haywood.

**15317. Construction of apparatus for the electro-deposition of metals.** Collis, Collis, and Head.

**17814. Safety collision devices for electric tramcars.** Haddan. (Rué y Montparlé.)

**26144. Electromagnetically-operated apparatus for controlling the inlet devices of steam and gas turbines.** Reuter.

**28701. Electric telegraphy.** Rugh.

1904.

**789. Electric railways.** Pullen

**1973. Electric telegraph systems.** Adams-Randall.

**2274. Telegraphic transmitters.** Wise. (Pierce.)

**2380. Device for protecting a wire branch which depends from an overhead electric wire.** Rosen.

**8022. Connections or connecting pieces for electricity conductors.** Hirsch.

**5097. Electric meters.** Cox. (Date applied for under International Convention, March 2, 1903.)

**5098. Electric lamps.** Steinmetz. (Date applied for under International Convention, March 6, 1903.)

**5307. Electric fuse boxes.** Roberts and Good.

**5824. Electric igniter for explosion motors.** Luthi.

**5861. Insulating linings for covers or containers for electrical apparatus.** Dorman and Smith.

**5921. Electric melting furnaces.** Soc. Anon. l'Industrie Verrière et ses Dérivés. (Date applied for under International Convention, March 21, 1903.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ¼-⅛ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-107 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3¼-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 91-94 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ½-⅝ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | ½-1 |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | .. | 98-99 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 72-77 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1⅜-2¼ |
| —— 5 per cent. Debentures ..... | 100 | .. | 96-99 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures ..... | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | — | 1½-1⅜ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2½-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | — | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | .. | 9-9½ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | .. | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | .. | 11¼-12½ |
| —— 4½ per cent. Preference ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | — | 18½-19½ |
| —— 4 per cent. Debentures ..... | 100 | .. | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | .. | 14½-15½ |
| Telegraph Construction and Maintenance ..... | 12 | .. | 34-37 |
| —— 5 per cent. Bonds ..... | 100 | — | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,800 .. | 1 | — | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | — | 113-116 |
| Bournemouth and Poole, Ordinary ..... | 10 | — | 11½-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | — | 9½-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10½-11½ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | — | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 102-105 |
| Brompton and Kensington, Ordinary ..... | 5 | — | 10¼-11 |
| —— 7 per cent. Preference ..... | 5 | — | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | — | 6⅜-7¼ |
| —— Nos. 20,001-30,000 ..... | 5 | — | 6⅜-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | — | 12½-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | — | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | .. | 7-7¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | .. | 102-104 |
| Chelsea Electricity Supply ..... | 5 | .. | 6-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | .. | 106-109 |
| City of London, Ordinary ..... | 10 | .. | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref. ..... | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary ..... | 10 | — | 7-8 |
| —— 6 per cent. Cum. Pref. ..... | 10 | — | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | — | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | — | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | — | 5⅜-6 |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | .. | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | — | 1¼-2½ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | — | 5½-6 xd |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7½-8½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | — | 11-12 |
| —— per cent. Debenture Stock Red ..... | 100 | — | 101-104 |
| Kensington and Knightsbridge and Notting Hill ..... | 100 | — | 101-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | — | 9⅜-10½ |
| London Electric, Ordinary ..... | 5 | .. | 1-1½ |
| —— 6 per cent. Pref. ..... | 5 | .. | 4½-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | .. | 94-97 |
| Metropolitan Ordinary ..... | 10 | — | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | — | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | .. | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | .. | 93-101 |
| —— Preference ..... | 4 | .. | 100-103 |
| Notting Hill Electric Lighting ..... | 10 | .. | 12½-13½ xd |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) .. | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and ... -14,310..... | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock ..... | 100 | .. | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures ..... | 100 | — | 98-101 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000.. | 5 | — | 3-3½ |
| —— 4 per cent. Debenture Stock ..... | 100 | — | 85-90 |
| South London, Ordinary ..... | | — | 3-3½ |
| St. James's and Pall Mall, Ordinary, 101-30,080 ..... | 5 | — | 14-15 |
| —— 7 per cent. Pref. ..... | 5 | — | 8-9 |
| —— 3½ per cent. Deb. ..... | 100 | — | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | — | 4⅜-4¾ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | — | 4¼-5 |
| Westminster, Ordinary ..... | 5 | — | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251..... | 5 | — | 6-6½ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 92 95 |
| —— 4 per cent. Pref. | 100 – | 98 101 |
| —— " " deferred | 100 – | 85 88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 122-125 |
| —— " " " '96 | 100 – | 120 123 |
| —— " " " '01 | 100 – | 118-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10 ⅞ |
| —— Ordinary, 1-50,000 | 10 – | 4 13/16-4 15/16 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — – | 93½-10⅛ |
| Waterloo and City, Ordinary | 100 – | 89-92 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 4⅞ 5⅛ xd |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 .. | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 .. | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 .. | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 .. | 3⅜-4½ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 .. | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 .. | 99-102 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 .. | 10½-10⅝ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 – | 102-104 p.c. xd |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 8½ 9⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10 10⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 115-118 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅜-3 xd |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 – | 5½-5⅝ xd |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 4⅜-5½ xd |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 104-107 |
| —— Prov. Cert., all paid | 100 – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅞ 2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4½-5 xd |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 xd |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 101-104 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 10¼-10⅝ |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 100 101 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12⅜-13⅛ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18½ 19½ |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 – | 109-111 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8¼ 8⅝ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11¼-11⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 – | ¼-⅜ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 – | ¼-1 |
| New General Traction, Ordinary | 5 – | ⅜ |
| —— 6 per cent. Cum. Pref. | 5 – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12¼-12⅜ xd |
| —— 5 per cent. Cum. Pref. | 10 – | 9⅜ 9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 99 102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8 9 xd |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,133 6 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 103-106 |
| —— Deferred Stock | 100 – | 91 93 |
| —— 6 per cent. Cum. First Pref. | 10 – | 10 12 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 10-12 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 – | 97 99 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 101-103 |
| Oriental Telephone and Electric Company | 1 . | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week ending | 1904. | 1903. | Increase or decrease. Week. | Current year. | Miles of single track open. 1904. | 1903. | Accounts for past year. Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Mile of track. Pas-s'nger | Car mile. | Total | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 16 | 1,206 | 870 | + 336 | +11,242 h | 19½ | 19½ | May 31 | 37,831 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | " 16 | 207 | 311 | - 104 | + 118 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | " 16 | 38 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | " 17 | 1,000 | 1,064 | - 64 | - 131 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | " 16 | 269 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | " 15 | 774 | 1,091 | - 317 | - 31 | 24 | 24 | March 25 g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | " 14 | 533 | 1,640 | -1,107 | + 26 | 17½ | 17½ | " 31 | 211,168 | 6,169,121 | 784,443 | 1·62 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | " 16 | 207 | 695 | - 428 | - 344 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | " 17 | 1,810 | 1,847 | - 57 | - 295 | 38 | 38 | March 31 g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | " 13 | 1,148 | 1,489 | - 341 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | " 9 | 4,805 | 3,801 | +1,004 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | " 17 | 881 | 931 | - 50 | - 112 h | 7½ | 6½ | " 31 | — | 10,432,508 | 1,031,983 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | " 15 | 4,725 | 5,644 | - 919 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | " 15 | 945 | 723 | + 222 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | " 17 | 321 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | " 9 | 2,194 | 1,872 | + 321 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | " 18 | 180 | 237 | - 57 | + 258 | — | — | " 31 | — | 2,216,583 | 320,129 h | — | — | — | — |
| Central London Railway | " 16 | 6,597 | 7,454 | - 857 | - 539 h | 6 | 6 | " 31 | 367,225 | 45,305,110 | 1,876,571 a | 1·87 | 66·6 a | 59,076 | 35·6 a |
| City & South London Railway | " 17 | 2,704 | 3,064 | - 360 | - 1,171 h | 6⅝ | 6⅝ | " 31 | 165,003 a | 19,069,319 a | — | — | — | — | — |
| Cork E. T. and L. Company | " 14 | 433 | 477 | - 43 | - 190 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | " 15 | 210 | 262 | - 52 | - 109 | 7·23 | 7·23 | March 31 g | 12,341 | 2,360,735 | 254,879 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | " 16 | 201 | 230 | - 29 | - 150 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | " 17 | 101 | 157 | - 56 | - 48 h | — | — | Dec. 31 | 5,786 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | " 15 | 3,774 | 3,977 | - 203 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06 h |
| Dublin S. District, Electric | " 15 | 799 | 1,140 | - 341 | — | | | | | | | | | | |
| Dundee City Tramways | " 13 | 892 | 905 | - 13 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | " 16 | 705 | 725 | - 19 | + 54 | 10·75 | 10·75 | March 31 g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | " 2 | 13,411 | 13,174 | + 237 | +56,048 h | 124 | 124 | May 31 g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40 d |
| Halifax Corporation | " 6 | 3,003 | 2,272 | + 731 | + 339 | 31⅜ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | " 9 | 1,546 | 1,186 | + 360 | + 8,914 | 34 | 34 | March 31 | 56,631 h | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | " 16 | 2,047 | 1,786 | + 261 | + 107 | 25 | 19 | " 31 | 87,707 h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | " 16 | 426 | 505 | - 79 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | " 13 | 119 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | " 13 | 203 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | " 16 | 5,124 | 5,843 | - 719 | + 835 | 77 | 77 | March 25 g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | " 9 | 10,463 | 10,413 | + 50 | + 3,272 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,485 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | " 17 | 1,629 | 1,823 | - 194 | + 15 h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185 a | 1·82 | 19·30 a | 5,110 | — a |
| London County Council | Mar. 12 | 10,129 | 8,604 | +1,525 | +84,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | April 16 | 143 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | " 16 | 11,267 | 12,009 | - 642 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | " 17 | 103 | 62 | + 41 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | " 16 | 3,395 | 3,296 | + 99 | — | 38½ | 38½ | March 25 g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | " 16 | 448 | 448 | — | + 171 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | " 16 | 1,668 | 1,970 | - 292 | — | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | " 4 | 1 8 | 119 | + 20 | — | 4½ | 4½ | March 31 g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Mar. 17 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | April 16 | 3,912 | 3,279 | + 633 | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | " 17 | 4,392 | 4,625 | - 233 | - 670 | 53½ | 53½ | Mar. 25 g | 216,309 | 56,812,049 | e,936,083 | 0·304 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | " 14 | 915 | 1,045 | - 130 | — | 11 | 11 | " 31 | 35,874 | 9,084,522 | 732,814 | 0·346 | 11·435 | 3,760 | — |
| Stockport Corporation | " 15 | 419 | 353 | + 66 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | " 17 | 1,119 | 1,136 | - 17 | - 263 | 18·48 | 18·48 | " 31 g | 69,930 | 13,937,121 | 1,270,957 | 1·13 | 11·3 | 3,943 | 6·8 |
| Wallasey U.D.C. | " 14 | 651 | 718 | - 67 | - 70 | 10·5 | 10·5 | " 31 g | 31,474 | 5,635,182 | 654,742 | 1·50 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | " 14 | 691 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | " 13 | 517 | 427 | + 90 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Municipal and County Club.**—The Right Hon. the Lord Mayor of London will be the guest of the club on the occasion of their house dinner at the clubhouse, Whitehall-court on Thursday, May 19.

**Institution of Mechanical Engineers.** — The Chicago meeting of this institution will be held from May 31 to June 3, after which it is proposed that the members shall visit the St. Louis Exhibition.

**Wireless Telegraphy.**—The *Petit Parisien* states that the experiments which have been conducted from the Eiffel Tower have been attended with encouraging results. Communications were exchanged with a point quite close to the Channel, and it is hoped that it will be possible in a short time to communicate with the coast or with a squadron manœuvring at sea.

**Glasgow University.**—On the proposition of the vice-president, Mr. John Gavey, who occupied the chair, the Institution of Electrical Engineers unanimously resolved to communicate their congratulations to Lord Kelvin on his election as chancellor of Glasgow University. Mr. Gavey observed that hitherto this honour had usually fallen to luminaries of the political world, and the recognition of the great services rendered to science by Lord Kelvin was therefore very gratifying.

**South-Western Polytechnic.**—The prizes and certificates gained during the past session will be presented by the Earl of Cadogan on Friday, the 6th prox., when his lordship will also formally open the new buildings. The chair will be taken at 8 p m. by Mr. R. C. Antrobus. The distribution will be followed by a concert under the direction of Mr. Seymour Dicker, the head of the music section. On the following evening a conversazione will be held from 7 to 10 p.m., during which time the building, including the laboratories, workshops, etc., will be open for inspection. There will also be scientific lectures and demonstrations, and musical and gymnastic entertainments will be provided by the students.

**New Books.**—We have received "Workshop Costs for Engineers and Manufacturers," by Messrs. S. and F. Pearn (London : the Technical Publishing Company, Limited, 21s.); "Dynamo, Motor, and Switchboard Circuits," by W. R. Bowker, C.E. (London : Crosby Lockwood and Son, 6s.); "Notes on Alternating Currents for Students," by Harold H. Simmons (London : Cassell and Co.); "Théorie de Maxwell et les oscillations Hertziennes" and "La Télégraphie sans Fil," by H. Poincaré, forming the twenty-third volume of the Physico-Mathématique series of the "Scientia" publications, issued by C. Naud, 3, Rue Racine, Paris, price 2fr.; and "Photography for All," by W. J. Harrison (London : Iliffe and Sons, 1s.).

**An Incandescent Lamp Compact.**—At a recent meeting of manufacturers in New York, the Edison Electric Light Company and the General Electric Company agreed to discontinue pending actions for infringement, and on their part the majority of the manufacturers undertook to pay the two patent-owning companies a royalty on every lamp sold. The parties state that the arrangement is not a "combine," but a friendly working agreement to obviate litigation and the cutting of prices, the latter having been fixed. An advance in prices is hinted at in some quarters as a result of this arrangement, but several lamp concerns, including the Sawyer-Man Electric Company, are not parties to the agreement, and it will be interesting to see the outcome.

**American Institute of Electrical Engineers.**—We have just received the *Transactions* of the American Institute of Electrical Engineers dated February, 1904. This volume is of very great interest, because it contains so much information on single-phase motors. Thus, the paper on "Speed-Torque Characteristics of the Single-Phase Repulsion Motor," by W. J. Slichter, is included, as is also the communication by Mr. Charles P. Steinmetz on "The Alternating-Current Railway Motor." The discussion and the communications received subsequently are most valuable. Another paper, by Mr. W. A. Blanck, on "Single-Phase Railways," is in the same volume. This deals largely with the details of construction, and with figures of first cost for the equipment of 60 miles of single-track interurban railway. Mr. Blanck makes the cost of equipping this line on the direct-current system £98,020, and on the single-phase alternating-current system £74,350. Worked out in rates per mile, these figures become £1,635 for the direct-current and £1,237 for the single-phase alternating-current system. The latter thus shows a saving of 25 per cent. in first cost.

**Rheinfelden.**—The historic works at Rheinfelden have proved such a success that steps are now being taken to obtain more power from the Rhine at this point. Our readers will remember that there are three falls on the Rhine near Rheinfelden, and that the first only has been used up to the present. It is now proposed to carry out large civil engineering works which will utilise the other two falls. The work will be of such a nature that the second and third falls will be combined, giving a head of from 26ft. to 40ft. according to the state of the river. An island in the Rhine will be utilised in the course of the works, and as the river here forms the boundary between Switzerland and Germany, one-half of the works will be situated in each country. It is proposed to devote the whole of the original works to the manufacture of aluminium. There is now plant of a rated capacity of 16,800 h.p. driven by water-turbines in the station, and also steam-turbines of 1,400 h.p. The fact that this output will be used entirely in the manufacture of aluminium shows that the electrical process with this object is commercially successful. The new stations, utilising the second and third falls, will have an aggregate output of 30,000 h.p., and will distribute electrical energy throughout the towns of Basle and Rheinfelden respectively.

**The Institution of Civil Engineers.**—At the annual general meeting of this institution, held on Tuesday evening, Sir William H. White, K.C.B., president, in the chair, the result of the ballot for the election of council for the sessional year 1904-5 was declared as follows: president—Sir Guilford Molesworth, K.C.I.E.; vice-presidents—Mr. F. W. Webb, Sir Alexander Binnie, Dr. Alex. B. W. Kennedy, F.R.S., and Mr. W. R. Galbraith; other members of council—Mr. C. N. Bell (Wellington, N.Z.), Mr. C. A. Brereton, Mr. R. Elliott-Cooper, Colonel R. E. B. Crompton, C.B., Mr. W. J. Cudworth (York), Mr. G. F. Deacon, LL D. Dr. F. Elgar, F.R S., Mr. R. A. Hadfield (Sheffield), Mr. G. H. Hill, Mr. C. W. Hodson (Bombay), Mr. J. C. Inglis, Mr. G. R. Jebb (Birmingham), Mr. T. C. Keefer (Ottawa), Mr. A. G. Lyster (Liverpool), Mr. J. A. McDonald (Derby), Mr. W. Matthews, C.M.G., Sir Charles Metcalfe, Bart. (Cape Town), the Hon. C. A. Parsons, F.R.S. (Wylam-on-Tyne), Mr. A. Ross, Mr. W. Shelford, C.M.G., Mr. Alexander Siemens, Mr. John Strain (Glasgow), Sir John I. Thornycroft, LL.D., F R.S., Prof. W. C. Unwin, B.Sc., F.R.S., Sir Leader Williams (Manchester), and Mr. A. F. Yarrow. The council have made the following awards for papers read and discussed before the institution during the past session: A Telford gold medal to Major Sir Robert Hanbury Brown, K.C.M.G., M.I.C.E.; a George Stephenson gold medal to Mr. G. H. Stephens, C.M.G., M.I.C.E.; and a Watt gold

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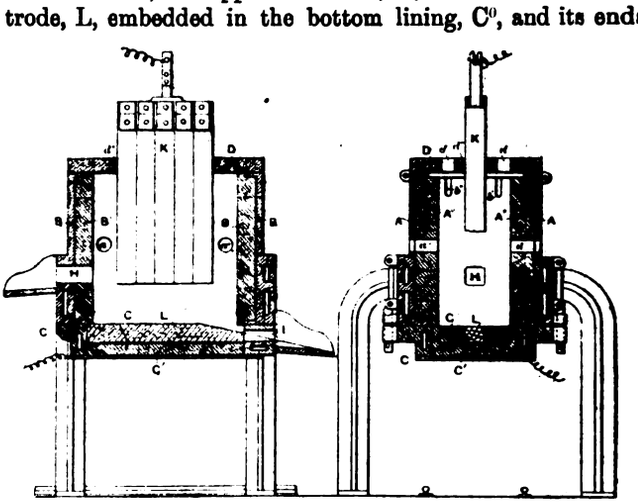
medal to Mr Alphonse Steiger, M.I.C.E; Telford premiums to Mr. E. W. De Russett, M.I.C.E, Mr. Hugh Robert Mill, D.Sc., LL.D., Mr. Alexander Millar, A.M.I.C.E., and Mr. T. E. Stanton, D.Sc., A.M.I.C.E.; a Manby premium to Prof. J. Campbell Brown, D.Sc.; and a Crampton prize to Mr. L. H. Savile, A.M.I C.E. The presentation of these awards, together with those for papers which have not been subject to discussion, and will be announced later, will take place at the inaugural meeting of next session.

**The New York Subway Fire.**—Further information concerning the fire which occurred in the Broadway on the 6th inst. in connection with the Rapid-Transit tunnel now in course of construction shows that, in order to make way for the subway structures, the contractors had removed the usual protecting manhole provided by the Empire City Subway Company for the conductors running in its ducts, and had massed the cable thus exposed in an inextricable tangle. To protect these cables from damage by workmen, the contractor had wrapped them with burlap coverings and surrounded them with woodwork. One of the cables which had been damaged was being repaired by a telephone splicer, who, in the carrying out of his work, employed the usual pot of heated paraffin, melted lead, and gasoline stove. Through being overheated, the paraffin took fire, and the flame was immediately communicated to the burlap about the cable and to the woodwork, the heat generated being intense. The burlap took fire, and melted off the lead covering of 2£ large telephone cables, containing 5,250 pairs of wire, eight Western Union cables carrying important telegraphic circuits, five postal telegraph cables, a burglar alarm cable of the Holmes Electric Protective Company, a cable of the American District Telegraph Company, a cable of the New York Stock Quotation Company, a cable of the Automatic Fire-Alarm Company, a burglar alarm cable of the Mercantile Electric Company, a city fire-alarm telegraph cable, a Gold and Stock Ticker cable, several circuits of the police telephone system, and various other circuits. The short-circuiting of the telephone wires overloaded the ringing generators and storage batteries of the Cortlandt-street central office, resulting in the operation of the circuit breakers. Besides the local service, lines to all parts of the States and Canada were interrupted. Through the indefatigable efforts of the New York Telephone Company the local wires began to operate again the same afternoon, and in the evening communication was restored on many of the trunk lines, whilst the following day saw the entire system working as though nothing had occurred. Incidentally, the accident exemplified the dependence of modern commerce upon telephonic communication, the dislocation causing business to be practically suspended in many of the large New York houses. From an engineering point of view the fire shows the need of fireproof conduits for each class of conductor. The bunching of inflammable cables tends to magnify the damage done.

**The Manufacture of Ferro-Nickel Electrically.** Among the papers read at the Washington meeting of the American Electro-Chemical Society, referred to in another column, was one on this subject by Mr. E. A. Sjöstedt, who gave an account of some electric smelting experiments, of which we are indebted to the *Electrical World and Engineer* of New York for the following report: The problem presented for solution consisted in the utilisation to the best advantage of the nickeliferous pyrrhotite of the Sudbury district, with special reference to the saving of the sulphur and iron, as well as of nickel and copper contained in the ore. It was decided to hand-sort the ore at the rock-house, using the grade higher in copper and gangue for the ordinary matte smelting, and the grade low in copper and gangue, but high in sulphur and nickel for the ferro-nickel industry. Since this latter ore with its high sulphur content requires a large excess of basic admixture, which, however, results in a slag too refractory to be kept fluid by the blast-furnace heat, it was decided to try an electric furnace process. Mr. Sjöstedt described various preliminary experiments. The final furnace used is shown in the accompanying illustration, and contains a rectangular water-jacketed body case, A B, with refractory lining, $A^0$ $B^0$, provided with a slag notch, H, vent holes, $a^0$, and stroke holes, $b^0$, a water-jacketed bottom frame, C, held removably on that body, and provided with a refractory lining on a plate, $C^1$, screwed to that frame, and having a tapping hole, I, provided in one of the ends; a cover of refractory material, D, having feed and vent holes, $d$ and $d^1$, and opening for the electrode; an upper electrode, K, and a bottom electrode, L, embedded in the bottom lining, $C^0$, and its ends



in contact with the metallic frame of the bottom. In this furnace ferro-nickel was made for several days from poorly-roasted ore (with about 3 per cent. sulphur and about 53 per cent. iron) at the rate of 60lb. per hour with an electric energy of 108 kw. With a furnace of 300 h.p or 500 h.p., which would be more economical, 200 h.p. would probably suffice for obtaining a gross ton of ferro-nickel per 24 hours. He gives an estimate of the cost, from which he concludes that a profit of over 5dol. per ton of metal produced could be obtained. The process has, however, not yet been established on a commercial scale.

**The Telegraphic Transmission of Handwriting and Pictures.**—Prof. Cerebotani, of Munich, recently lectured at the Berlin Urania on the interesting telegraphic apparatus designed by himself. After continuously improving his invention for many years past, Cerebotani finally tested the same on the telegraphic lines connecting Munich and Augsburg, Milan and Rome, Milan and Turin, and finally Munich and Berlin, the results being quite satisfactory. It is intended to apply the system to wireless transmission of pictures, etc., which would be particularly easy on account of the exceedingly small current intensities (about two milliamperes) sufficient to actuate the receiving apparatus. The electromagnetic arrangements consist of four coils, comprising two windings each and crossing one another on a small board. According as the currents put into these coils are more or less strong and of the same or of opposite directions, an enormous quantity and variety of currents may be generated in both directions, resulting in corresponding electromagnetic effects. The nearly unlimited number and variety of these current impulses is the most important feature of the apparatus, while the receiver shows a similar arrangement. In the case of the apparatus being used as a type-printing telegraph, the metallic types embedded in a non-conductive substance obviously play the most important part with the transmission. In this case the apparatus does not, however,

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seem to afford any special advantages as compared with the Hughes apparatus, apart from the possibility of its being operated without wires. The Cerebotani apparatus, on the other hand, is likely to assume a much higher importance as a fac-simile telegraph. In the latter case the sending apparatus contains a pen, carried over the paper by means of a system of co-ordinates, and to which corresponds a similar device in the receiving apparatus, which, however, is susceptible of being modified or reduced. The system of co-ordinates is embodied by two bars crossing each other at right angles, and being provided each with a slit where the other is made to slide. By means of this device for guiding the pen the latter may obviously be conveyed to any point of the writing paper, producing at each point the current impulse corresponding to the same, and which will cause the pen placed in the receiving apparatus to record this point at the identical place in the receiver. Some practice, it is true, is required to handle the apparatus. A speed of 100 letters per minute seems to be quite practicable, and the apparatus may be used wherever a Morse apparatus is being employed. It may even be connected to a telephone, and used simultaneously with the latter. The range of transmission seems to be practically unlimited. In the case, however, of any drawbacks being met with in this connection, relays would have to be resorted to.

**London Traffic Commission.** — At the resumed sitting of the Royal Commission last week Mr. John Gavey (vice-president, Institution of Electrical Engineers), engineer-in-chief of the Post Office, who superintended the provision of telephones for London, and designed the plan on which the work was done, stated that underground ducts had been constructed for nearly 60,000 subscribers in the City, Mayfair, Hampstead, Westminster, and Kensington. The Postmaster-General was willing to carry out street work in the night, but any attempt to confine it to the night-time would be quite impracticable, as the work would be protracted, and it could not be done efficiently. He also considered as impracticable the suggestion that different undertakers should carry out their work simultaneously. Mr. Alfred Willis, formerly general manager to the South-Eastern and Chatham Railway, and now a director of the Baker-street and Waterloo Railway, had come to the conclusion that it was too late for Parliament to lay down any general scheme for providing railway accommodation or traffic facilities within the Metropolis. He expressed the opinion that the present congested state of the streets was likely to improve, as it was partly attributable to the large number of improvements in progress. He considered that the requirements of the City and the West-end were substantially met by the existing tubes and the 'buses. The latter served a class of passenger which the tubes did not—the "in and out" passenger. The best means of providing for suburban traffic was to encourage the railway companies to supplement their services by tramway connections as feeders. Tramways, or street railways, might even in some cases be of standard gauge, so as to permit the street railway cars running on to the metals of local, main, or branch railways. He believed in mutual running powers over the different tramway systems, but deprecated municipal ownership. In regard to workmen's trains, he was disposed to favour moderate subvention by the County Council or local authorities. He outlined a scheme for a tribunal, which he said could be formed by an amalgamation of the lay members of the Railway and Canal Commission and the Light Railway Commission. Sir Robert Hunter, solicitor to the Post Office, gave evidence as to the powers of the Pastmaster-General to break up streets. The procedure which the Postmaster-General was compelled to adopt by the Telegraphs Act was much more cumbrous and tedious than that which was applicable to gas and water companies, as he could not break up any street for the purpose of placing telegraphs under it without obtaining consent from the road authority, or, in default of that, leave from the county court judge or magistrate. With one or two exceptions, the Postmaster-General had had no difficulty in arranging with the several road authorities for the construction of telephone works in London. The cable ducts for this work were laid so that additional cables could be led in through manholes without any further disturbance, and practically the only necessity for breaking up a street now arose in the case of connecting new subscribers. Every care was taken to reduce interference with traffic to a minimum, and to consult the views of the local authorities.

**The American Electro-Chemical Society.**—The meeting of this institution was held on the 7th, 8th, and 9th inst. at Washington. The social features included a reception by President Roosevelt at the White House, a smoking concert and a banquet, speeches being delivered at the last of these by Dr. Wiley, Prof. H. S. Carhart, Dr. J. W. Richards, Colonel Reber, Mr. C. J. Reed, and Dr. Needham. It was decided to hold the next meeting in September, during the week of the International Electrical Congress at St. Louis. Dr. F. A. Wolff, of the National Bureau of Standards, read a paper on "Standard Cells." In view of the fact that the advisability of an international agreement concerning the fundamental electrical units will be discussed at the International Electrical Congress, the author gave a review of the main points which are to be taken into consideration in connection with this question. He considered that only two of the units should be defined; the third one follows from the others by means of Ohm's law. As its definition can be easily made perfect by slight modifications, the ohm should be one of the two fundamental units to be defined. The author believes that the Weston will replace the Clark as the standard cell, because of its low temperature coefficient and the absence of hysteresis. He described a new electrolytic method of preparing mercurous sulphate by means of a mercury anode and a mercury cathode, with an electrolyte of sulphuric acid. Its grain structure is such that there is no probability of its influencing the E.M.F. In conclusion, the author expresses the opinion that a Weston cadmium cell with saturated solution should be used for establishing the second unit. A paper was read on "Economic Balance in an Electrolytic Copper Refinery," by Mr. Lawrence Addicks, an account of which we reproduce from the *Electrical World and Engineer* of New York. The author pointed out the close interdependence of the relations between various factors which form the economic balance in an electrolytic copper refinery. He separated the problem into three variables—tank resistance, age of electrodes, and current density. Tank resistance is made up of metallic conductors, contacts, anode slimes, counter E.M.F. due to concentration changes, electrolyte, and a negative quantity due to imperfect efficiency. He discussed these various factors in detail. Concerning the temperature coefficient, he remarked that it is large, and that it is necessary to strike a balance between power saving, cost of heating, increased contact losses, and increased cost of keeping the copper contents of the electrolyte down to the required figure. Concerning the question of age of electrodes, much depends upon whether or not the refiner is charged with interest on the metals tied up in the process. Finally, from the standpoint current density the problem becomes largely one of output. In the light of this multiplicity of relations, it is easy to see why no two refineries use just the same current

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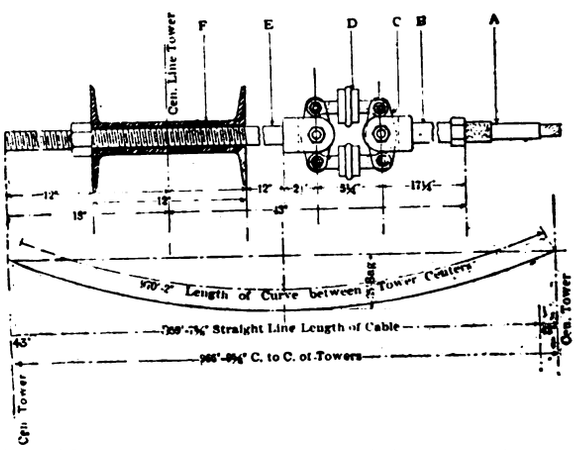
densities, temperatures, etc. A difference in the cost of labour or power or supplies would tip the economic balance to a new reading at once. Finally, the lowest cost per ton may not be the cheapest cost per ton. This apparent paradox is due to the fact that with a current density somewhat greater than that giving the lowest cost per ton, the output may be sufficiently increased to give greater earnings in spite of the higher cost per unit.

**Electric Mining in the Transvaal**—The reports of the Government mining engineer for the years ending June 30, 1902 and 1903 respectively, on the electric mining installations in the Transvaal are reprinted as appendices to the minutes of evidence taken before the Departmental Committee on the Use of Electricity in Mines. The first of these reports gives much useful information as to the development of electrical mining plants in South Africa. They show, for instance, that at the middle of last year the direct-current motors employed in the mines had an aggregate output of 8,196 h.p., whereas the three-phase motors had an aggregate output of 9,132 h.p. It is the first year that the aggregate output from the three-phase motors exceeded that from the direct-current machinery, but, owing to the large expansion in power distribution, nearly all extension work is being done on the three-phase system. One of the largest companies in the field is the Rand Central Electric Works, Limited, whose rate for power is briefly as follows: 2d. per unit for a load of 10 hours per day; 1·41d. for a load that is constant throughout the 24 hours. The company also charges per brake horse-power, and here again the rate varies with the number of hours used per day. For uninterrupted use throughout the 24 hours the charge is £3. 17s. per month, which includes the maintenance of the motors. This price comes down to 42s. if the motors are only used for 10 hours per day, and if the maintenance is done by the user. This company had under construction in June of last year a power line using current at 10,000 volts for the Geduld gold mines. The line will be the property of the Geduld Proprietary Mines, but it is being constructed by the Rand Central Electric Works. It is intended for working, eventually, a considerable portion of the machinery on six new large mines (Geduld sub-companies). This overhead electric line will be constructed according to the following provisions: (1) For the support of the copper conductors iron posts will be used of Siemens and Halske pattern, 24ft. high; (2) the wire conductors or mains will be at least 18ft. above the level of the ground traversed; (3) for the protection of the electric copper conductors, the posts will carry four galvanised steel wires parallel to the said conductors; (4) the two lower steel wires will be joined by transverse wires at a distance from each other not exceeding 7ft., so that in the event of the copper conductors breaking the latter will be caught in the network so formed; (5) all such steel wires will be put in efficient connection with the earth at every supporting pole; (6) uncovered bare copper conductors will be used of 0·11 square inch of copper section, which at a current density of 2,000 amperes per square inch would allow 220 amperes to run through the main, while, according to the estimate, not more than 115 amperes will be required; (7) the distance between every two conductors will be at least 28in.; (8) at all crossings of public roads, ways, or paths the poles will be lengthened so that the wires will be 22ft. above the level of the ground traversed; (9) in all cases where the newly-to-be-constructed conductors are required to cross low-tension conductors, the former will be suspended above the latter, and will be at right angles to them; (10) the poles will be at a distance from each other of not more than 90ft.; (11) the mains, sub-mains, and all conductors whatsoever will be efficiently protected by lightning arresters.

**A Long-Span Transmission Line.**—We have abstracted the following description of a long-span transmission line from an article by Mr. B. Wiley in the *Electrical World*. The line in question is used in connection with a 250-volt power supply from the Carrie furnaces over the Monagahela River to the Homestead Steelworks. In order to cross this river a span of practically 1,000ft. was required, and, after calculation, this was found to be more economical than either a cable in the river bed or the increased length of line to go down the river to a bridge and then up the other side. Four aluminium cables each of 800,000 circular mils are anchored on to steel structural towers on either side of the river. The details of the anchorage of the cables to these towers are shown in this illustration.




The cables were cut to the required length and furnished with aluminium sleeves, A, which were clamped to the cable under hydraulic pressure. These sleeves on opposite ends are threaded right and left handed respectively, and fit copper clevice bolts, B. C is a steel forging and D a strain insulator. E is a steel tension bolt for adjustment of sag and F represents portion of tower. The leads to and from the cable are flexible stranded wire, and the connection was made by flaring the ends, wrapping them about copper clevice bolts, B, and then soldering. The author calculates that aluminium was the right metal to use, and that it had only 48 per cent. of the weight of a copper cable of equal conductivity and 60 per cent. more strength. The load to be carried was 800 amperes and the permissible drop 40 volts. The other details connected with the design of the cable were that the maximum sag at 212deg. F. should not exceed 35ft. The maximum wind pressure was taken at 40lb. per square foot, the minimum temperature at 20deg. F., and the probable ice coating at ¼in. With the cable used the weight per foot run with this ice coating works out at 1·125lb. From the formulæ for the catenary curves, the author then calculates what the sag will be at 20deg. F. below zero, provided it is adjusted to have the 35ft. deflection at 212deg. F. This deflection in the winter would be 18·3ft., which corresponds to a maximum tension of 29,400lb. As the ultimate tensile strength of this section of cable is 28,008lb., it will be necessary to slack off the cables during the winter and to take it up again in the spring, in order that the maximum deflection may not be exceeded in the summer. While the details of the line have been well looked into, we are surprised that such a low factor of safety has been allowed, and should have expected that the elastic limit of the material will be exceeded under climatic variations of temperature.

**An Investigation of the Gases Occluded in and given off from Radium Bromide.**—As pointed out by Profs. Dewar and Curie in a paper read at the meeting

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of Jan. 25 of the French Academy of Sciences, 0·4 grm. of pure dried radium bromide were left for three months in a glass bulb communicating with a small Geissler tube and a mercury gauge after a rather perfect vacuum had been made in the apparatus. Now an evolution of gases was found to take place quite spontaneously during these three months, this evolution being proportional to the time and as high as one cubic centimetre per month at atmospheric pressure. According to the spectroscopic examination made with a Geissler tube, there was only hydrogen and mercury vapour present in the tube. A small amount of water may be supposed to have been introduced in the tube along with salt and to be decomposed gradually under the action of radium. The same specimen of radium bromide was conveyed to Prof. Dewar's laboratory at the Royal Institution, England, in order to be used there for measuring the evolution of heat at the boiling temperature of liquid hydrogen. The radium bromide was introduced there into a quartz bulb, fitted with a tube of the same substance. After the vacuum had been made in the bulb, the quartz tube was brought to a red heat, when the radium bromide was found to melt. On further pumping by means of a mercury air pump, the occluded gases as given off during the heating were collected. The gases sucked by the pump traversed, before entering the latter, three small U-shaped glass tubes, dipping into liquid air and arresting the greater part of the radium emanations, as well as the less volatile gases. The gases sucked by the mercury pump and collected above mercury in a glass testing tube were next examined by Dewar. Under atmospheric pressure they occupied a volume of 2 6 cubic centimetres, and proved to contain part of the radium emanation carried along by them and rendering them radioactive and luminescent. The proper light emitted from the testing tube filled with gas, after three days' exposure in a photographic quartz spectroscope, gave a discontinuous spectrum, comprising three lines coinciding with the origin of the three main bands of nitrogen—namely, 3,800, 3,580, and 3,370. During these three days the glass tube assumed a dark-violet coloration, while half of the gas volume was absorbed. After introducing the gases into a Geissler tube, nitrogen bands were also obtained on causing the latter to be traversed by electric sparks. On condensing nitrogen in liquid hydrogen a stronger vacuum was obtained than in the Geissler tube, so that the spark indicated only the presence of hydrogen. The quartz tube containing the radium bromide was afterwards melted and freed from any occluded gases; then it was sealed up in an oxy-hydrogen blow-pipe, while the pump was allowed to act, then the tube was sent back to Paris. Mr. Deslandres now undertook (about 20 days after the tube was sealed up) a spectroscopical research of the same. As stated by Deslandres, the internal gas, on being illuminated from a Ruhmkorff coil by means of two small paper covers, surrounding the two ends of the tube, would give the whole of the helium spectrum; even after an exposure of three hours no other lines than those of this gas could be observed in a photographic quartz spectroscope. The proper light given off spontaneously from the radium tube without any induction coils gave always a continuous spectrum without any dark or bright lines. It is true that the spectroscope used possessed only a slight power of dispersion.

**Transformer Efficiency Curves.**—Mr. A. E. Kennelly contributes an interesting article to the *Electrical World* on the form of efficiency curves of potential transformers. In order to simplify the matter, he assumes that under load the hysteresis and eddy-current losses are the same as when the transformer is excited only. This is not quite correct, but is not sufficiently so far out as to affect the result for practical purposes. The other loss is due to the resistance of the cable coils increase as the current squared—*i.e.*, as the output squared. Hence the efficiency, $n$, of the transformer, as represented by the system of Fig. 1, will be

$$n = \frac{e\,i - i^2\,r - p}{e\,i},$$

where $e\,i$ is the input at primary terminals in watts, $p$ the constant excitation loss in hysteresis and eddy currents (watts), while $i^2\,r$ is the copper loss in both windings taken conjointly. From this formula Mr. Kennelly goes on to

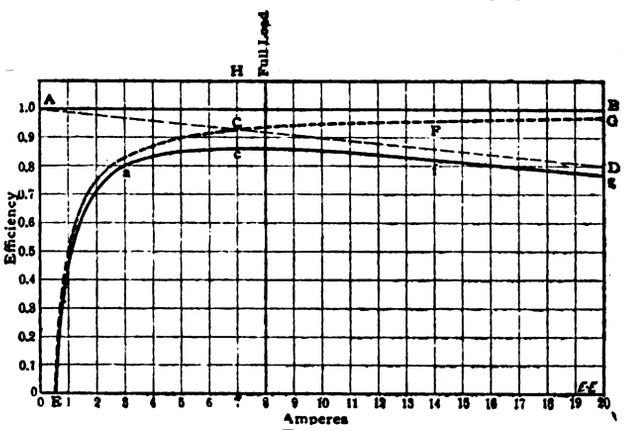

FIG. 1.

show that the efficiency curve can be divided up into two portions, one of which represents the copper loss in the form of a straight line, while the other—the rectangular hyperbola—represents the excitation losses. This hyperbola is represented by the dotted curve E C G in Fig. 1, while the inclined line A D represents the copper losses due to the resistance of the coils. Combined together we get the curve E a c f g, which is the efficiency curve of the theoretical transformer in question. The curves for an actual transformer are shown in Fig. 2. The whole matter is summed up by

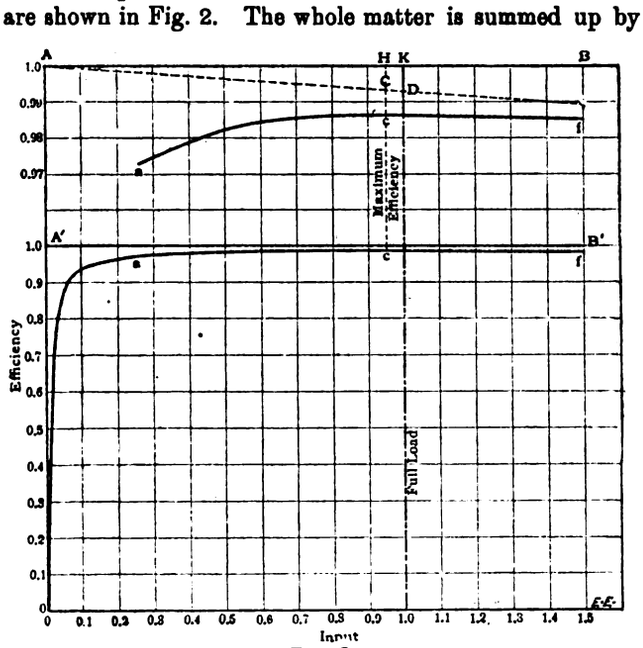

FIG. 2.

the following three conclusions: (1) the efficiency curve of a constant-potential transformer is an acute hyperbola; (2) the point of maximum efficiency corresponds to equal excitation and $I^2$ R loss, or equal losses in iron and copper; (3) the drop of pressure in resistance in the transformer at maximum efficiency is half the drop of efficiency. It can be shown that these propositions also hold when the curve is drawn to output as abscissæ instead of input. Similar reasoning applies to constant-potential shunt motors and generators, subject to somewhat greater limitations in accuracy.

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## TYPES OF DIRECT-CURRENT LOW-TENSION SWITCHGEARS.

BY W. E. WARRILOW, A M.I.E.E.

*(Continued from page 569.)*

The cellular or pigeon hole type of switchgear introduced by Mr. Ferranti, and so successfully applied by him for controlling high and extra high voltages, has also been modified to meet the requirements of low-tension work. The construction is too well known to need description here, and for the present purpose it will be sufficient to state that little or no difficulty has been experienced in adapting it for the control of direct current. If it succeeds in replacing gears of other makes in the same manner which it has done in the field of alternating-current work, it will supply a long-felt want in dispensing with the hideous arrangement of couplings which now seems inseparable from those forms of board having connections at the back. The design of this type of board is well suited for accommodating in a neat manner the multifarious connections which have always to be dealt with when controlling low-tension currents. If the designs which have already been put forward meet with the general approval of engineers, there would seem every prospect of the arrangement of direct-current boards being simplified and standardised. Fig. 10 represents a typical board accommodating three dynamos, one motor, one Highfield booster, and four traction feeder panels. The frame consists of four 2in. horizontal slate slabs cemented into the wall and divided by vertical division slates into a number of separate compartments, each of which accommodates some particular fitting of the board. Commencing at the bottom (above the regulating table) with the dynamo panels on the right-hand side, two cells per machine are provided, and the lowest is fitted with ammeter and automatic device. Above these are a knife switch and carbon break circuit breaker respectively, the latter being automatically opened by the attachment in the cell directly below it. The topmost pigeon holes accommodate sections of 'bus bar (lighting and traction) and change-over switches for connecting the machines below to either bar. The centre of the board is fitted with recording ammeters and Board of Trade panels, while the left-hand portion is devoted to the traction feeders. These are each provided with ammeters, carbon circuit breaker, kicking coil, and lightning arrester. The lower portion of the gear is occupied by a regulating table extending the whole length of the board. The right-hand portion accommodates hand-wheels for operating the regulating resistances, and the field-breaking switches are also mounted on the front vertical slab of the table. The negative switch for the motor is also fixed to this slate, and adjoining it in a separate compartment are the field switch and fuse release switch for the Highfield booster. The left-hand section of the table is fitted with lightning arresters and kicking coils for the traction feeders.

The board described above is one of the earliest forms of this construction, and is generally used for currents up to about 500 amperes per panel. When the load exceeds this amount, the carbon break switches are replaced by a circuit breaker in which the arc is dispersed on a pair of horns mounted at the top of the gear. Fig. 11 represents four traction feeders fitted up in this manner. The cellular principle is still adhered to, and the upper part is divided into spaces in which the horns are fixed. Directly below, on the underside of the supporting horizontal slates, are the 'bus bars, and connection is made from these to an ammeter resting on this second slab. This instrument plugs into contacts at the back of the panel and can be readily withdrawn at any time, as its shunt is placed directly between the prongs at the back of the case. The middle cells are devoted to the switch mechanism and operating handles. A special feature of this device is the free handle, which has been introduced to combine in one complete circuit breaker the functions of a separate single-pole switch and automatic device. The main body of this switch comprises a pillar securely bolted to a supporting casting cemented in the third slate in porcelain insulators. A system of links and levers is employed coupling up with the main handle, which when raised imparts a vertical motion to the laminated contact fixed to the top of the switch mechanism. This contact merely serves the purpose of bridging two terminals fixed in the slate at the top of the panel, consequently there are no moving connections necessary. The mechanism can be tripped by a trigger projecting forwards from the front of the switch, over an adjustable release pin which passes through the slab and engages with the automatic device in the panel below. This latter consists of a cast-iron box in which a

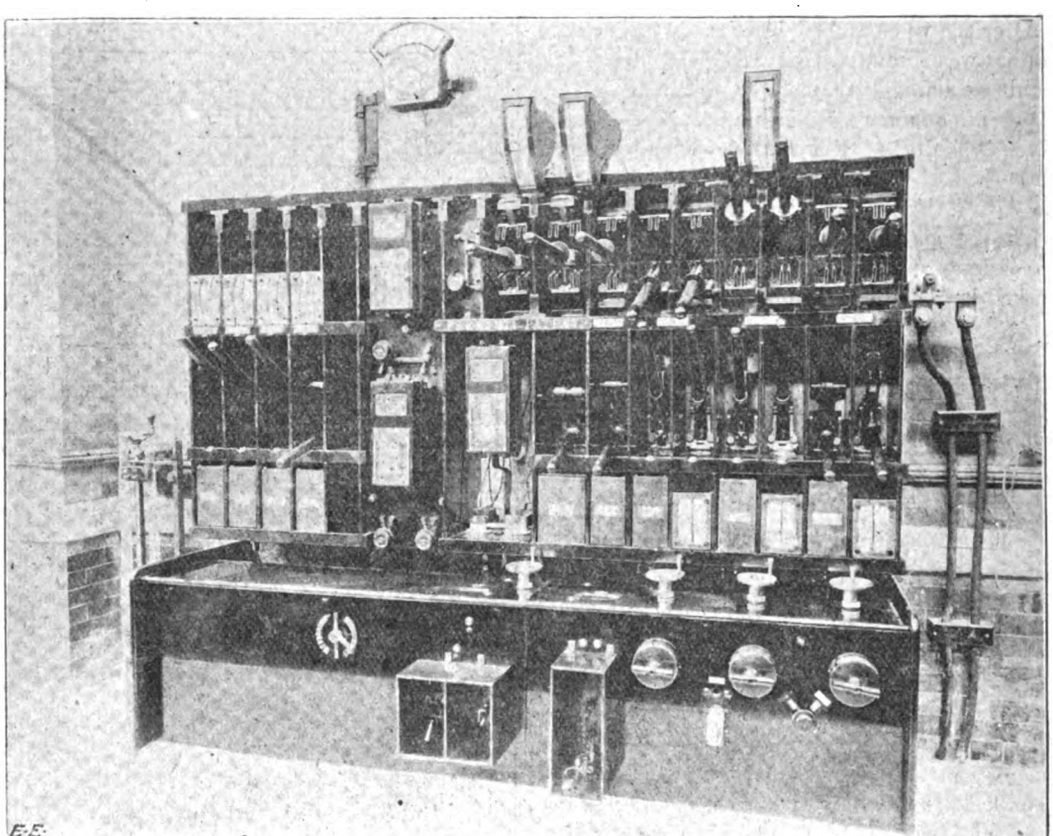

FIG. 10.—Lighting and Traction Gear, Cellular Form (Ferranti).

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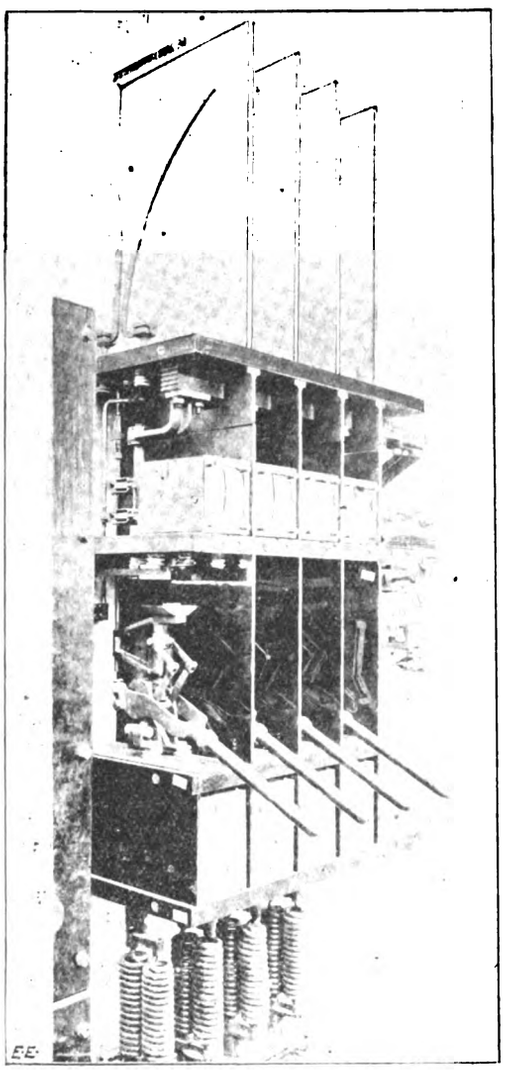

FIG. 11.—L.T. Horn Break Switch Panels (Ferranti).

coil and soft iron plunger are fitted, the contacts from the coil projecting through the back of the case for plugging into fixed clips at the wall end of the panel. This device is similar to the ammeter in that it can be withdrawn from its cell for examination at any time. It will be seen that the switch proper comprises (1) the horns at the top of the board, (2) the switch mechanism and main contacts in the central cell, and (3) the automatic tripping coil in the bottom panel of the board. The circuit breaker can be opened or closed by the handle alone, but should there be anything wrong on the line the release mechanism is at once tripped, and the circuit breaker will act quite independently of the

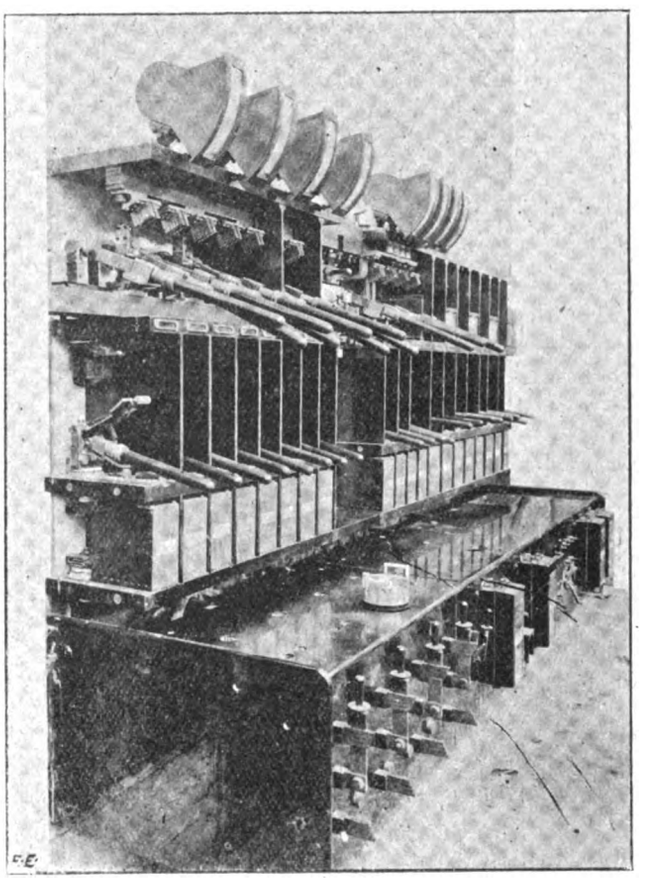

FIG. 13.—Lighting and Traction Generator Board (Ferranti).

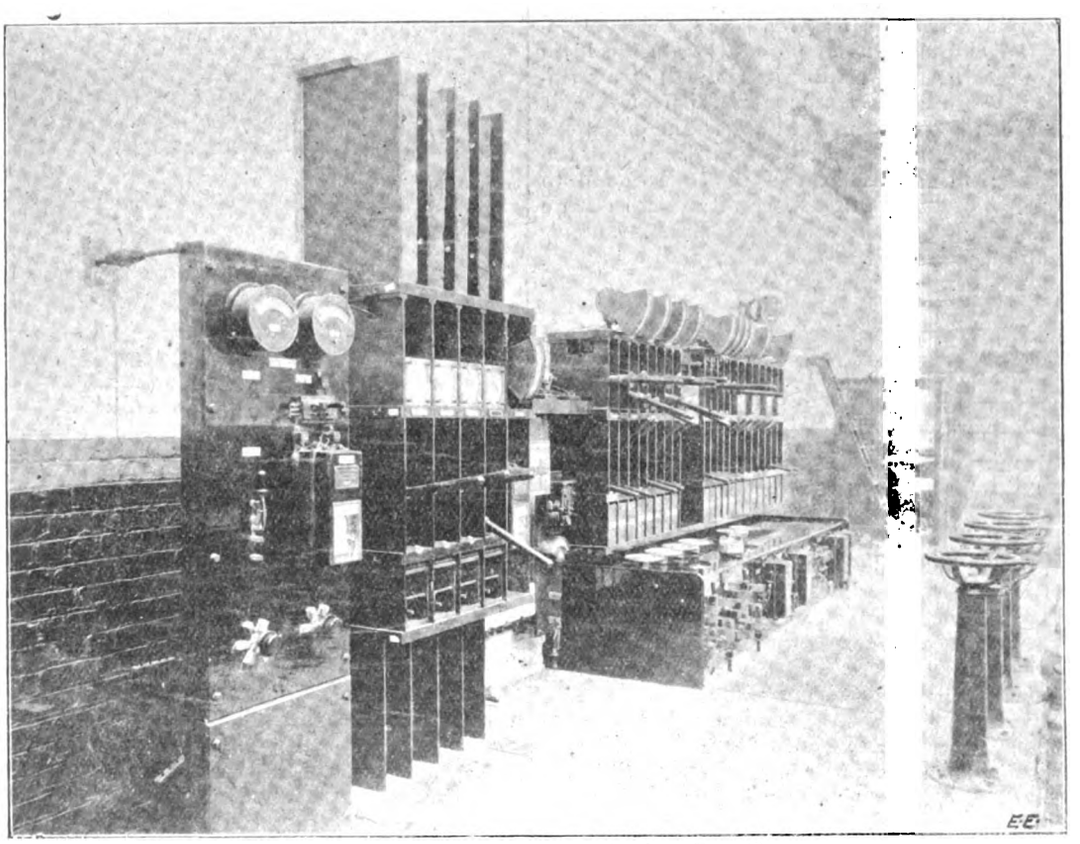

FIG. 12.—Combined Lighting and Traction Gear (Ferranti).

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handle, even if this be retained in the grasp of the switchman. For machine panels a similar arrangement can be employed, but the circuit breaker is designed for operating on the passage of a reverse current. In this case a small relay magnet is employed to close the circuit of a coil shunted across the terminals of the machine, the relay swinging over from a vertical position to complete the circuit. The device needs resetting after it has come into operation.

Fig. 12 represents a typical assembly of panels on the cellular principle for controlling lighting and traction generators. In the foreground are the traction feeders and Board of Trade panel. The middle distance is occupied by the gear controlling the generators, balancers, and lighting feeders, the latter being at the extreme end of the board. Duplicate 'bus bars are provided with change-over switches for coupling the generators with either set of bars. Wattmeters are inserted in the bars between the generators and both the lighting and traction feeders, so that the total energy delivered to each may be registered separately. Fig. 13 is a nearer view of the same gear with the division pieces removed to show the change-over switches and contents of the switch panel. The equaliser switches and recording instruments can also be plainly seen on the regulating table. The horizontal slab of this latter is fitted with hand-wheels for the regulating resistances, though these are not in position. Provision is also made for a portable voltmeter, which can be plugged into sockets corresponding to the terminals of each generator, for paralleling purposes. The instrument has two scales permitting of a coarse and then a fine adjustment of the machine voltage when switching in.

*(To be continued.)*

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 630.)*

### SYNTONY.

A body vibrating in a medium usually gives rise to waves, the intensity of the waves depending on the rapidity of the alternation. Thus we may have a very slow pulsation, say of the air, of great amplitude, producing little effect except perhaps the alternate rise and fall of a sensitive pressure gauge, whereas a rapid pulsation of the air gives rise to a loud noise or a musical note. The pulsations may even be so rapid that our ears fail to distinguish the sound produced; thus at each end of the scale we fail to perceive the effect of the vibrations. So it is with etheric vibrations. A magnetic alternation of sufficient rapidity induces an alternating electrostatic field, and energy is given out, whereas a slow alternation gives rise to practically no electrostatic effect. In the latter case little or no energy is emitted, or, rather, it nearly all returns to its source. For a progressive wave half its energy must be static and half kinetic—in ordinary current induction the energy is all kinetic. It seems, therefore, that the rapid vibrations are the most advantageous if we wish to transmit a message to a distance, but for great distances the rapid waves of small length are too easily prevented from reaching their destination by "screening," whereas for slow vibrations obstacles, if not of *iron*, have little effect, even conductors not having a serious screening effect if the vibrations are slow enough. To detect the electric vibrations, a form of detector is necessary, and some of these have already been referred to. But the importance of the receiver being in *tune* with the vibrations it is intended to detect was pointed out by Dr. Lodge in 1890, as deduced by him from an experiment with Leyden jars. For telegraphic purposes the Leyden jar is replaced by a condenser, the circuit of the jar being replaced by a large horizontal coil of wire, the frequency being lowered by this means to some thousands or even hundreds per second, so that an ordinary telephone might be used as a receiver in a shunt to the receiving condenser. Instead of the etheric oscillation produced by the spark of a coil, an alternator or source giving an alternating current may be employed. The importance of accurately tuning the receiver to its alternating dynamo or source is now recognised by all, and was fully explained by Dr. Lodge, who illustrated the matter by noting the analogous quantities as follows: electric—self-induction, resistance, capacity; mechanical—inertia, viscosity, elasticity (*Proc.* Inst.E.E., vol. 27, p. 809).

A mechanical idea of an alternating circuit without condenser is given by Dr. Lodge. It is that of a truck on level rails pulled and pushed alternately by a piston. To vary the resistance the truck could be braked, to increase the self-induction the truck might be loaded, but to represent capacity we must imagine the truck fitted with a spring recoil tending to return the truck to its mean position. The truck has now—by the insertion of the springs—a period of vibration or oscillation of its own, and if disturbed

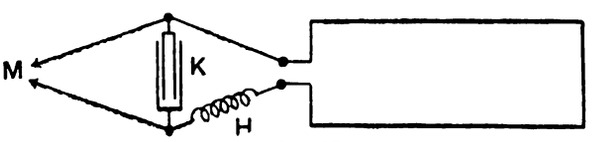


FIG. 27.

it will swing to and fro a certain number of times per minute, gradually coming to rest. To keep it in alternation without springs a great amount of energy was required and wasted, and a very strong push and pull by the piston; whereas with the springs, if only the push and pull are in tune or synchronism with the natural period of oscillation of the truck, comparatively little energy is required, that stored in the springs at each compression being nearly all given out again at the next forward movement. So even a very slight push, if given at proper intervals, could set the truck in violent oscillation. Thus, in the electric circuit, the analogue of force of the springs is the voltage at the terminals of the condenser; the analogue of current is velocity of the truck as it passes the mean position. Without the condenser the oscillations are feeble if there is considerable self-induction in the circuit, and without plenty of self-induction the magnification of voltage at the right frequency is small. With large self-induction and small resistance it would be possible (as

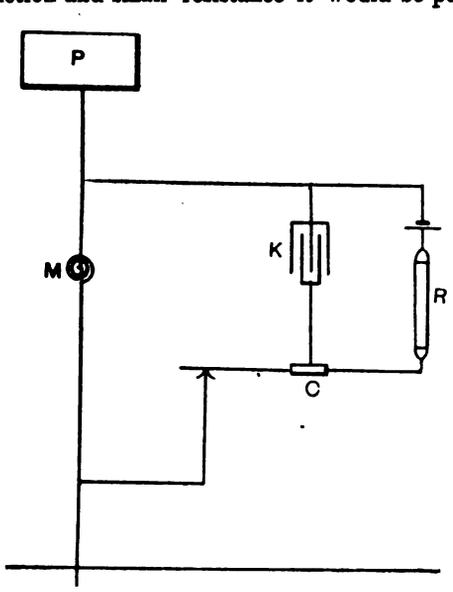


FIG. 28.

in an enormous copper coil) to multiply the applied voltage thousands of times, so as to burst any condenser. Dr. Lodge concludes that in an unaided self-induction process, it is impossible to work well over really long distances without proper syntony or tuning unless an extravagant amount of power be employed. The elements of the mathematical side of the theory are also given by Dr. Lodge, who describes some methods whereby the tuning may be effected. As regards receivers, if the current is of the *interrupted* kind, a coherer may be employed as a shunt to the receiving condenser, and a relay worked by the signals so obtained. For the more sinuous law current of an alternator the ordinary coherer is hardly sensitive enough. Thus when an alternator is employed to produce the etheric

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oscillations, the receiving circuit must be modified, as a filings coherer is unsuitable. A telephone may be used.

One method suggested by Dr. Lodge is shown in Fig. 27. M is the magnifying telephonic arrangement, K a condenser of about 20 microfarads capacity, H the thick-wire winding of a hedgehog transformer inserted as extra self-induction. The telephonic magnifiers were not found so satisfactory as reed or tuning-fork magnifying telephones with only a single pair of carbon contacts. The coil is here hung to a reed or fork of definite pitch, and also carries a pellet of carbon which presses lightly on another fixed pellet, thereby acting as a single-contact microphone.

The tuning-fork telephone, which responds only to one definite note, is an apparatus which seems to promise the much-wanted secrecy for ether wave telegraphy. The vibrations of a telephone diaphragm may be magnified and used to ring a bell or work a Morse printer, as in the phonophoric receiver of Mr. Langdon Davies.

Another important improvement introduced by Dr. Lodge is shown in Fig. 28, where a condenser is shunted across the terminals of the receiver R to take up the extra oscillations. The syntonic responder, M, is also used.

*Marconi's Methods of Securing Syntony.*—Mr. Marconi read a paper before the Society of Arts in May, 1901, in which he described various methods by which tuning could

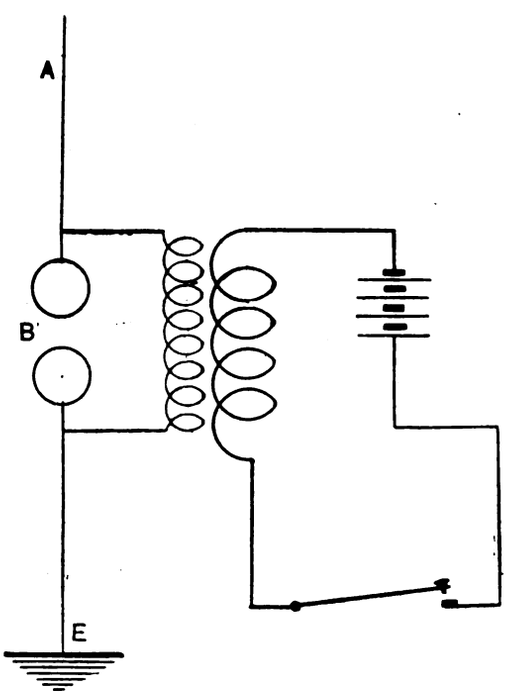


FIG. 29.—Early Form of Marconi Transmitter.

be effected. With simple vertical wires connected directly to the coherer at receiver, and spark gap at the transmitter (Fig. 29), no tuning of any consequence is possible. If the aerials were very different in length, a certain amount of selection was possible. Thus two stations five miles apart, using aerials 100ft. long, would not interfere with two other stations, with aerials 20ft. long, two miles from one of the first-named stations. The method adopted by Mr. Marconi in or after 1898 of connecting the receiving aerial to earth through the primary of an induction coil or transformer instead of to the coherer, and of connecting the ends of the coherer to the secondary of the same, also shunting across the coherer an adjustable condenser, the whole forming a resonator tuned to respond to the given waves, was an important advance. This method is shown in Fig. 30. The importance of this tuning was illustrated by Mr. Marconi by an example in which bell-ringers gave their impulses to the ropes in proper time, and thus succeeded in ringing heavy bells with a comparatively small expenditure of energy. The heavier the bell the slower the impulses had to be. If the impulses were wrongly timed—*i.e.*, untuned—the bell did not ring. The same sort of thing happens in a very small fraction of a second if we try to induce electrical oscillations in a good resonator. If the resonator be of the *persistent* kind, we must apply a large number of properly *timed* or *tuned* electric oscillations from a *persistent* oscillator in order to properly affect the resonator. A vertical conductor like a round wire is *not* a persistent oscillator. Its capacity is small and its power of radiating great, so that the oscillations which take place in it are rapidly damped. In this case receivers or resonators differing in pitch *will* respond. It has been found that the best results are obtained when the length of the secondary of the receiving induction coil is equal to that of the transmitting wire. Many methods are described by Mr. Marconi, who mentions, among other things, a steam motorcar fitted up with wireless apparatus for field service, aerials being dispeused with. On the roof of the car is placed a cylinder, which can be lowered in travelling, its height being about 6m. to 7m. (19·7ft. to 23ft.). A 25cm. (10in.) spark induction coil, worked by accumulators and taking about 100 watts, is used for transmitting, and the accumulators can be recharged by a small dynamo worked by the car motor. By this means communication was carried on with a syntonised station 31 miles distant. Signals may be transmitted to a considerable distance when the cylinder is horizontal.

*Cylinders Instead of Aerials.*—Mr. Marconi has found, as already stated, that good radiators can be constructed with cylinders of moderate height instead of aerials. Fig. 31

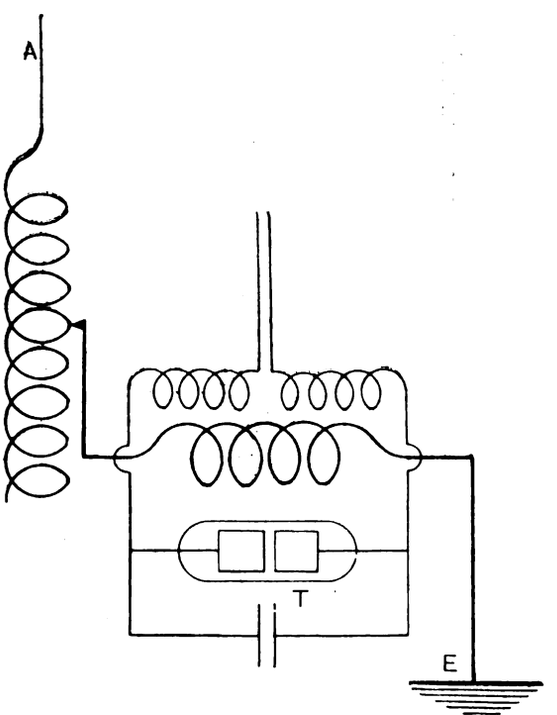


FIG. 30.—Syntonic Receiver (Marconi).

shows these copper cylinders, the inner being connected to earth with an air space between the cylinders. The outer cylinder is connected to one side of the spark-gap through a variable inductance, the other side being connected to the earth-wire of the inner cylinder. The source of energy is in the primary circuit of a transformer, the secondary of which is connected to the two sides of the spark-gap as shown. The capacity of the radiator is large, and the energy set in motion by the spark discharge cannot be all radiated in one or two oscillations, but forms a train of waves such as is required. The receiver is very similar to the transmitter, having similar cylinders, the receiving induction coil or oscillation transformer being placed where the spark-gap is in Fig. 31, and capacity being provided, by which the receiving circuit is tuned to the period of the transmitter. We believe Mr. Marconi used concentric cylinders in his experiments between Poole and St. Catherine's Point (31 miles) in the spring of 1900. It has been stated that to secure good effects with cylinders some means of directing the waves is necessary, as electrostatic induction is here of importance (M. Emile Guarini in the *Scientific American* (Supplement), April 25, 1903).

Mr Marconi states that he believes the days of non-tuned etheric signalling are numbered. "The ether about the English Channel, and, indeed, elsewhere, owing to wireless activity, has become exceedingly lively; an untuned

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receiver keeps picking up messages, or parts of messages from various sources, and these often interfere with the message one is trying to receive." Mr. Marconi adds, "I am now prepared with syntonic apparatus suitable for commercial purposes." This statement was also authenticated by Dr. Fleming, who said, "Mr. Marconi has not only constructed a receiver capable of receiving trains of waves, but also capable of *not* receiving those not adapted to it." Yet people about the English Channel are said to give trouble in connection with Mr. Marconi's messages. They also say that they can pick up the said messages. The explanation of the latter probably is that a "slack" system with small capacity is like a very weak spring, and will respond to oscillations of almost any wave-length. Such a system will, probably, receive almost any message sent out within a certain radius of it, but if two or more messages are sent out simultaneously in its neighbourhood, it will receive all, and the result will be an unintelligible jumble. Remarkable experiments carried out recently at Poldhu (March, 1903), under the supervision of Dr. Fleming, showed that messages dispatched simultaneously from the large Transatlantic station and a

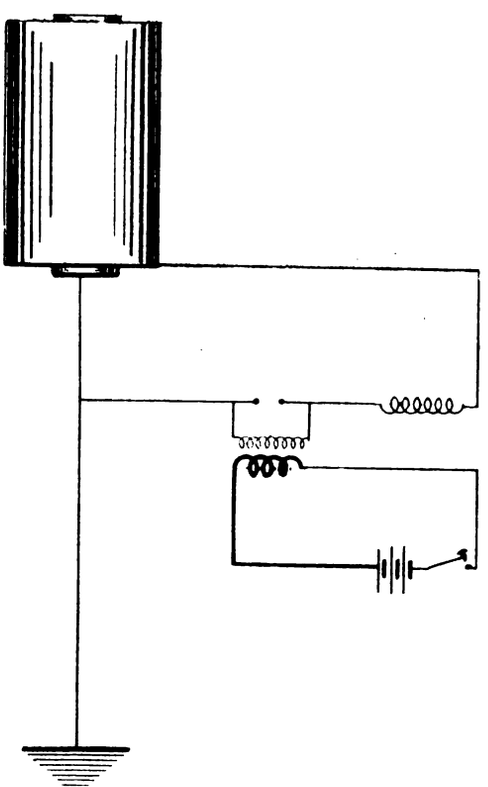

FIG. 31.

small ship station near were received perfectly correctly and distinctly on the same aerial of a properly tuned station a few miles away. This is one of the most remarkable instances of perfect tuning yet made public. One should imagine that the great station sending out waves of great length, and the smaller station with its probably very different wave-length radiation, offered a particularly good opportunity for tuning with success. It would be interesting to know how far it is possible to tune in this way, say, the apparatus of a number of ships of a squadron, and whether it is possible by this method of syntonisation to communicate with one of the ships without the others detecting the message. Also whether the working of a transmitting apparatus within a few miles of Poldhu interferes at all with the messages received from America, the oscillations conveying which must be very much attenuated when they reach our shores.

*(To be continued.)*

**North Wales Telephone Areas.**—At a recent meeting held in reference to the claim of the users of the telephone in North Wales to a rearrangement of the areas, it was decided to ask Mr. Herbert Lewis, M.P., who took the chair at the previous meeting, and all the Welsh and other members of Parliament whose constituents are affected, to urge the Postmaster-General to receive a deputation.

## THE EDUCATION OF THE AMERICAN ELECTRICAL ENGINEER.*

BY PROF. W. E. AYRTON, F.R.S.

*(Concluded from page 637.)*

There is no question about an engineering professor in America being *occasionally permitted* to do a small amount of outside work: he is practically *required* by the college authorities to be so actively engaged in practice that he becomes recognised in the world of affairs as the working authority on his subject. "Don't know a successful engineering professor who is *not* engaged in outside work, who, in fact, is *not* successful in outside work," was the opinion round the lunch table of those in authority at the Library of Congress, Washington.

"The head of every department in a technical college is a consulting engineer in practice," said another.

Mr. Barclay Parsons, who spoke not merely as a large employer of labour, but as a trustee (a member of the governing body) of Columbia University, told us: "We not only permit outside work, we encourage it in our staff. When Prof. Burr (of 'Civil Engineering') was appointed a member of the Isthmian Canal Commission we gave him long leave to go to Port Rico." And when I asked with reference to this and other examples which he gave, "But do the students like such long absences of their professors?" he replied, "Yes, they lose him for days or months, but they gain, for he brings back accounts of the new work he has done."

I had a long talk with President Schurman, of Cornell University, where there are some 1,200 students of engineering alone. He considered that there was no question about the importance of the engineering professors engaging in practice, but that when a professor was away from the university for six months doing private outside work, he had been led to ask the Dean of the Science Faculty, "Are we losing this man's time?" The reply, however, had always been, "The university gains" So he had been led to conclude that even "to the extent to which it"—*i.e.*, outside work—"was done, it undoubtedly led to the welfare of the university."

"In fact," said President Schurman, "I recently received a letter from Mr. Walter C. Kerr, president of Messrs. Westinghouse, Church, Kerr, and Co, which proposes our giving our engineering professors even still more opportunity to take part in outside work than at present. Mr. Kerr is a trustee of our university, and was formerly an assistant professor in it, so that he is quite familiar with our organisation." The following is an extract from this letter, which is dated June 23, 1903:

"I have given some thought to a feature in technical education—at least, certain portions of engineering education—which might be improved.

"Without undertaking to rehearse all of the facts surrounding the conditions under which this education is given, I think it is true that college professors after 10 or 20 years of work grow out of touch with the arts they are teaching, and become what is generally called 'too academic.'"

"This is not true of all, nor does it apply equally to all of the different departments of engineering, but more particularly those in which close touch with the art is particularly necessary to competent instruction."

"I have, therefore, thought that certain chairs—perhaps a half-dozen or more—in the department of technical engineering, and perhaps some in the other engineering schools, might be filled by two men instead of one, these men serving alternate terms of two, three, or four years each in the university and out in practice. I am aware that there are limitations and difficulties to this method, but I doubt whether they are as great as those existing under the present plan

"I am reminded of the practicability of this through the fact that Prof. A. W. Smith, Dean of the Department of Engineering in the Leland Stanford University, has worked for us for two years most acceptably, and after opportunity

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to stay with us in high position, and at better salary than a university can pay, he chose last fall to go back to his university position. Again, this summer he is with us, and in the fall will be back at Leland Stanford. There are doubtless others whose temperaments would adapt themselves to such dual relationships, and I believe the beneficial effect upon temperament would be quite equal to the material benefit otherwise gained.

"I think it would not be difficult to find a half-dozen or more concerns in the country who would be willing to agree to thus employing such men alternately with the university, and it would not be necessary that they should go to the same place every time."

"The professors who turn out the best students are the very men who are running around about outside work," said the chief electrician of the Westinghouse Company, and he gave me an example of a professor who spent so little time at his college, and apparently gave the students so little attention, that he ran the risk at first of being thought to neglect them. "But he was found to show such real strength as a manager and director, to come back with such modern ideas about engineering needs and necessities, etc., that he was actually requested to take a post at a larger college at a higher salary."

Some of the professors at Cornell earn two or three times as much as their university salary, "which is not, therefore, made less than that of a brother professor, who may give his whole time to the college, because an hour of the former man is considered as being worth many times that of the latter." Such teaching is too valuable to require any compulsory attendance being imposed on the students. They come at 8 a.m., some much earlier; "the attendance is voluntary" as far as the university is concerned, but "if a man came habitually late the freshmen and sophomore boys would guy that fellow and make life miserable for him," said one of the engineering professors.

"A college gets a better reputation if it is known that their professors get large fees outside, because they are then better able to instruct," said another.

Dr. Humphreys, the president of the Stevens Institute of Technology, New Jersey, a college for the training of *mechanical* engineers only, but numbering amongst its staff a professor of English, an instructor in modern languages, a professor and an assistant professor of electrical engineering, etc, told us that he was a partner in Messrs. Humphreys and Glasgow, of New York, of the same firm in Victoria-street, London, the president of the Buffalo Gas Company, etc., but the trustees thought that, in spite of his many business occupations, or, rather, because he was so occupied commercially, he was the person to appoint as Professor of Business Engineering, President of the Institute, and one of the trustees. "I consider distinctly," said he, "that an engineering professor should be interested in business. If a man is not capable of doing outside work, he is not capable of teaching. The staff does not consult me to get permission about outside work; the Stevens Institute Department of Tests may carry on any outside work in the institute's laboratories, and may retain all but 10 per cent. of the fees they receive.* This large proportion of fees that the staff is allowed to retain is not for the object of curtailing the income they receive from the institute."

This extra remuneration has, however, the important result of materially increasing the income of the staff. For my enquiries showed that the fixed salaries paid by colleges to assistants were often—allowing for the different value of money—not higher in America than in Great Britain. This was attributed, for example, by Mr. Steinmetz to "the survival of European practice." He looked forward, however, to improvement in this, since "the main object, the main desire, of educational authorities, was to get the men who were most up to time in methods."

On each of the many occasions that the importance of outside work was urged on me, I pointed out the possible risk of a man becoming so immersed in professional work, and deriving so large an income from his practice, that he might come to disregard the salary derived from the university, and neglect his students. Although I remembered that even in Great Britain the teaching of a surgeon was not considered the less valuable because he performed many successful operations, and that a musician was not regarded as necessarily neglecting his pupils because he was paid large fees to appear on the concert platform, still, even at the risk of appearing dense, I made a point of raising the preceding objection because I knew that it would be the English point of attack. But I was always answered that the risk I referred to was far less serious than the risk of the professor's teaching deteriorating from his losing active touch with the industry. "The man who spends all his time at the college slips behind. If a man is good enough to be a professor, he can be trusted to be fair; if he is going to rob us, he is not good enough to be at the college at all."

A professor in one of the large cities, whose college salary is 6,000dol., receives also 4,000dol. a year as the secretary of an engineering society. Whenever the society meets away from that city leave of absence is given him by the university. "He divides his time at his discretion. The university is proud of his having been chosen as the secretary; the society is proud to have so distinguished a professor."

One of the staff in one of the large laboratories in Columbia University gave me a list of the regular fees charged for the commercial tests carried on at the laboratories. "We are encouraged by the university to do outside work. The assistants are more or less free the half of each day." "But suppose you were asked to carry out during term time a *prolonged* test at a distance from New York, how would you arrange?" I asked. "Engage a staff of suitable outside men to carry on the work under me, and bring them for a day or two into these laboratories if special training was necessary." "No, the university would not charge these men a fee for working a day or two in the laboratory for this purpose."

And what applies to the staff applies to the students. At the Cornell University "the fourth-year electrical engineering students, with some of the third-year men as assistants, may go out for some days a week, or for some weeks, with a thousand dollars or more worth of apparatus, lent them by the university, to carry out commercial tests hundreds of miles away under the professor."

"Reality" is the watchword of engineering education in America, for not merely are the professors on the faculty of an American college engaged in real outside work, but several lectures are given yearly by engineers who are otherwise wholly engaged in practical work, and not connected with the college. For example, in the last catalogue of the Massachusetts Institute of Technology it is stated: "During the past year the following gentlemen have given instruction of this nature:

"Mr. George W. Blodgett, formerly electrician of the Boston and Albany Railroad, on 'The Application of Electricity to Railway Signalling'; Mr. Hammond V. Hayes, electrical engineer of the American Bell Telephone Company, on 'Telephone Engineering'; Prof. Elihu Thomson on 'Recent Developments in Electrical Engineering'; Mr. C. J. H. Woodbury, of the American Bell Telephone Company, on 'Electricity in its Relation to Fire Risks'; Dr. Louis Bell on 'The Electrical Transmission of Power and the Application of Electricity to Railway Transportation'; Mr. S. Everett Doane, of the Marlborough Electric Company, on 'The Manufacture of Incandescent Lamps'; and Mr. Odin B. Roberts on 'The Nature and Function of Patents for Invention.'"

"I dare say you think this subversive of all discipline," suggested my host as we walked through the empty engineering laboratories at Ithaca, the engineering students having decided, without reference to the university, to abstain from college work for two days out of respect for their Dean, who had suddenly died, "but our aim is to encourage a division of responsibility, so that the man who is nearest the thing to be done acts for himself without waiting for instructions. We hold our students responsible only for the results obtained. It is a great advantage for the young men in America to get out of the beaten track."

* Principal Humphreys considered 10 per cent. of the fees, paid for private outside work carried out in the college laboratories, too small a proportion to reimburse the institute for cost of material, wear and tear of apparatus, etc., but that was the existing rule.

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Here was one of the causes for the American spirit of initiative, alertness, and enterprise put in a nutshell.

In America much less importance is attached to examinations than in Great Britain. Whether a student is worthy of a degree is left to the decision of his professors, without the intervention of outside examiners. They are greatly influenced, they told me, by their estimation of the value that the student will be to the world. On the other hand, America's judgment of a professor is based on his power of attracting students, on the demand shown by the industry for the men he turns out, and generally on the name he makes for his college. And so far from *valuing* an engineering professor for daily attendance at college from some early hour in the morning to some late hour in the afternoon, the authorities would, as a rule, deem such constant attendance a neglect of duty, because such a professor was not seeking outside for practical knowledge and experience to impart to those he had to teach.

America being a go-ahead country, and the land of youth, one is somewhat astonished at being told by various thoughtful people—from the President of the United States downwards—that there is a growing impression that a student should not leave the professional school until he is 24 or 25 years old. For they urge that, after leaving the high school at 17 or 18, he ought, before proceeding to the professional school, to go to college to learn "classics and culture," since an engineering student should receive considerable literary training to fit him to become the all-round man who can command commercial success. For example, at the Stevens Institute all the engineering theses written by the students "must satisfy the department of English." Some American engineers, however, think that 24 or 25 is too late for a student to enter the factory, and so they suggest, as an ideal course for an electrical engineer, something like the following: at the public elementary school, 6 to 14 years old; at the public high school, 14 to 17 years; at the university, 17 to 20 years; at the technical college, 20 to 23 years.

In England even 23 would usually be thought too late to enter works, because it would be feared that the man might not so readily take off his coat and buckle to as at an earlier age. But it must be remembered that the American students, while at the technical college, are taking part in outside work under the practical engineers who are their college teachers. Hence one can understand the statement that was made to me, "The men whom you are surprised to find holding such important positions in factories, although not much over 30, are the very men who did not leave the technical college until they were 23 or 24." "The graduate may have been 25 before he donned a jumper, but in five years he learned more with the college training he had as a foundation than the regular journeyman in 15 years of actual work in the shop."

Education is immensely valued in America, and the people are willing to contribute large sums for its support. The money is not voted grudgingly, but in the belief that a splendid investment is being made. This wide-spread enthusiasm for education, and the realisation that to keep engineering teaching abreast of engineering progress the professor must lecture on what he is doing and not on what other people have done, probably accounts for the absence of any jealousy being shown by the practical man towards the professors who combine a remunerative private practice with teaching.

Organisation is a marked feature in American undertakings. At any important university, for example, the engineering teaching is subdivided between several professors, each giving instruction in his own particular branch or sub-branch, each, therefore, being able to keep his thoughts on one line of development, each having the time and the available energy to materially aid in that development. In England, on the other hand—even in its capital—over 150 students may be found in the electrical engineering department of a college, men carefully selected by entrance examinations, men giving their whole time all day, every day, to the study of their profession, and yet one single professor of electrical engineering, with a staff of poorly-paid assistants, is considered sufficient. Yearly some of the students may go out into dynamo manufacture, some into electro-chemistry, some into electric traction, some into manufacture of submarine cables, some into electric power transmission, some into wireless telegraphy, and so on, yet that professor, while staying the greater part of his time inside the college walls, is expected in some miraculous fashion to keep himself in such practical touch with all these branches that, no matter what may be the one a student may select, that student shall be equally well prepared to enter on his profession.

Since want of funds will probably render it impossible for even the most important colleges in London to have a separate professor for each branch of electrical engineering, it is extremely important that all the chief London professors of that subject should be gathered together in one spot, and provided with an adequate staff and equipment, so that each may devote himself to the efficient teaching and development of a definite branch of the subject.

Educational authorities in America agree with our own in deprecating the idea of one building, or set of buildings, being used by students up to graduation, and another building, or set of buildings, for post-graduate students. They consider that one professor, with his staff, should give all the teaching—ante and post graduate—in one branch, say, electric traction on roads, railways, and canals; another, with his staff, all the teaching in another branch, say land and submarine telegraphy and telephony; while a third professor, with his staff, would deal with, say, the design, manufacture, and testing of heavy electric machinery, etc. Ante-graduate students should not feel that they had merely to acquire knowledge, and that its advancement should be left solely to the post-graduate one. All students (junior or senior), all teachers (young or old), should learn to enquire, and in order to do so they should have the chance of seeing one another at work.

In fact, if the best teaching and the greatest development in each branch is to be secured, the Americans think that the division lines should be drawn vertically between branches of the subject, and not horizontally between students of different ages.

As in the American college, so in the factory the effects of organisation are very noticeable. At a large electrical works one man is expected to be the authority on direct-current machinery only, another on single-phase alternating-current machinery only, another on polyphase alternating-current machinery only, etc.; hence each line receives constant development. In the great workshop of the Westinghouse electric works at Pittsburg, there is a portion devoted to *experiments* on tools for use in that workshop. Among the many large buildings of the General Electric Company at Schenectady there is one mainly devoted to *research*, with a complete staff of its own.

In a factory in America the instruction, "Originate; don't copy," can be and is literally carried out. No wonder, then, that each time one goes to that country one finds oneself in a new electro-technical world.

A comparison between students in the two countries shows that the American student is usually not as scholarly, nor as well read, as the English student of the same age, but "he has his knowledge in a better form to apply." The British system turns out a man full of knowledge and principles, while the American product is a business man with a scientific training. The characteristics of each nation have their advantages. To America we look for that rapid, bold, and successful application of science to industry which has brought about the commercial invasion of the world, while to Europe we look for those scientific imaginings and creations which are apparently so unimportant to-day, but which to-morrow revolutionise old industries and give birth to new ones.

My grateful thanks are due to all my American friends for the great help and the many kindnesses which they have always showered on me. And even during this last visit, when, in order to obtain information, I was compelled to give them much trouble, and when, to avoid deriving an exaggerated impression of the superiority of the young American electrical engineer, I was forced to display a doubtful and critical spirit, they invariably showed that sweet and lovable courtesy which I have always found so characteristic of their nation.

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## CONTINUOUS-CURRENT TRANSFORMERS.

BY J. W. BURLEIGH.

At the present time it appears that continuous-current transformers are not used to any great extent. The chief reason for limited use is, of course, due to the impossibility of obtaining a variation of voltage by inserting a resistance in shunt winding, the only method of varying voltage being to introduce a resistance in main circuit of either dynamo or motor windings. This is decidedly not an economical proceeding, especially when a wide range of voltage is required. Occasionally, however, there arises a case when it is only required to transform from one constant voltage to another voltage which is also constant. In the event of this, it would appear that, viewed from almost any standpoint, it is preferable to employ a machine with motor and generator windings, assembled on the same core, having a field common to both, usually termed a continuous-current transformer, its chief advantages over a motor-generator being that its prime cost is about half, the efficiency is much higher, commutation troubles are practically eliminated, requires less space, etc. The prime cause of these superior points is mostly due to the fact that owing to the dynamo and motor windings being on the same core, and that the current in one winding "flowing" in an opposite direction to that of the other completely neutralises any field distortion. It is generally acceded that to obtain successful commutation we must increase the "reversing" field in proportion to the reactance volts. The writer finds from his experiments that we can be assured of a sparkless machine provided we have a reversing field of one Kapp line per reactance volt. In a continuous current transformer it naturally follows that the reversing field is equal to density in gap, irrespective of length of air-space; therefore if we employ a density of, say, six lines per square inch, we can deal successfully with a rectance voltage of six. That the balancing effect of the two windings greatly diminishes the cost of manufacture can readily be seen. In most of the cases which the writer has come in contact with, a density of from four to five lines was ample; this low density, together with a "mechanical clearance" gap, points at once to a considerable reduction in field copper—that is, compared with an ordinary dynamo or motor—in which case it is necessary to use from 50 to 100 per cent. greater density, and usually, for a sparkless machine, a gap considerably longer than required simply for mechanical clearance. And again, owing to the absence of distortion, we can employ a relatively large number of conductors on armature. This naturally means a light field system due to the less areas required; in fact, owing to the comparatively small flux permissible, one can easily use cast-iron magnets without their looking in any way ponderous—this in itself constitutes a great monetary saving. The use of cast steel in continuous-current transformer magnets is almost out of the question, as in nearly every case occurring in practice a different magnet casting is required, therefore it behoves the designer to produce as simple a pattern as possible, as it might only be utilised to fulfil one order.

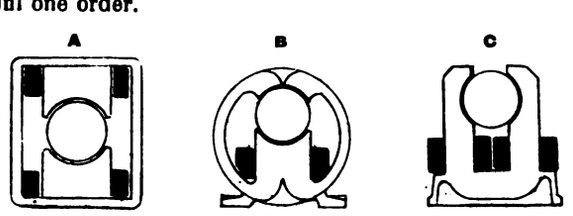


FIG. 1.

The use of either of the magnet systems shown in Fig. 1 tends towards an economical machine, as either design will permit "feet" to be cast on, a bed-plate being dispensed with and bracket bearings used. In nearly every case which has come under the writer's notice, it has been found a disadvantage to use a four-pole magnet system.

As regards efficiency, it would naturally be expected that it would be higher in a continuous-current transformer than in a motor-generator. In the former we have only one armature revolving and the field system, beside a less number of bearings, and not only this, we are permitted to use copper gauze brushes owing to the excellent commutating properties. On the whole, it would be expected that the commercial efficiency in continuous-current transformers would be from 10 to 30 per cent. higher than a motor-generator of similar output.

As an example of the method adopted by the writer for designing these machines, a transformer is chosen with a primary voltage of 230, output 50 volts 40 amperes at about 1,350 revolutions per minute. The reader need not be troubled with the necessary trial calculations; for this reason only final figures are given.

As a first step the flux is determined; this varies as the square root of watts per revolution generated. We may write $\sqrt{W_R} \times C' = Z_a$. $W_R$ = watts per revolution. C varies from 150 to 170. $Z_a$ = number of Kapp lines through armature. $W_R = \frac{50 \times 40}{1,350} = 1{\cdot}48$. Chosen value of C', 161. $Z_a = \sqrt{1{\cdot}48} \times 161 = 196$.

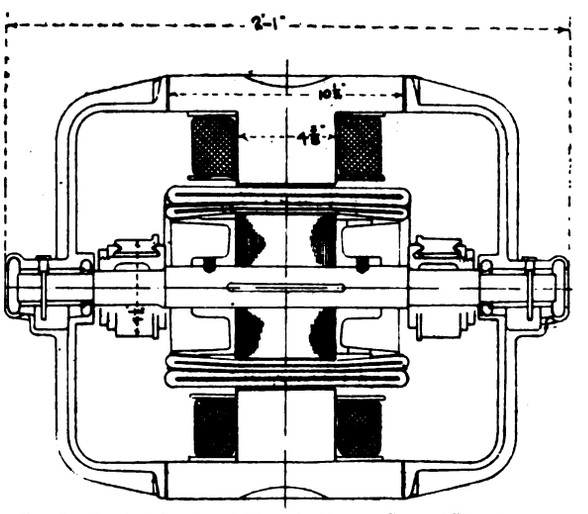

FIG. 2.—Vertical Section of 2-kw. Continuous-Current Transformer.

Reference to article on "Continuous-Current Dynamos" in *Electrical Engineer* dated Jan. 29, 1904, will show method of obtaining product of D × L (D = diameter of armature, L = length of armature), when values for C', $dg$, $\beta$, have been decided upon ($dg$ density in gap, $\beta$ ratio of polar span to polar pitch).

$$dg = 4{\cdot}75,\ \beta = {\cdot}678.$$

$$DL = \frac{\sqrt{W_R} \times 2 \times C'}{dg \times \pi \times \beta} = \frac{\sqrt{1{\cdot}48} \times 2 \times 161}{4{\cdot}75 \times \pi \times 678} = 38{\cdot}7.$$

Before actually deciding on a dimension for D it will be necessary to calculate the number and size of slots, which can readily be done when we have arrived at number of conductors required. Seeing that both primary and secondary windings are in same field, and that they both "cut" an equal number of lines, it is obvious that on open circuit the voltage ratio of transformation is exactly dependent on ratio of conductors in each winding. To arrive at ratio of conductors for full load we must deduct the lost volts in primary winding from primary voltage, and the voltage drop in secondary winding must be added to secondary voltage.

For the case in hand we may take the primary drop as being 10 volts and secondary four volts.

$$\text{Therefore conductor ratio} = \frac{(230 - 10)}{(50 + 4)} = 4{\cdot}08, \text{ say } 4.$$

Number of conductors for primary may be calculated from formula

$$N_c = \frac{V \times 10^6}{S \times Z_a}.$$

$N_c$ = number of conductors, V = internal volts, S = revolutions per minute.

$$\therefore N_c = \frac{220 \times 10^6}{1\,350 \times 196} = 832.$$

$$N_c \text{ for secondary} = \frac{832}{4} = 208.$$

Number of slots selected = 52. Primary has 16 conductors per slot of 14 S.W.G.; secondary, four conductors

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per slots of 14 S.W.G., two in parallel. Size of slots required = ·25in. by 1·27in.

Assuming minimum width of tooth as being ·133, the pitch of slots = ·133 + ·25 = ·383.

$$D = \left(\frac{\cdot 383 \times 52}{\pi}\right) + 2 \text{ depth of slot} = 8\tfrac{7}{8}\text{in}$$

$$\therefore L = \frac{38\cdot 7}{8\ 875} = 4\cdot 375.$$

It will be now possible to determine what the reactance voltage is. The greater inductive effect is, in this example, in the motor winding. We will, therefore, calculate the reactance volts in this winding only.

$$\sim \text{ of commutation} = \frac{\pi\ D'\ R}{120\ W}.$$

D′ = diameter of commutator in inches; W = width of brush.

In this case D′ = 4½in.; W ⅝in.

$$\therefore \sim = \frac{4\tfrac{1}{2}\ \pi\ 1{,}350}{120 \times \cdot 625} = 255.$$

Inductance = $(E \times 20 \times T_s^2 \times T_{sc}) + (F \times 2 \times T_s^2 \times T_{sc}) \times 10^{-8}$

E = embedded length;
F = free length;
$T_s$ = turns per section;
$T_{sc}$ = turns short-circuited;
E = 8″; F = 29·75″; $T_s$ = 8; $T_{sc}$ = 3.

$$\therefore I = (8 \times 20 \times 8^2 \times 3) + (29\cdot 75 \times 2 \times 8^2 \times 3) \times 10^{-8} = \cdot 000421.$$

Reactance volts = $I \times 2\pi \times \sim \times C_c$.
$C_c$ = current in each conductor = 5·25 amperes.
Reactance = ·000421 × 2π × 255 × 5·25 = 3·55 volts.

Taking this voltage into consideration with "reversing" field chosen—viz, 4·75 lines—we should anticipate a machine absolutely free from sparking.

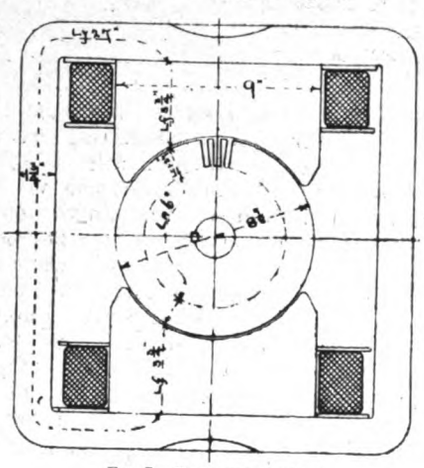

FIG. 3.—Transverse Section.

The type of magnets selected is as A (Fig. 1), which type in this case conduces to a cheap field system. The total ampere-turns required is 4,405, calculated from following details:

$Z_a$, 196. Leakage factor, 1·2.

| | Areas, square inches. | Length of path. | Density. | Ampere-turns. |
|---|---|---|---|---|
| Armature | 18 | 6in. | 10·88 | 50 |
| Teeth | 10·2 | 2·54 | 19·2 | 120 |
| Gap | 41·3 | ·1875 | 4·75 | 1,675 |
| Field | 39·3 | 7½in. | 5·98 | 500 |
| Yoke | 37·0 | 27in. | 6·36 | 2,060 |
| Total ampere-turns | | | | 4,405 |

The windings on field coils are as follows:

| | | | Weight per coil. |
|---|---|---|---|
| Each coil | 1,320 turns 22 S.W.G. | = 1,150 yds. 45·5 ohms. | 8·3 lb. |
| ,, ,, | 1,710 turns 23 S.W.G. | = 1,750 ,, 93 ,, | 9·15lb. |
| Turns per coil | 3,030 | ohms per coil 138·5 (cold) | 17·45lb. |

Resistance (warm) of both coils = 316 ω. Shunt current = $\frac{230}{316}$ = ·728 ampere. Total turns, 6,060; ampere turns, 4,410.

The next step will be to calculate the various losses. We will first take the $C^2R$ losses in armature windings. The resistance (warm) $R_a$ of a two-pole armature may be calculated by the following formula:

$$R_a = \frac{N_c \times \lambda \times R'}{250}$$

where λ = mean length of one turn;
R′ = resistance per yard.

$$\therefore \text{Resistance of primary winding} = \frac{832 \times 37\cdot 75 \times \cdot 004784}{250}$$

= ·6 ohm. Armature current, 10·5 amperes; watts lost = $10\cdot 5^2 \times \cdot 6 = 67$.

$$\text{Resistance of secondary winding} = \frac{208 \times 37\cdot 75 \times \cdot 002392}{250}$$

= ·075 ohm. Armature current, 40 amperes; watts lost = $40^2 \times \cdot 075 = 120$.

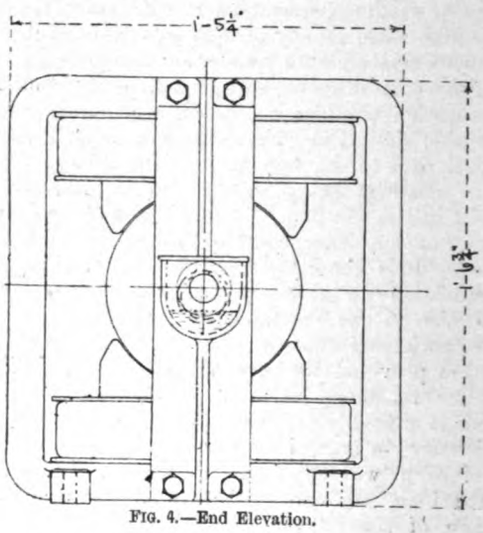


FIG. 4.—End Elevation.

The calculation of eddy hysteresis and eddy-current losses is based on method recently published by Mr. Hobart. By this method, as probably most readers are aware, we obtain the product of density in armature and frequency of reversal of flux. Then from curve derive corresponding watt loss per pound. In case under consideration the density in core is 10·88 lines frequency = 22·5. Density × frequency = 2,450. This corresponds to a loss of 2·3 watts per pound; weight of laminations, 51lb.; estimated core loss = 51 × 2·3 = 117 watts.

| | | |
|---|---|---|
| Total loss in armature = | $C^2$ R primary winding | 67 watts |
| | $C^2$ R secondary winding | 120 ,, |
| | Hysteresis and eddy currents | 117 ,, |
| | | 304 |

Length of winding over ends = 11in. This gives a cooling surface of $8\frac{7}{8}\ \pi\ 11 = 306$ square inches. With this small loss—viz., one watt per square inch—we should anticipate that temperature rise would not exceed 50deg. F.

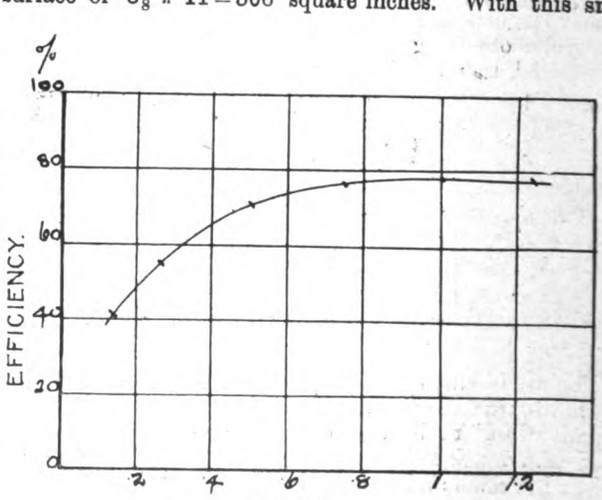


FIG. 5.—Efficiency Curve of 2-kw. Continuous-Current Transformer.

The size of each commutator is 4½in. by 1¾in. The motor has one 1in. by ⅝in. brush each side; this results in

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a frictional loss of 17 watts, taking coefficient of friction as being ·3. The contact loss is 11 watts—that is, assuming a resistance ·03 ohm per square inch. Dynamo commutator has one 1½in. by $\frac{5}{16}$in. copper gauze brush. Friction loss is 13 watts, contact loss 20 watts (on the assumption that resistance of contact = ·003 ohm per square inch). From data which we now have we can easily predetermine efficiency. The following is a summary of the various losses:

| | | |
|---|---|---|
| Total loss in windings and core | 304 | watts. |
| Motor commutator | 28 | ,, |
| Generator commutator | 33 | ,, |
| Bearing friction, windage, etc. (estimated) | 40 | ,, |
| Shunt 230 volts, current ·728 ampere | 168 | ,, |
| Total loss | 573 | |

Output = 2,000 watts. Input will therefore be 2,000 + 573 = 2,573 watts. Efficiency at full load $\frac{2,000}{2,573} \times 100 = 77\cdot9$ per cent. It is improbable that efficiency would be above 65 per cent. for a motor-generator of same output.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

683. When drying out a three-phase generator of the Oerlikon type the following connections were made: The three open ends of the generator stator windings were all shorted together. The generator was then run up to 400 revolutions per minute. A current of 10 amperes 100 volts from one of the exciters was passed through the rotor field, which showed 16 amperes on ampere-meter in one of the stator windings, just enough to warm up the windings of stator. The following happened: the exciting current was kept quite constant, and if the speed of the generator increased or decreased it would show no difference on the ampere-meter in stator coils—the current kept constant at 16 amperes; and if the generator was only just moving, the current would still remain the same, but the moment the generator came to a standstill no current would be shown on ammeter. I should like to know the reason of this.—J. C. J. (India).

684. State the principles underlying thermal storage, and, if possible, give rough details of existing plant.—J. E. H.

### ANSWERS.

*Question No.* 676.—Give a description of what you consider the best modern synchronising device for three-phase circuits.

*Best Answer to No.* 676 (*awarded* 10*s.*).—Synchronising devices have received considerable attention from several inventors during the past few years, the result being that several mechanical indicators are now on the market which show at a glance the phase relations of the machines to be thrown in parallel. With the original synchronising devices, consisting only of lamps, the operation of putting machines in parallel was a tedious one, occupying considerable time and resulting in many bad "throw-ins."

In Fig. 1 is given a diagram of the switchboard connections and synchronising arrangements for a three-phase plant, the arrangements being similar to that adopted on the main switchboard at the power-house of the Central London Railway. The arrangement may thus be considered as typical of modern practice. Referring to Fig. 1, it will be seen that each generator is connected to the 'bus bars through the main switch, current transformers, C T, being inserted in two of the phases for the ammeters, $A_1$ $A_2$, as the generators are of 5,000 volts. P T is a potential transformer for supplying the machine voltmeter, V. This transformer has a ratio of $\frac{5,000}{125}$ volts, the voltmeter being of 150 volts capacity, with scale graduated up to 6,000 volts. A similar transformer is used for synchronising, the line voltmeter, L V, supplied from this transformer being similar to the machine voltmeter. By inserting the plugs, $P_1$, $P_2$, $P_3$, the secondaries of the synchronising and machine potential transformers are connected in series such that when the machines are in phase there is a potential difference of 250 volts across the two secondaries. The plugs on the machine panels are arranged to connect the sockets vertically—thus, | |; while those on the synchronising panel are arranged for a horizontal connection—thus, =. The holes are drilled at the corners of a rectangle, and

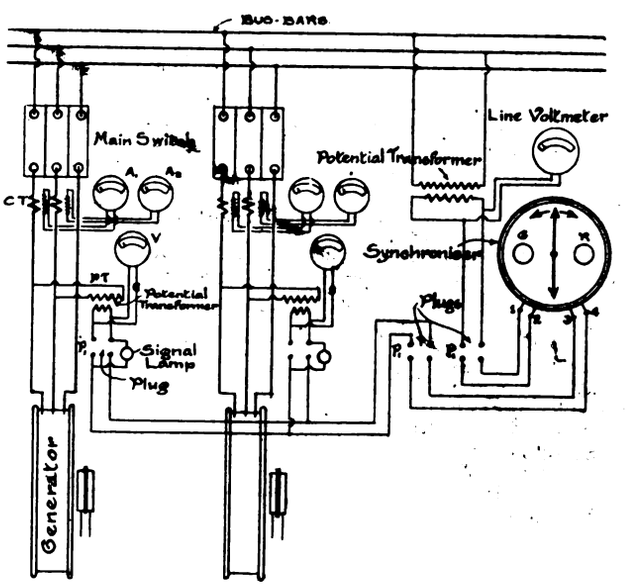


FIG. 1.

thus the plugs can only be inserted one way. Only one plug is supplied for the machine panels and two for the synchronising panel. The synchronising voltmeter, S V, has a range of 300 volts, the scale being graduated up to 12,000 volts. The synchronising lamps are usually run at lower than the rated voltage, as a slight difference in the brightness can be more readily observed in this case than when the lamps are run at full voltage. In synchronising a machine, plugs, $P_1$, $P_2$, $P_2$ are inserted, the voltage of the incoming machine being adjusted to the 'bus bar volts (in this case 5,000), and the speed adjusted until the synchronising voltmeter reads 10,000 volts—*i.e.*, twice the reading on the line or machine voltmeters—when the main switch is thrown in. With

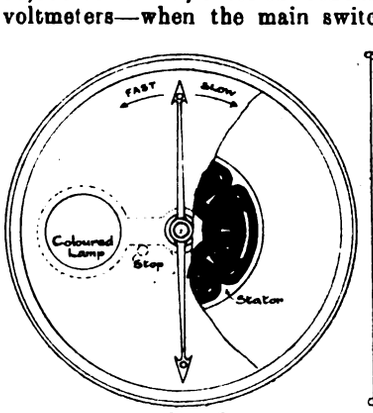


FIG. 2.

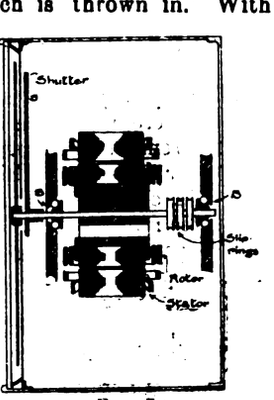


FIG. 3.

such an arrangement no indication is given by the lamps to the engine-driver as to whether the speed of the incoming machine is too fast or too slow. A system of connections, due to Messrs. Siemens and Halske, to overcome this difficulty in three-phase circuits, consists in having three lamps mounted at the corners of an equilateral triangular frame. By means of suitable switches the lamps are so arranged that, when the machines are in phase, they all glow simultaneously, but if the speed of the incoming machine is too slow the lamps each glow in succession, the light appearing to rotate in one direction, while if the speed

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is too fast the light will appear to rotate in the opposite direction, thus giving the engine-driver an indication as to how the speed of the incoming machine stands. This device has not, to the writer's knowledge, been commercially used n this country.

The ideal synchronising device is that known as the "rotary synchroniser," patented by Messrs. Everett, Edgecumbe, and Co. This apparatus has been found thoroughly satisfactory, and is used in some large installations in this country, notably at the power station of the Midland Electric Power Corporation at Ocker Hill, Staffordshire. This synchroniser is shown in Figs. 2 and 3, the former being part outside elevation, and latter being a section through centre line. The interior of the instrument contains a miniature induction motor, both the stator and rotor having a two-phase winding, the rotor being supplied with three slip-rings. The rotor is fixed to the shaft which carries the double-ended pointer, the shaft revolving in ball bearings, B. The winding on the stator is usually arranged to produce a four-pole field. The two circuits of the stator are connected as shown in Fig. 4, one phase through a reactance and the other through a non-inductive resistance, consisting of an incandescent lamp. The rotor windings are similarly connected (see Fig. 4). The terminals of the stator portion (Nos. 1 and 2) are connected to the 'bus bars through a potential transformer, if the machines are of high voltage, and the terminals of the rotor portion (Nos. 3 and 4) to the incoming machine as shown in Fig. 5, which is the diagram shown in Fig. 1 modified for the rotary synchroniser. In this case the plugs on the synchronising panel are all similar to those on the machine panels, the plugs being inserted to make connections thus : | |.

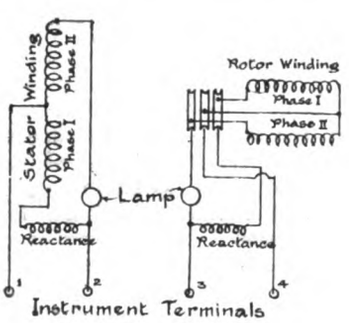


FIG. 4.

The stator and rotor windings are so connected that the two rotary fields produced in stator and rotor by the phase-splitting device previously mentioned are caused to rotate in the *same* direction. Now, in an ordinary induction motor when running, the frequency of the rotor field is nearly equal to that of the stator field. It is the difference in the frequency of the two fields that provides the torque of the motor, for if the frequency of the rotor field were equal to that of the stator, there would be no torque exerted, and the rotor would remain at rest. The action of the rotary synchroniser depends on this fact, for if the incoming machine is in phase with the 'bus bars, and if rotor and stator have the same number of poles, both fields will revolve at the same speed and the rotor will remain at rest. If the frequency of the current in the stator is greater than that in the rotor, the latter will revolve in the same sense as the field, the speed depending on the number of poles and the difference in frequency of stator and rotor currents. If, however, the frequency of the rotor current is the greater, the rotation will be in the opposite direction. Thus an indication of the speed of the incoming machine is given by the arrows marked "fast" and "slow" on the dial of the instrument. In order to indicate at a distance, two discs of different colours or two different coloured lamps are arranged to shine through the dial of the instrument, as indicated by R and G in Fig. 5. By means of a shutter, S (Fig. 3), carried friction-tight on the shaft of the rotor, one of these lamps is obscured. Thus, if the incoming machine is running too fast, a red light would be shown on the dial, at, say, the right-hand lamp, while if the machine were running too slow, a green light would be shown on the dial, at the left-hand lamp. The shutter (shown dotted in Fig. 2) is prevented from rotating by the stop shown, another stop being also fixed near the opposite lamp. Instead of one arm to the shutter, two may be arranged at about 120deg. apart, with the two stops arranged as above, thus the shutter having only 60deg. to turn through instead of 180deg. in order to obscure one lamp and show the other. The two

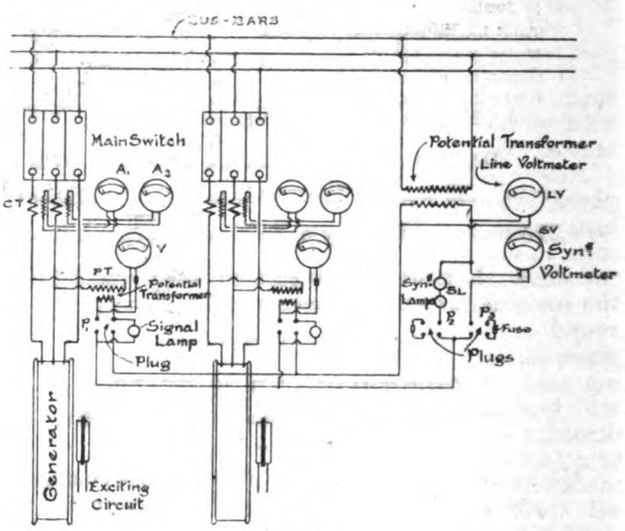


FIG. 5.

lamps are supplied from the rotor and stator circuits, and form the non-inductive resistance (Fig. 4) used in the phase-splitting device for producing the rotary fields in stator and rotor.

In the diagrams of Figs. 1 and 5 it will be observed that synchronising is done on one phase only. This is now standard practice for all polyphase plant.—MONOPHASE.

*Answer to No.* 676 (*awarded* 7*s.* 6*d.*).—Any synchroniser suitable for single-phase circuits is also suitable for polyphase circuits, as it is never necessary to synchronise more than one phase. The older synchronisers consisted simply of a three-legged transformer core with a primary winding, connected to the 'bus bars, on one limb, a primary, connected to the incoming alternator, on the other limb, and a secondary on the third limb connected to a lamp which only burnt at full brilliancy when both primaries were acting in step, and driving flux through the secondary. As the incoming machine got nearer and nearer to the correct speed, the brightness of the lamp fluctuated more and more slowly until at synchronous speed the lamp burnt steadily, and the machine was then switched in. This device indicated whether the machine was out of phase, but did not show whether it were too high or too low in speed. A

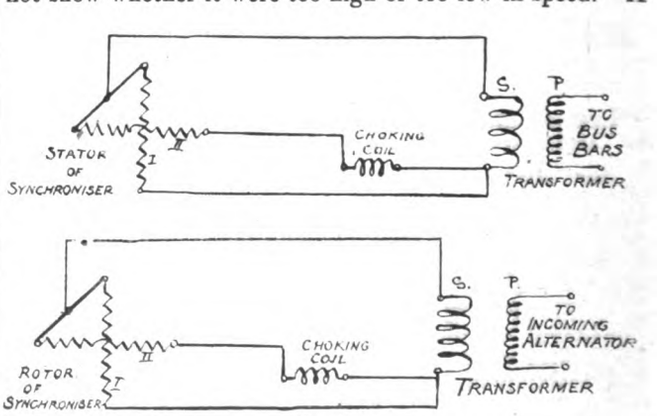


FIG. 1.

modern synchroniser cannot be considered complete unless it indicates to the engine-driver whether the incoming engine is to be raised or lowered in speed.

One of the neatest devices for this purpose is the synchroniser introduced by Messrs. Everett, Edgcumbe, and Co. This instrument resembles an ordinary dial switchboard meter, and when used on a high-tension circuit requires the aid of two small reducing transformers (Fig. 1). The instrument works on the same principle as a two-phase

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induction motor, but in this case current is led into both stator and rotor. The current taken from one phase of the 'bus bars, either direct or through a transformer, is split up into two currents, differing approximately 90deg. in phase, by means of a choking coil in one branch. One of these currents is taken into one set of coils on the stator, and the other into another set of stator coils displaced 90deg. in phase relatively to the first set, just as in the stator of a two-phase motor or the starting and running windings of a single-phase motor. A current from the corresponding phase of the incoming alternator is also split up into two currents with approximately 90deg. displacement between them, and these currents are taken into the two sets of coils on the rotor, which is also wound like the stator of an ordinary two-phase induction motor.

Now, if the 'bus bars and the incoming alternator are in phase, two rotary fields may be supposed to exist in the instrument, one due to the stator coils, and one due to the rotor coils, both running round at the same speed and in the same direction. Under the influence of the stator field, the rotor, considering it as short-circuited, will tend to run round at full speed in one direction, like any other two-phase motor. Under the influence of the rotor field (assuming that the stator windings are short-circuited) the stator will tend to run round at the same speed and in the same direction—*i.e*, the stator being fixed, the rotor would tend to rotate at full speed in the *opposite* direction. The two tendencies being made exactly equal, no actual rotation will result, and the rotor will merely move slightly round until the rotor and stator coils have so set themselves relatively to one another that a minimum current will flow in each—*i e*, the stator and rotor coils of a given phase will set themselves with their axes in line and with their ampere-turns tending to produce magnetic flux in the same direction along the same magnetic circuit. This position of the rotor indicates the correct instant for switching the alternator in, and is marked by the pointer of the instrument being vertical. If, on the other hand, one frequency (say that connected to the rotor) is higher than the other, the rotating flux due to the rotor will cut the stator conductors at a higher speed and induce a larger current (assuming that the stator windings were short-circuited) than that due to the stator (assuming the rotor windings short-circuited). Consequently the former will produce a predominating torque, and keep the rotor (with the pointer) in rotation in a given direction. When the stator has the higher periodicity the direction of rotation will be reversed, thus giving a clear indication as to whether the speed of the incoming machine should be raised or lowered. To make the indication visible at a distance, the instrument is usually also fitted with a pair of lamps, one being red and one green, and one or the other of these is exposed to view by means of a shutter according as the rotor moves in one or the other direction.—Q.

*Answer to No.* 676 (*awarded* 5*s.*).—There are a great many methods of determining when alternators are in step. Some of these are acoustic, but the greater number use incandescent lamps as an indicator. Another indicator, comparatively modern, is an instrument known as a synchroscope. In the United States, the general rule with lamp indicators is to connect up the synchroniser, so that the lamp is dark at synchronism. In this country it is more generally the rule to have the lamp at full brilliancy at synchronism. The latter is clearly the better method, for if the filament of the lamp be broken, in the case of darkness indicating synchronism, there is the great possibility of throwing the machines together, clean out of step. It may be said, on the other hand, though, that it is difficult to determine the full brilliancy. The lamp indicator takes many forms, but the principle is the same in all. It consists primarily of a small transformer wound with two primary circuits—one connected to the 'bus bars and one to the incoming machine—each of which controls one and the same secondary circuit. From this it follows that when the phases of the two primary circuits are in agreement, a lamp or lamps run from the secondary will light up; but when the former are in dissimilar phases, the inductive action in the secondary is nullified, and the lamps do not glow.

Another type of indicator is described in the description of the Manchester Corporation works in the *Electrical Review* for June 26, 1903. It consists of a telephone and battery circuit for the purpose of synchronising the engines not only electrically, but also mechanically. The circuit is carried to the valve gear of each engine, which momentarily closes it at a certain point in each revolution of the crank-shaft. The make-and-break is short-circuited in the case of an engine which is at rest. It will be seen that, unless the contacts are made simultaneously on each engine which is running, the telephone circuit will never be complete; hence it is only when the engines are running not only at the same speed, but with the cranks in step, that the telephone responds.

To describe the instrument known as the synchroscope. It consists of a rotor and stator wound like a two-phase induction motor. In one circuit of each phase is connected a choking coil, in the other a non-conductive resistance, with the result that a rotary field is produced in both rotor and stator, and the connections are so arranged that the two fields rotate in the same direction. The rotor is connected to the incoming machine and the stator to the 'bus bars, if necessary through transformers. If, now, the incoming machine be running faster than the machines already connected, to the 'bus bars, the rotor will commence to rotate in one direction; if, however, the incoming machine be running slower, the rotor will rotate in the opposite direction. Equality of frequency is shown by the rotor standing still, while the exact moment of synchronism is indicated by a pointer attached to the rotor coming to rest opposite a mark on the dial. In order to show at a distance—for example, at the engine—whether the rotor is rotating in one direction or the other, an arrangement of red and green lamps is fixed to the instrument. Opinions vary as to the value of each device, therefore the engineer must make his own choice.—MARSHALL H. TATE.

[N.B.—Will Mr. Tate kindly send his address?—ED., *E. E.*]

*Question No.* 677.—How would you calculate the number of series turns for a compound rotary similar to the 900-kw. three-phase rotaries designed by Mr. Parshall in his book, "Electric Generators," and used, I believe, in the Central London station.

*Best Answer to No.* 677 (*awarded* 10*s.*).—It is doubtful if any definite rule can be given for the amount of series winding required. This is not a fixed feature of a rotary converter, but has to be altered to suit the running conditions. For instance, Parshall and Hobart, in their work on "Electric Generators," give the amount of series winding as about 25 per cent. of the strength of the shunt coil. An arrangement is, however, provided by which more or less of the main current can be cut off from this series winding. Thus the magnetic field flux due to the series winding may be varied as found convenient. With either lag or lead a rotary converter does not run satisfactorily; if the current lags, strengthening the field will mend matters, as the stronger field causes a lead in phase. It will be seen, therefore, that the series winding suitable for running from one generator might be totally unsuitable for another. It is a question of balance between capacities and inductances. Series winding is said to have a steadying effect under large variations in current on the constant-current side; it also acts as a choker to suppress the alternating current superimposed with the direct current.—M. M.

## GRAVESEND AND NORTHFLEET ELECTRIC TRAMWAYS.

The report for the year ended Dec. 31 last states that the total revenue from the year's working amounts to £12,977. There is a net profit of £3,305. Adding to this the sum of £938 brought forward from the previous account, and deducting the dividend paid on the preference shares on Oct. 1 last, there is an available balance of £3,315. The directors recommend there should be placed to reserve and renewals fund £1,000 and, after payment of preference dividend, a dividend be paid of 3 per cent. for the year on the ordinary shares subscribed at Jan. 1, 1903, and on the remainder as from the dates of the various instalments, leaving to be carried forward £727. The total capital expenditure to Dec. 31 last amounts to £122,077. Considering the adverse weather and the depression of the local industries, the directors consider the results of the year's working to be satisfactory, especially as the Windmill-street line could not be opened before May 4, and electrical energy was not available for early workmen's cars until October.

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THE

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## ELECTRICITY IN MINES.

The report of the Departmental Committee on the Use of Electricity in Mines issued recently has now been further supplemented by the publication of the full minutes of the evidence taken before this committee. This latter publication contains the evidence given by no less than fifty-six witnesses who, from their experience, were representative of the various interests involved. Thus there were thirteen scientific experts, electrical engineers, and electrical manufacturers heard before the committee, nineteen colliery proprietors and managers, seventeen miners' agents and miners, and seven representatives from insurance companies, electrical fusemakers, etc. The evidence is much too voluminous to be referred to in detail here, and is well summed up in the report of the Mines Committee. In this report, under the heading of "Dangers of Electricity," the committee rightly observe that accidents may result if so potent an agent as electricity is installed with insufficient skill and handled with carelessness or ignorance. If, however, properly arranged and used, electricity in mines presents no such danger as would justify its prohibition. Other agents, such as gunpowder, nitro-explosives, are much more dangerous in mines unless properly handled, and present features of greater danger than are likely to be found in electricity if properly handled. The committee quote the instance of an incandescent lamp in a mine, which may, if broken, ignite fire-damp if present in sufficient quantity. It must be remembered in this respect that any miner's safety lamp, if broken, would fire the gas with even greater certainty. Acting on the belief that every precaution should be taken to protect the miner, the committee proceeded to draw up rules for the installation and use of electricity in mines which the Home Office are likely to adopt. No such code of rules will entirely prevent accidents, but all concerned will agree that there is much safety to be derived from a well-prepared code if universally enforced. Such a code, if drafted on liberal lines, will not prevent a manufacturer developing new uses for electricity in mining work, and will at the same time protect him from unfair competition from firms who have not had experience of mining, and hence do not know the quality and strength required in mining apparatus. In glancing through these rules, we find them generally acceptable, but in a few instances there is a tendency to go into detail, which we consider unnecessary, and which by increasing the cost of working is likely to hamper the industry. For instance, it is laid down that no higher pressure than 650 volts shall be used for any other purpose than the transmission of energy or for motors, and that even then the following condition shall be complied with—*i.e.*, no motor or transformer shall be of less normal rating than 75 b.h.p. The four remaining conditions secure what we consider absolute safety in the equipment and in the installation of high-voltage plant, and we fail to see under these conditions why so high a limit as 75 h.p. should be adopted. Under special circumstances, where high-voltage transmission is adopted, it may frequently be advantageous to supply motors of 25 h.p. from the high-voltage mains when these are situated at a considerable distance from the low-voltage centres of distribution; or, on the other hand, while the motors may be of small output, the transformer to supply them may be fixed at the end of a long line, in which case, under the present clause, the mine authorities could be compelled to instal a 75-h.p. transformer in order to supply 15 h.p. or 20 h.p. in motors. From economical reasons a limit of output on high-voltage machinery will adjust itself, and as long as due precautions are taken in installation there will be no undue danger to the miners. Another instance in which the rules might

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be reconsidered before final adoption is in those clauses relating to switchboards; for instance, Section 2, Clause 10, provides that "where the supply is at a pressure exceeding the limits of low pressure (250 volts), there shall be no live metal work on the front of the switchboard within 8ft. of the platform." As these rules, if adopted, will be retrospective, they would involve a large amount of reconstruction work in present installations. It is questionable, also, how far this clause is practical in giving the desired safety. All the switches, fuses, circuit breakers, instrument shunts, etc., would need to be fixed to the back of the board, which, with the connections, would be much more complicated than at present. It would also tend to increase the liability to breakdown, and there would be no greater security to the men who have to keep the switchboard in order. We really think that for voltages up to 650—*i e*, the medium pressure adopted in the rules—this clause should not be operative. There are other details in connection with switchboard working, such as sectionalising in order that the boards may be cleaned, which tend, we think, to defeat the object for which the rules are drawn up. We trust that these and other criticisms which may be presented by mine owners and electrical manufacturers will receive the attention of the Home Office before the rules are officially put in force Subject to a few such modifications, the rules are most valuable, and are striking evidence of the good work done by the committee.

## MICA AND ITS APPLICATIONS.

BY J. C. B.

Mica is a substance that is now so very common, that to conjecture as to what would have been the influence on electrical industry had the substance not been a commercial article would be difficult; indeed, as regards electrical progress, mica has always been, as it were, ready to hand to aid any discovery or improvement. On the discovery of the principles of the self-excited dynamo, which marked the advent of both a scientific and commercial evolution, it seems a most fortunate coincidence that such a material should have been to hand, and one that so successfully filled in, so to speak, the interstices of modern progress. Just before this time some practical use to which mica could be applied was being diligently sought after; now, however, what is required are new sources of supply to cope with the multifarious demands for the material. The substance has become now as essential to every branch of electrical engineering as electricity itself seems to be to human progress.

From a geological point, mica, slate, and gneiss are the oldest stratified rocks that we are acquainted with. That it was known in past ages is evident from the many marks of ancient operations to be found in mines, and in so many places, for the material was employed for windows, mirrors, and ornaments in the early days. In some form or other mica exists all over the earth; it may be found in granite and quartz, rubelite, green tourmaline, feldspar, lepidolite, and many other minerals. It varies in colour from white through green, yellowish, and brownish shades to black, and its colour is greatly influenced by the mineralogical peculiarities of the rock in which it occurs or has been associated, and its commercial value varies also with these circumstances.

One of the most important properties of mica, and one on which its value depends, is the remarkable property of lamination, its structure being so perfect that it is possible to divide it by cleavage into leaves $\frac{1}{250000}$th part of an inch. In consequence of its powerful insulating property, and also the very great advance made in electrical industries, the demand for mica at the present day in almost every country is so great that the supply is almost inadequate. It is not only the superior insulating property of the mineral that gives it such an advantage, but its characteristic and peculiar structure which makes it so adaptable as an insulator requiring very little machining or shaping; for instance, it is a substance which could not be well replaced as an insulator of commutator segments, for it is not only the best but an efficient insulator under every condition. In the case of the commutator its hardness makes it invaluable, for it wears away under the friction of the brushes nearly at the same rate as the hard-drawn copper of the commutator itself.

Further, the fact that heat has no injurious effect on either its physical structure or insulating property, makes it almost indispensable in armature construction, safety appliances, and a multitude of industrial applications, such as lamp chimneys, smoke radiators or preventers, and all purposes where transparency, infusibility, and toughness are required. As is the case with the incandescent burner chimneys, it is also taking the place of glass in many respects, especially on board ship, where its combined transparency and tenacity enable it to withstand the wear and tear and the concussion of heavy firing. The qualities of elasticity and toughness are properties in which it is not excelled by anything natural or artificial. These properties are taken advantage of in its employment as an absorbent of nitro-glycerine, and when so used explosions by percussion are rendered less liable, while at the same time nothing is taken from the nitro-glycerine; and for such purposes the pulmose mica is used, or that kind in which the scales are arranged in a feathery form.

The unalterable nature of the substance and its resistance to the corrosive action of acids, smoke, and dust, make it also invaluable as a decorative material; the French silver mouldings are made with ground mica, which is accomplished by passing the prismatic or foliated material through a mill, which process increases the bulk, forming a mass of translucent and beautiful bean-like scales. Mica is also now being used extensively as a lubricant, and for such purposes it has no superior, except plumbago; it is likewise employed for boiler covering, as roofing material, and as fireproofing for safes, etc. As a reflector of light it has very many applications, for it can be readily stamped into any desired shape. At the present such reflectors are on the market in very many varieties, being admirably adapted to electric incandescent lamps.

Probably the most interesting and beautiful properties of mica are its optical, which, in connection with polarisation of light, are both edifying and instructive. Mica under such conditions is what is called a biaxal crystal, which cleaves perpendicular to the bisector of the angle between the optic axis. Its properties in this respect are used for instructive demonstrations of the property of thin films.

There are so many ways of utilising scrap and cuttings of this material in the manufacture of other insulating substances, such as micanite, etc., that it is almost impossible to find any real mica that may be pronounced useless.

## THE PULSATION OF THE DIRECT-CURRENT OUTPUT OF ROTARY CONVERTERS.*

The results of numerous investigations tending to show that the direct current obtained from a rotary converter is of a pulsating nature have been published recently. M. B. Field connects these pulsations with the teeth of the armature. Cramer suggests a variety of other explanations. The present article is an attempt to show that the chief cause of the pulsations is the superposition of the ohmic voltage drops due to the direct current and the alternating current within the armature conductors. Both Steinmetz and Kapp (1898) have based their calculations of the ohmic loss in rotary converters on the superposition of the direct and alternating currents; and Pichelmayer's investigations in 1899 have shown that this assumption is safely allowable, provided that the alternate-current input is of sine form. This assumption will, therefore, be made in the present article.

Let the direct current per brush be $2c$ and the voltage

* Translation in abstract of an article by R. Elsässer in *Elektrotechnische Zeitschrift* for March 3, 1904.

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on the direct-current side $E_g$. A two-polar field will be considered throughout. The direct current per armature path is then $c$. If $\gamma$ is the angle subtended by the connections of one phase stated as a fraction of the pole-pitch, $k$ the E.M F. factor, $e'_w$ the effective E.M F. per phase:

$$e'_w = k \times \tfrac{1}{2} \times \gamma \times E_g \quad . \quad . \quad . \quad . \quad . \quad (1)$$

But for a single-phase circuit $\gamma = 1$, so $e'_w = \frac{1}{2} k_2 E_g$
for a three-phase circuit $\gamma = \frac{2}{3}$, so $e'_w = \frac{1}{3} k_3 E_g$
for a six-phase circuit $\gamma = \frac{1}{3}$, so $e'_w = \frac{1}{6} k_6 E_g$

Assuming a sine wave of current, the amplitude of the alternating current is $J_w = \sqrt{2} \cdot i'_w$, where $i'_w$ is the effective value of the alternating current. In order to produce $c$, a watt component, $i'_n$, is required, the direct-current output, $2 c E_g$, corresponding to an alternate-current input of $x \cdot i'_n \cdot e'_w$, where $x$ = the number of phases. Or, generally,

$$i'_n = \frac{2}{k_x} c$$

and

$$J_n = \frac{2\sqrt{2}}{k_x} c = \eta c \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(Kapp, "Dynamomaschinen," p. 452).

An addition must be made to this watt component for the current keeping the rotary in motion and supplying the losses. This addition for a given load may be stated as $q \cdot \eta \cdot c$, so that the total power current per phase will be

$$J_n = \eta \cdot c + q \cdot \eta \cdot c = \rho \cdot c \quad . \quad . \quad . \quad . \quad (3)$$

If a phase displacement exists between E.M.F. and current, the amplitude of the current per phase will be

$$J\,\phi = \frac{J_n}{\cos\phi} = \rho \cdot c \cdot \frac{1}{\cos\phi} \quad . \quad . \quad . \quad . \quad (4)$$

Let $\omega$ be the resistance of the armature per unit length of arc (unit arc being 57° 17′ 44·8″), the resistance per pole pitch will then be $\pi \cdot \omega$, and for any angle $a$ degrees it will be $a_b \times \omega$ when $a_b$ is the length of arc corresponding to $a$ degrees. The alternating current, as motor current, acts in opposition to the direct current of one armature side during the greater part of a period, and as the instantaneous values add up algebraically it is only the instantaneous difference which is actually set up.

For calculation purposes, however, both currents can be considered independently. Only one half of the armature need be dealt with, as the other half is simply a repetition with altered sign. The brushes will be assumed to be in the neutral position. Any shifting of the brushes has much the same effect as an equal displacement, in the reverse direction, of the alternating-current vector, and so need not be separately considered.

## I.—Single-Phase Rotary Converters.

Converters for ordinary single-phase currents may be considered as working with two phases whose current and

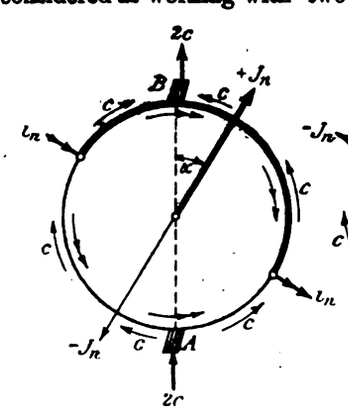

Fig. 1.

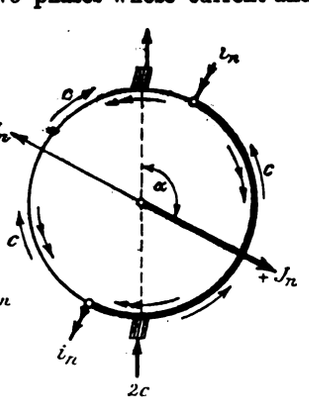

Fig. 2.

voltage vectors are displaced by 180deg; the conductors of each phase extend over a whole pole-pitch. The neutral line is also the time axis.

(*a*) *Voltage Drop on the Continuous-Current Side.*—A voltage drop equal to $c \cdot \omega \cdot \pi$ occurs between A and B (Fig. 1) in the direction from A to B. The drop due to $(-) J_n$ is in the same direction, whilst that due to $(+) J_n$ is in the opposite direction. It will be seen from Figs. 1 and 2 that two main divisions must be considered—one from $a = 0$deg. to $a = 90$deg., and the other from $a = 90$deg. to $a = 180$deg.

For the angle $(J_w, E_w) = \phi = 0$, the following equations may be obtained:

When $a = 0$deg. to 90deg. or 180deg. to 270deg. the voltage drop =

$$e_{vg} = c\,\omega\,\pi - \rho_2 \cdot c \cdot \sin\,a \cdot \omega \left(\frac{\pi}{2} + a_b\right) - \rho_2\, c \sin\,(a+\pi)\,\omega \left(\frac{\pi}{2} - a\right)$$

$$e_{vg} = c\,\omega\,\pi \left(1 - \rho_2 \sin\,a\,\frac{2\,a_b}{\pi}\right) \quad . \quad . \quad . \quad (5)$$

When $a = 90$deg. to 180deg. or 270deg. to 360deg.

$$e_{vg} = c \cdot \omega \cdot \pi - \rho_2\ c \cdot \sin\,a \cdot \omega \cdot \left(\frac{3}{2}\,\pi - a_b\right) - \rho_2 \cdot c \cdot \sin\,(a+\pi) \cdot \omega \cdot \left(a_b - \frac{\pi}{2}\right)$$

$$e_{vg} = c \cdot \omega \cdot \pi \left(1 - \rho_2 \sin\,a \cdot 2 \cdot \left(1 - \frac{a_b}{\pi}\right)\right) \quad . \quad (6)$$

$c \cdot \omega \cdot \pi$ is the voltage drop which would occur if the machine were working as a direct-current generator.

The expression within the bracket reaches a maximum value—viz., 1—for the angles $a = 0$deg., 180deg., and 360deg., and a minimum value, viz. $(1 - \rho_2)$, for $a = 90$deg. and 270deg. The superposed pulsating voltage, therefore, has a periodicity double that of the alternate-current supply. Since $\rho_2$ is always greater than 1, the average voltage drop is decidedly smaller than $c \cdot \omega \cdot \pi$, and twice during each period of the alternate-current supply a voltage rise occurs on the direct-current side. The value of the total voltage difference is dependent not only on the current, but also on the relative width of pole, $a_p$. Thus

| $a_p =$ | ·5 | ·6 | ·666 | ·7 | ·75 | ·8 |
|---|---|---|---|---|---|---|
| $K_2 =$ | 1·635 | 1·55 | 1 495 | 1 46 | 1·415 | 1·365 |
| $\eta_2 =$ | 1·73 | 1·825 | 1 892 | 1 94 | 2 0 | 2 072 |

The values of $K_2$ are calculated by formulæ given by Prof. Ossanna, and differ somewhat from Kapp's values. The total voltage difference is consequently greater, the greater the relative pole width—*i.e.*, width of the rectangular flux curve with no flux in the interpolar gaps—is made. $\rho_2$ is determined from $\eta_2$ by formula (3). Fig. 3 shows the values obtained by formulæ (5) and (6) for the different positions of the armature, assuming that $\rho_2 = 2$ and $c \cdot \omega \cdot \pi = 1$. Here the maximum voltage difference is seen to be twice as great as the drop of the direct-current machine The curves have sinusoidal tops, but form a sharp cusp at the lower extremities. The area above the zero line is decidedly greater than that below.

It is also of interest to consider the voltage drop on the direct-current side at no load—*i.e.*, when $c = 0$. In this

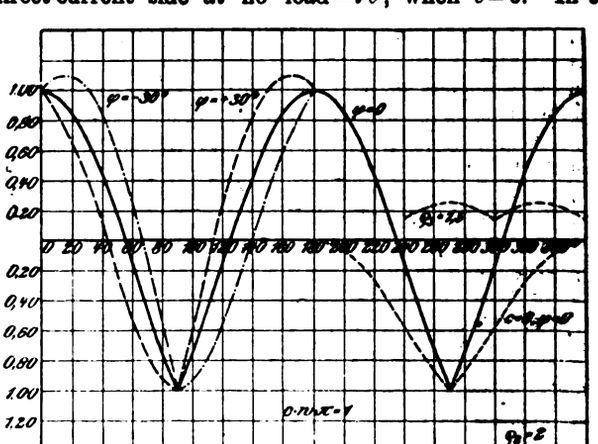

Fig. 3.—Single-Phase Transformer, Direct-Current Side.

case $J_o$ is inserted in place of $\rho_2 c$, and then for $a = 0$deg. to 90deg., 180deg. to 270deg. the voltage drop =

$$e_{vo} = J_o \cdot \omega \cdot \pi \left(-\frac{2}{\pi} \cdot a_b \cdot \sin\,a\right) \quad . \quad . \quad (7a)$$

For $a = 90$deg. to 180deg., or 270deg. to 360deg.,

$$e_{vo} = J_o \cdot \omega \cdot \pi \left(2 \cdot \sin\,a\left(\frac{a_b}{\pi} - 1\right)\right) \quad . \quad . \quad (7b)$$

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Here also a pulsating voltage rise exists having a periodicity twice that of the alternate-current supply. The curve is shown in Fig. 3 for $J_o \cdot \omega \cdot \pi = 1$, and has exactly the same characteristics as the curve with load, but varies between 0 and $(-J_o \cdot \omega \cdot c)$. When an internal phase displacement between $E\omega$ and $J\omega$ equal to $\pm\phi$ exists, the instantaneous value of the alternating current becomes:

$$i_{ic} = \rho \cdot c \cdot \frac{1}{\cos\phi} \sin(\alpha \pm \phi)$$
$$= \rho_2 \cdot c \cdot (\sin\alpha \pm \tan\phi \cdot \cos\alpha).$$

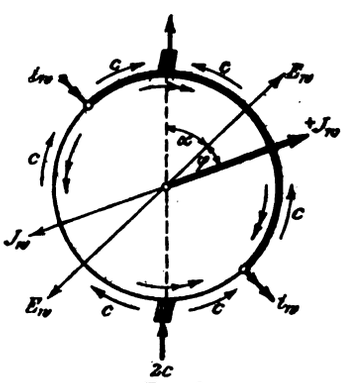

FIG. 4.

So that for $\alpha = 0$deg. to 90deg.

$$e'_{vg} = c \cdot \omega \cdot \pi \left(1 - \rho_2 (\sin\alpha \pm \tan\phi \cos\alpha)\left(\frac{2}{\pi} \cdot a_b\right)\right) \quad (8a)$$

and for $\alpha = 90$deg. to 180deg.

$$e'_{vg} = c \cdot \omega \cdot \pi \left(1 - \rho_2 (\sin\alpha \pm \tan\phi \cdot \cos\alpha) \cdot 2 \cdot \left(1 - \frac{a_b}{\pi}\right)\right) (8b)$$

(see Fig. 4). The maximum value of the voltage drop changes rapidly both in amount and in phase displacement with increasing $\phi$. The curves for $\phi = +30$deg. and $\phi = -30$deg. are shown in Fig. 3. The shape of curve is not much affected, nor is the value of the total voltage difference ($\pm\frac{1}{2}$ per cent.).

(*b*) *Voltage Drop on the Alternate-Current Side.*—Assuming that the direct current is constant, which is quite allowable as the small fluctuations dealt with above may be neglected, the voltage drop on the alternating side for no internal phase displacement and $\alpha = 0$deg. to 90deg. is

$$e\phi = \rho_2 \cdot c \cdot \sin\alpha \cdot \omega \cdot \pi - c\omega \times \left(\frac{\pi}{2} + \alpha\right) + c \cdot \omega \left(\frac{\pi}{2} - \alpha\right)$$
$$= c \cdot \omega \cdot \pi \left(\rho_2 \sin\alpha - 2\frac{a_b}{\pi}\right) \quad . \quad . \quad . \quad (9a)$$

and for $\alpha = 90$deg. to 180deg.

$$e\phi = c\omega\pi \left(\rho_2 \sin\alpha - 2\left(1 - \frac{a_b}{\pi}\right)\right) \quad . \quad . \quad (9b)$$

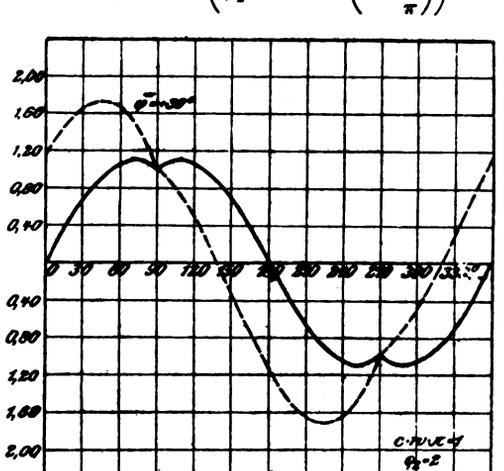

FIG. 5.—Single-Phase Converter, Alternate-Current Side.

The values of $e\phi$ are positive from 0deg. to 180deg., are zero for values of $\alpha = 0$deg. and 180deg., and follow the same equation, but with negative sign, between 180deg. and 360deg. The voltage drop on the alternating side, therefore, has the same phase and periodicity as the alternating supply. Fig. 5 shows the curve for $\rho_2 = 2$, from which it is clear that the voltage drop is about half what it would be if the machine were used as an alternate-current generator or motor. The curve has two maxima in the positive and negative portions, and at 90deg. and 270deg. it has sharp cusps. The curve for $\phi = +30$deg. is also shown in Fig. 5. The equations for phase displacement are analogous to those obtained above. The drop is in all cases decidedly smaller than that of the same synchronous motor.

## II.—THREE-PHASE CONVERTERS.

In this case, as shown in Figs. 6 to 8, the winding may be

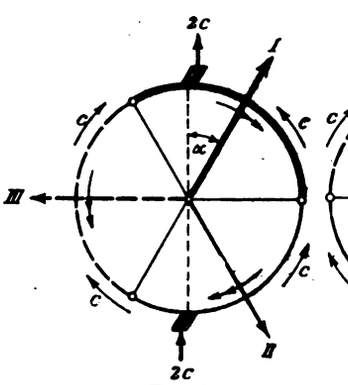

FIG. 6.

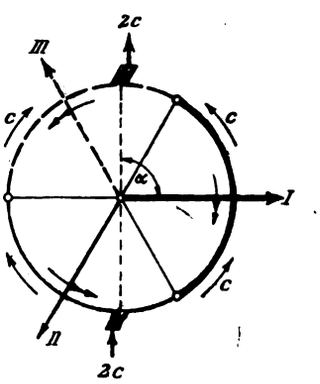

FIG. 7.

divided into three portions: $\alpha = 0$deg. to 60deg., $\alpha = 60$deg. to 120deg, and $\alpha = 120$deg. to 180deg. Proceeding as above, a series of equations may be developed showing that the voltage drop on the direct-current side reaches

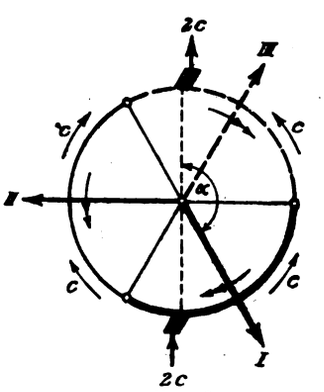

FIG. 8.

minimum values equal to $c \cdot \omega \cdot \pi \left(1 - \frac{\sqrt{3}}{3}\rho_3\right)$ for armature positions of $\alpha = 0$, 60, 120, 180, 240, 300, 360 degrees, and maximum values of $c \cdot \omega \cdot \pi (1 - \frac{1}{2}\rho_3)$ at $\alpha = 30$, 90, 150, 210, 270, and 330 degrees. The superposed pulsating voltage, therefore, has a frequency six times as great as that of the alternating supply, and has a minimum value whenever one of the three phases falls to zero current, and a maximum value when the current of any phase rises to a maximum.

Unlike the single-phase converter, the voltage drop in

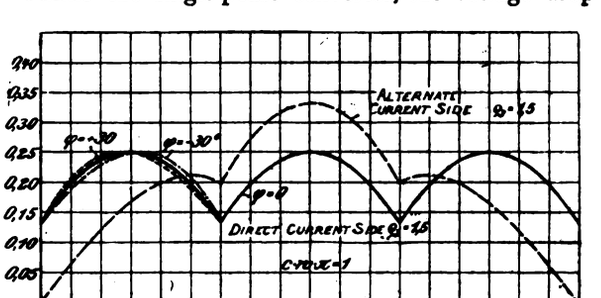

FIG. 9.—Three-Phase Converter.

the three-phase converter is always positive, though it is still only dependent on the load and the relative width of pole. The curves in Fig. 9 are drawn on the assumption of $\rho_3 = 1.5$, which corresponds to about the same width of pole as that used for the single-phase curves. It will be seen that the drop is only a fraction of that of the same

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direct-current generator (in this case it reaches a maximum that $\frac{1}{4} c.\omega.\pi$), and that the total voltage difference is also very much reduced (for $\rho_3 = 1{\cdot}5$ it is about $\frac{1}{10} c.\omega.\pi$). If the direct-current side is on open circuit ($c = 0$), the drop due to the no-load current, $J_{o1}$ acts on the direct-current side as a voltage rise. For the machine in question the maximum rise would be $-J_o\omega.\pi.{\cdot}866$, and the minimum $-J_o.\omega.\pi.{\cdot}75$. Phase displacement is shown in Fig. 9 to have principally a distorting effect, the increase in drop being insignificant. The effect of $\phi = \pm 30$ is shown by the dotted lines in Fig. 9 The drop on the alternate-current side can again be shown to have the same periodicity as, and to be in phase with, the alternate-current supply. The amount of this drop is also much less than that of the machine as an alternating motor, as shown by the curve in Fig. 9.

### III.—Six-Phase Converters.

In the case of the six-phase converter, it is only necessary to consider the portion of the armature period from

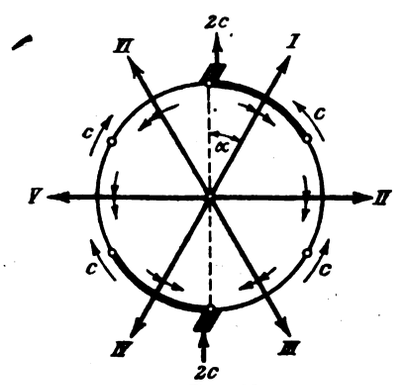


Fig. 10.

$\alpha = 0$ to $\alpha = 90$deg., dividing it into two parts: $\alpha = 0$deg. to 30deg., and $\alpha = 30$deg. to 90deg., and the equations show that the voltage drop on the direct-current side reaches maximum values equal to $c.\omega.\pi\left(1 - \frac{\sqrt{3}}{3}\rho_6\right)$ for the armature positions $\alpha = 0$deg., 60deg., (120deg., 180deg. . . .), and minimum values equal to $c.\omega.\pi\left(1 - \frac{2}{3}\rho_6\right)$ for the armature's positions $\alpha = 30$deg., 90deg. (150deg. . . . .) The position of the pulsations will be seen to be displaced by 30deg. in phase relatively to the corresponding waves of the three-phase converter, which can be understood by an examination of Fig. 10, but the amount of the pulsations is alike in both cases, as shown in Fig. 11. On the alternate-current side the equations show that an actual rise in voltage occurs, but it is of small amount, as shown in Fig. 11.

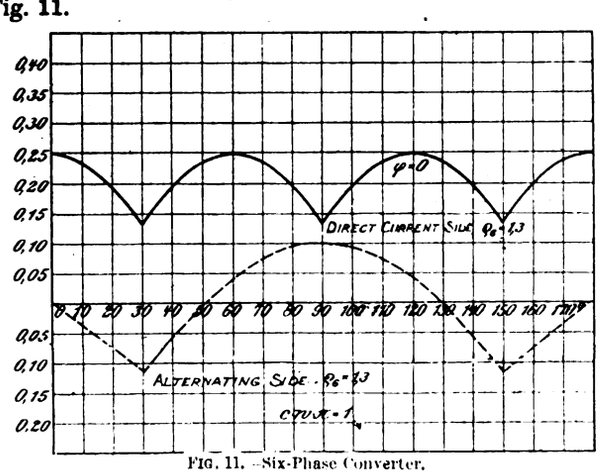


Fig. 11.—Six-Phase Converter.

The conclusions arrived at by the above investigation are, therefore:

1. That every rotary converter under all conditions produces a pulsating voltage on the direct-current side directly due to the superposition of the ohmic drops of the direct and alternating currents. Other causes of pulsation are only subsidiary.

2. The frequency of this pulsation is twice as great as the supply frequency in the single-phase converter, and six times as great in the three-phase or six-phase converter.

3. In multiphase converters the drop remains always positive, and is only a fraction of the ohmic drop of the same machine used as a direct-current generator. In the single-phase converter, the voltage drop becomes negative twice in each armature period. The difference between the greatest and least voltages is several times as great as the drop of the same machine used as a direct-current generator.

4. The amplitude of the pulsations depends on the load and the pole-form of the machine.

5. Even on open (direct-current side) circuit voltage pulsations occur, so that the true voltage ratio of the converter cannot be obtained by measurement of the terminal voltages on open circuit.

A short consideration of recent experiments on the subject will be of interest. Differences in the results obtained by different investigators—*e.g.*, Prof. Banti and Mr. E. Cramer—may be put down to differences in the general design of the machines employed. Thus the question of armature resistance is of great importance, and a machine designed as a rotary converter would naturally have a higher armature resistance (on account of the lower losses occurring) than a standard direct-current machine of the same output used as a temporary converter. The former machine would consequently show considerably greater voltage differences than the latter. The fact that Mr. Cramer failed to notice any pulsations with the three-phase connection will be easily understood by an inspection of Fig. 3, in which the curves of a single-phase machine and a three-phase machine of the same size are shown together. In the case of Mr. Field's machine, it was probably only a coincidence that the frequency of the pulsations corresponded with the number of armature teeth, for the generator curve is strongly indented, and the curves of ohmic drop would, therefore, be similarly indented, giving rise to two periods per pole and phase. The difference in behaviour observed when loaded on accumulators and when loaded on resistances may, perhaps, be explained as follows. When working on a resistance load the whole voltage is absorbed as a resistance drop, and the pulsating voltage drop, therefore, forms only a small percentage of the total; on the other hand, with a battery, by far the greater part of the voltage is balanced by the back E.M.F. of the cells, and the pulsating drop forms a very large percentage of the resultant working voltage. Consequently the current pulsates decidedly, almost following the form of the voltage curve. During each armature period, therefore, decidedly different current strengths occur, and, since with constant excitation on a synchronous motor changes of current correspond to changes of armature phase (or position in space relatively to the generator), it follows that positive and negative driving torques must occur. Under favourable conditions these can set up swinging and changes of angular velocity, which may eventually throw the machine out of step. The occurrence of irregular angular velocity on open circuit in the case of Mr. Cramer's machine is open to doubt.

## NEW COMMITTEES.

The following new committees have been appointed:

Acton.—*Electricity*: Messrs. Ainsley, Baldwin, Morris, Jarratt, Poulton, Bulleo, Cronin, and King.

Beckenham.—*Electric Lighting and Tramways*: The whole of the members of the Council.

Birkdale.—*Electricity, Lighting, and Licensing*: Councillors W. H. Hayes (chairman), Broderick, Stephen, Whiteley, Buck, Houldsworth, Rushworth, and Stowe, with the chairman and vice-chairman.

East Barnet Valley.—*Highways and General Purposes*: all members. *Lighting*: all members. *Light Railways*: Councillors Bowden, Gilson, Wood, Plowright, Stutters, Stringer, and the chairman.

Newton—*Lighting*: Messrs. J. Chudleigh, S. Hacker, G. H. Hearder, W. H. Holman, H. Mills, A. J. Murrin, H. T. Parker, A Sampson, and W. R. Vicary.

Weston super Mare—*Baths and Lighting*: Messrs. Biggs, Board, Clark, Dubin Fellard, Hurst Norman, Pate ..., Rider and Watkin. *Tramways*: As before, with the addition of Mr. Nevile in place of Mr. Pickles, with M. France as chairman. *Electricity*: the whole of the member, with Mr. Bouchier as chairman.

Whitby.—*Electric Lighting*. The whole of the Council.

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## TRADE NOTICES AND NOVELTIES.

### Sugden's Patent Superheater.

Accompanying are illustrations of a superheater for Lancashire, Cornish, and dry-back boilers, which has been patented and introduced by Messrs. T. Sugden, Limited, 180, Fleet-street, London, E.C. Fig. 1 shows the superheater isolated

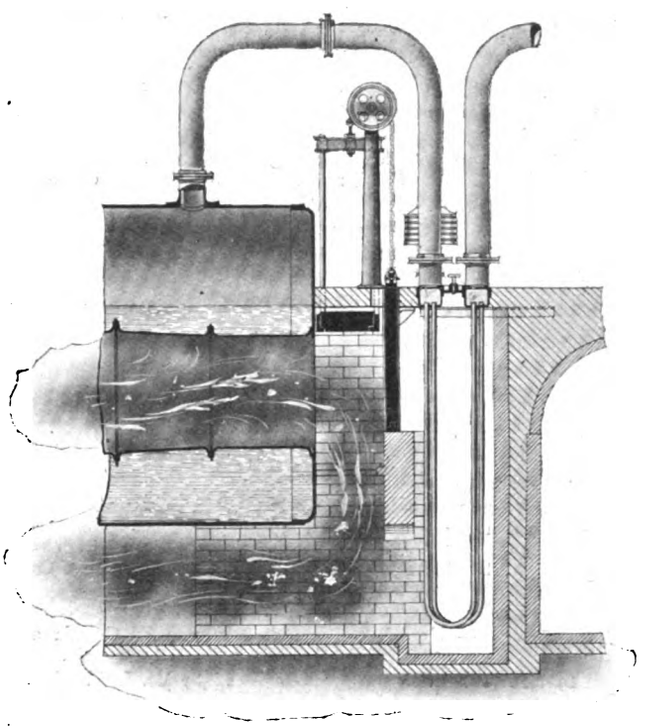


FIG. 1.—Superheater Isolated.

when steam is first being raised in the boiler, and Fig. 2 shows it at work. It will be seen that by means of balanced dampers the superheater may be cut out or put in operation at will. By adjusting the position of these dampers the degree of superheat can be controlled. The dampers are constructed of firebricks or slabs, fitted in iron frames, which are well protected from

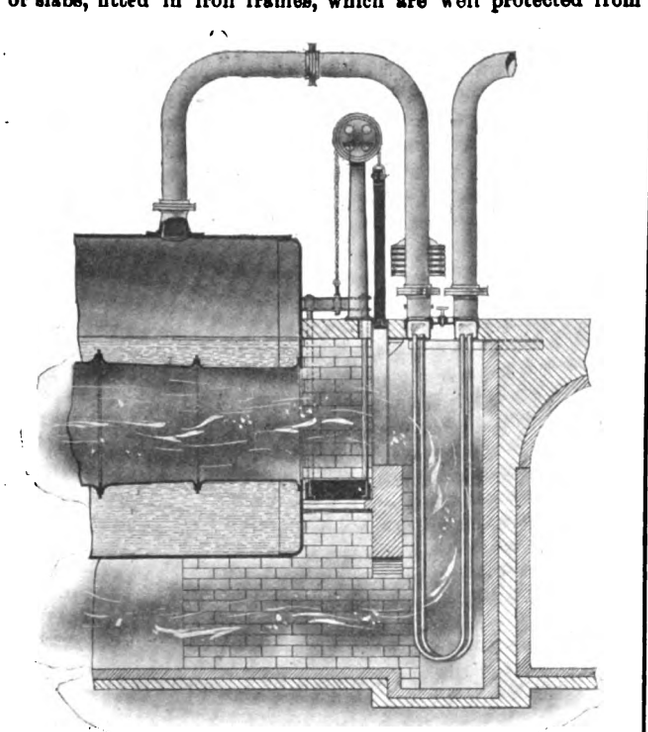
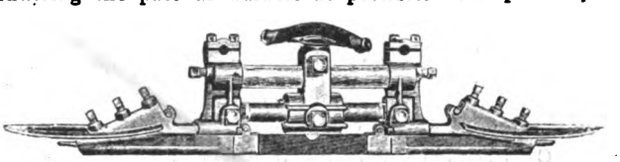


FIG. 2.—Superheater at Work.

the heat. Steam from the boiler enters the inlet box or header, and is distributed equally amongst the bent tubes, through which it passes to the outlet box or header, which is connected to the steam-main. The rectangular boxes or headers are made of steel of strong section, into which the bent tubes are expanded. A handhole cap is placed opposite the end of each tube. Cleaning doors are also arranged between the headers, which admit of the tubes being cleaned by means of a wire brush or steam jet whilst the superheater is at work. The usual brick division wall can be built in the downtake to prevent any injury to the joints and fittings due to vibration of the boiler. Moreover, the heating surface of the superheater can be proportioned within certain limits to give the desired degree of superheat. The advantages obtained with the arrangement described should gain this superheater considerable favour.

### A New Section Insulator.

The section insulator illustrated herewith is of a type recently introduced by Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C. This insulator combines the following among other advantages: The terminals which hold the trolley wire at either end of the device may be detached from the body or central portion and renewed, if necessary, without removing the body from the line. These terminals are easily attached or detached by means of an interlocking device, and are provided with horizontal flanges at the points where the trolley wheel leaves the wire. The wheel rides on these flanges over the joint between trolley wire and the section insulator terminal so that the extremely hard wear to which the trolley wire is usually subjected at point of entrance to section insulator is entirely avoided. The trolley wire is fastened to the terminals in such a manner that the few inches of wire coming outside each rigid end clamp is provided with a reinforcement to counteract the tendency to crystallisation of the wire at the clamping point. In putting up the section insulator, the process may be facilitated by separating the terminals from the body, fastening them to ends of trolley wire, hanging the centre part in position on the span wire, then pulling up the trolley wire with terminals attached and locking them on to the body. When, as a result of repairs, the trolley wire ends have been cut at the place occupied by a section insulator, and it is necessary or desirable to use a longer section insulator to fill in the gap, special long terminals may be substituted for those of the regular length, and the whole device thus lengthened out. The renewable strip is of lignum vitæ, and provided with auxiliary terminals, which take whatever sparking occurs at these points, rendering the part as durable as possible. Clamps are pro-



New Section Insulator.

vided for attaching side feeds in such a manner that when the same feed wire is used for feeding two trolley wires it is only necessary to strip the feed wire at exactly the points clamped. The insulating strip, which is found to give out first in use, is renewable, and easily slipped into position without charging any other parts or removing any screws. It is adapted to either round or grooved trolley wire. Hence it is claimed that the insulator saves the trolley wire, the linesman's time, and contributes to the general permanence, safety, and economy of the line.

## ST. MARYLEBONE LIGHTING.

The following offers from the Metropolitan Electric Supply Company were considered by the Borough Council of St. Marylebone yesterday. The offers are dated April 19, 1904, and signed by the secretary of the company:

*Supply of Current in Bulk.*—In consideration of the Council taking from the company the whole of the current required in the borough the company are prepared to accept the price of ¾d. per unit for the quantity supplied in excess of that represented by two hours' average daily supply during each quarter of the maximum demand made upon the company in the quarter, the said two hours' average daily supply being charged at 3d. per unit, the average price of the whole of the current supplied in any one year not to exceed 1·70d. per unit. My directors believe this scale of charges will under existing conditions work out to a lower rate than 1·70d. per unit, and if the Council considerably increase their motor and street-lighting loads, and provide storage batteries sufficient to take a reasonable proportion of the peak, the average charge should not be more than about 1·40d. The supply to be given for a period of 27 years from Jan. 1, 1905, with the right to either party of claiming a revision of price at the end of nine and eighteen years, the revised price to be settled, failing agreement, by arbitration in the manner provided in the agreement of May 8, 1901. As part of this arrangement the company will be prepared, if required, to provide and fit up in any sub-station to be erected by the Council in St. John's

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Wood, or in the existing generating stations at Manchester-square or Rathbone-place (if the Council remove the steam plant and adapt those stations for transforming purposes), such motor-generators as the Council may require, together with all necessary switchgear, balancers, starting machines, cable connections, and travellers, for the sum of £7. 10s. per kilowatt. In this way the contemplated outlay by the Council of from £280 000 to £300,000 on a 9,000-kw. generating station, with the necessary machinery and trunk mains, would be reduced to £41,000 for all the additions necessary to bring up the capacity of the existing transforming plant in the borough to 9,000 kw., subject only to the cost of altering the present buildings. No estimate of that cost has been made, but it cannot be much, especially after giving credit for the value of the existing steam plant. If desired, the directors will have plans prepared, and name an inclusive sum for which they will undertake to alter as well as equip these two stations, in which sum will also be included, if the Council wish it, the cost of erecting a sub-station in St. John's Wood on a site to be provided by the Council.

*Lease of the Marylebone Undertaking.*—As an alternative to the offer of a bulk supply, my directors are prepared to accept a lease for the same period of 27 years on terms which will relieve the Council of all charges for interest and sinking fund (except in respect of costs) which will devolve upon them during the currency of the lease under the pending Bill as amended in Committee of the House of Commons, subject to the company having power at any time to terminate the lease on two years' notice in the event of another order being granted and confirmed by Parliament. These charges my directors understand to be: (1) interest, at a rate to be agreed, on £1,212,000 payable under the award, and on capital expenditure in 1902, 1903, and 1904, estimated at £150,000; (2) sinking fund on a 3 per cent. basis in respect of the above-mentioned sums, repayable in 35 years from Jan. 1, 1908.

The directors are strongly of opinion that the costs of the arbitration should not be capitalised and that each party should bear its own costs. They are, therefore, prepared to return to the Council the amount which has been paid to them under taxation. The company would also provide all the capital required for the business in Marylebone during the lease, subject to repayment on its termination less 1¼ per cent. per annum from the several dates of expenditure. As bearing upon the question of depreciation, it must be borne in mind that the plant which depreciates most—the steam generating plant—is outside the area, and will be maintained at the sole expense of the company.

These offers were considered both by the consulting engineer to the Corporation (Mr. Arthur Wright) and by Messrs. Price, Waterhouse, and Co., and reported on as commercially unacceptable. The Electric Supply Committee accordingly passed the following resolution, which was to be considered by the full Council yesterday: "Resolved that the Council be recommended to authorise the expenditure during the next two years of £400,000, exclusive of the cost of site, for the purpose of erecting a generating station, and purchasing the necessary plant and machinery, and for the finishing of the conversion to a continuous-current supply of the districts not yet completed by the Metropolitan Electric Supply Company, Limited, provided that the sum can be raised by loan."

The reasons for the above decision are as follows: The committee are advised that they can produce the electrical energy more cheaply than is equivalent to the supply in bulk at above rates. They object to be bound to take a supply in bulk for 27 years. As regards the leasing for the undertaking, parliamentary powers would have to be obtained. The terms of the offer for leasing only provide for the repayment of £775,000 during the period of the lease, and the Council would have to accumulate the remaining £500,000, as well as the then value of the additional expenditure by the company during the period of 27 years.

The following extract from Mr. Wright's report on the cost of the unit is of interest generally: "From a reference to the late arbitration proceedings, it will be seen that under even the ideal conditions assumed only 85 per cent. of the electricity bought could be converted ready for distribution from the sub-station, and that only 84 per cent. of this latter quantity could be sold to the consumers. The offer for the bulk supply at 1·7d. per unit therefore really means a cost of 2·38d. per unit sold exclusive of the cost of distribution, administration, and mains repairs, all of which, being common to both systems, may be taken at the figure adopted during the arbitration—viz., ½d. per unit. To these items of cost must be added at least another one-ninth of a penny to cover the wages of the necessary men at the sub-station, and the repairs (other than depreciation) of the 12,000 h.p. of converting machinery and elaborate high-tension switchgear required for the load. The total cost per unit sold, therefore, under the ideal assumed conditions is thus brought up to practically 3d. per unit, or 1d. more than the estimated outside cost on the Borough Council's scheme for the year of 1910." He proceeds to show that this 1d. per unit, if capitalised at 6·4 per cent. for interest, sinking fund, and depreciation, would in 1910 represent £585,000, which is much more than the capital expenditure for providing an independent generating station.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 29.

**Institution of Civil Engineers.**—At 11 a.m., students' visit to the works in progress at the new thoroughfare between Holborn and the Strand.

**Royal Institution.**—At 9 p.m., the Dean of Westminster on "Westminster Abbey in the Early Part of the Seventeenth Century."

**Junior Institution of Engineers.**—At 6.30 p.m., visit at the Caseland Higher-Grade Board School, Wells-street, Hackney, to inspect the ventilating and heating systems.

SATURDAY, APRIL 30.

**Royal Institution.**—At 3 p.m., Mr. Cyril Davenport, F.S.A., on "Jewellery" (III.).

**Manchester Association of Engineers.**—Visit to Northwich on inspection of the River Weaver mechanical and electrical arrangements. "Inland Navigation," by Mr. Sauer (provisional).

**Institution of Electrical Engineers.**—At 10 a.m., students' visit to the Western Electric Company, North Woolwich.

MONDAY, MAY 2.

**Society of Arts.**—At 4.30 p.m., Cantor Lecture: "The Majolica and Glazed Earthenware of Tuscany," by Prof. R. Langton Douglas (Lecture II.).

**Society of Engineers.**—Jubilee meeting. Mr. Percy F. Nursey, past-president and secretary, will give a historical sketch of the society, entitled "A Jubilee Retrospect," and a paper will be read by Mr. A. S. E. Ackerman on "British and American Coal-Cutting Machines."

TUESDAY, MAY 3.

**Society of Arts.**—Colonial Section: at 4.30 p.m., "Canada and Great Britain," by Mr. W. L. Griffith.

**Royal Institution.**—At 5 p.m., "Meteorites," by Mr. L. Fletcher.

WEDNESDAY, MAY 4.

**Institution of Electrical Engineers.**—At 7.30 p.m., students' meeting, "Alternating Current Commutator Motors," by Mr. F. Creedy.

**Society of Arts.**—At 8 p.m., "Statistics of the World's Iron and Steel Industries," by Mr. William Pollard Digby.

THURSDAY, MAY 5.

**Institution of Electrical Engineers.**—At 2.30 p.m., students' visit to the Electrical Power Storage Company, Millwall E.

**Rontgen Society.**—At 5.30 p.m., "Three Years' X-Ray Work," by Dr. L. Herschell Harris; "The Röntgen Society—its Past Work and Future Prospects," by Mr. J. J. Vezey; "Some Experiments with Alpha Rays," by Mr. F. H. Glew.

**Iron and Steel Institute.**—At 10.30 a.m., annual meeting.

**Royal Institution.**—At 5 p.m., "Great Britain and Europe (1763-1793)," by Mr. S. Hassall.

FRIDAY, MAY 6.

**Junior Institution of Engineers.**—At 8 p.m., "The Design of a Dry Dock," by Mr. A. W. Young, member.

**Tramways and Light Railways Association.**—At 8 p.m., at the Society of Arts, discussion on "Running Powers," introduced by Mr. Thos. W. How.

**Iron and Steel Institute.**—At 10.30 a.m., annual meeting (continued). At 7 p.m., annual dinner, Hotel Cecil.

**Physical Society.**—At 7.45 p.m., council meeting. At 8 p.m., "An Experiment with Lubricating Oil," by Mr. W. A. Price. "Some Instruments for the Measurement of Large and Small Alternating Currents," by Mr. W. Duddell; and an exhibition of Apparatus from the National Physical Laboratories (date changed from May 13).

**Royal Institution.**—At 9 p.m., "Anthropoid Apes," by Dr. P. C. Mitchell.

**South-Western Polytechnic, Chelsea, S.W.**—Distribution of prizes by Lord Cadogan, K.G.

**Association of Municipal Engineers.**—At Newcastle, general meeting.

SATURDAY, MAY 7.

**Royal Institution.**—At 3 p.m., "Sonata Style and the Sonata Forms," by Mr. Donald F. Tovey.

**South-Western Polytechnic.**—At 7.10 p.m., conversazione, lectures, and demonstrations.

**Association of Municipal Engineers.**—At Newcastle, general meeting.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Buxton, May 20 and 21.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

**Institution of Mechanical Engineers.**—Chicago Meeting, May 31 to June 3.

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# LEGAL INTELLIGENCE.

## MAXWELL v. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED.

This case was decided by Mr. Justice Kennedy last week. Mr. Roskill, K.C., and Mr. Horace Marshall appeared for the Thomson-Houston Company, and Mr. Scott-Fox, K.C., and Mr. Bairstow represented the other parties, Messrs. Robert W. Blackwell and Co., Limited. The action was originally tried before his lordship and a jury at the Leeds Assizes in 1901. The plaintiff, Miss Agnes Maxwell, of Halton, near Leeds, was, in June, 1899, travelling on the outside of a horse tramcar along Cookridge-street, Leeds, while the trolley wires and overhead installation were being executed for the electric tramways by workmen employed by Messrs. Blackwell. These workmen allowed an iron rod to project out, and this caught the plaintiff under the chin and seriously injured her. At the trial there was a great contest as to who was liable, the Thomson-Houston Company having contracted with the Corporation to do this work, and having engaged Messrs. Blackwell as sub-contractors. In the result the Thomson-Houston Company were held liable to pay £850 damages and costs to the plaintiff. They appealed, and the Court of Appeal upheld the judgment. The Thomson-Houston Company, having brought in Messrs. Blackwell as third parties, now alleged that they, as sub-contractors, were bound to indemnify them in respect of this judgment. After considerable agument his Lordship came to the conclusion that Messrs. Blackwell were under a contract of indemnity to the British Thomson-Houston Company, and he gave judgment accordingly for £850, with the whole costs of the action except the costs of the appeal. Stay of execution was granted on the usual terms.

## SMOKE FROM ELECTRIC LIGHT GENERATING STATION.

The Wellingborough justices dealt last Friday with a charge against the County of Northampton Electric Power and Traction Company, Limited, of committing a breach of the Public Health Act.

**Mr. Parker,** on behalf of the Wellingborough Urban District Council, stated that smoke issued from works in the occupation of the defendants so as to become a nuisance and be injurious to health. The chimney belonged to the Urban District Council, and had been used for the refuse destructor works. It was so used for a year before the defendant company entered on their premises, but then there was no black or injurious smoke. Now the black smoke always came just before the time for lighting up by the electric company.

The **Council's Inspector** stated in the course of his evidence that he thought it was possible for people to suffer from the smoke 60ft. below the shaft. He did not say the shaft was from 90ft. to 100ft. high, and did not think it was the highest in the town. There was a long flue into the chimney from the Council's destructor works, but this was under control, so that only white smoke went into the chimney. The witness said that the average height of the houses round the works was 24ft. or 25ft., but still held that a nuisance could be created.

**John James Patrick,** foreman to the Council, and **Thomas Radley,** another fireman, gave corroborative evidence, and medical evidence was also given as to the injuriousness of the smoke.

**Mr. Archer,** on behalf of the defendants, pointed out that the Council were owners of the chimney, and, as the agreement showed, had joint control of the flue. If any nuisance was caused, the Council were liable.

**Henry James Nesbitt,** managing engineer for the defendant company, said the chimney stack was not under the control of the company. He understood that under the original agreement they were to get all their power from the dust destructor plant. Under the second agreement the Council's destructor was to supply steam to the defendant company sufficient to work their machinery. The smoke was to an extent from the destructor works, and also from the boilers of the company. There was no nuisance of any kind.

Other evidence having been given for the defence, the Bench decided the nuisance had been proved, and fined the company £3.

# COMPANIES' MEETINGS AND REPORTS

## ORIENTAL TELEPHONE.

The tenth ordinary general meeting of the shareholders of the Oriental Telephone and Electric Company, Limited, was held on the 27th inst. at the Great Eastern Hotel, Sir Auckland Colvin, K.C.S.I. (chairman of the Company), presiding.

The **Chairman** said that the year under review again showed a steady progress at all the branches as well as in the subsidiary companies. This progress was most noticeable in Egypt, Rangoon, and Singapore. Larger receipts might be expected from Egypt this year when fresh installations, which have been in hand for some time, will be completed. The Company's operations in Egypt are of three kinds—the exchanges in Cairo and Alexandria and other minor towns; the trunk line between Cairo and Alexandria, which was opened last year, which has been erected and is maintained by the Egyptian Government, and leased provisionally to the Company for a term of two years, expiring on April 30, 1905, when the terms of the lease are open to reconsideration, and finally, what are known as provincial lines. These lines connect the centres of the Government Administration in the provinces with various sub-centres indicated by the Government. They are erected by the Company, and leased annually to the Egyptian Government for terms of 25 years from the date of their being handed over in working condition to the Egyptian Government. These lines, as at present approved by the Egyptian Government, cover 3,500 miles, and the chairman understood that the Company was about to receive a further order for a considerable fresh extension. In Hong Kong, also, business is extending rapidly, and in that city cable construction, partly underground, will have to be carried out. In the seven cities of Calcutta, Bombay, Madras, Rangoon, Moulmein, Singapore, and Hong Kong, metallic circuiting by underground cables has to be carried out by the Company, according to agreement with the several Governments, within the next four years. Bombay, it is understood, will meet its own expenditure; but a considerable portion of the Calcutta expenditure and the whole of the expenditure in the other towns named must be met by funds provided by the Company. The Company still hold some £12,000 of consols, which will be available in connection with any extraordinary capital expenditure within the next few years. Following on the granting of the 60 years' license by the Indian Government, the Straits Government has also conceded a new lease, or license, for a term of 31 years, the term being shorter than that of the Indian licenses, inasmuch as the capital outlay necessitated by reconstruction will be of much less importance in Singapore than in India. The Cairo and Alexandria exchanges have been very greatly strengthened by the completion of the underground circuiting. The trunk line between Cairo and Alexandria has met a great want, and becomes more and more popular. The other smaller exchanges are working satisfactorily. Fresh exchanges, it is believed, will shortly be opened in other towns, and in the growth of the provincial lines the Company has an assured and constant source of increase to its revenue. During the last year the Egyptian Company suffered a great loss in the death of their manager in Egypt (Mr. W. N. Evans), who had been with the Company as manager for 16 years. He has been succeeded by Mr. Stevenson, who previously had been the local manager in Alexandria for many years, and the Company have now secured the services of Mr. Thomas, late of the Eastern Telegraph Company in Alexandria, to succeed Mr. Stevenson in the latter post. In view of the capital expenditure which has already taken place, and which still lies before the Company, in consequence of the rapidly-growing extension of business, the Board have, in principle, approved of the establishment of a capital redemption fund, but at the present moment a definite decision as to the detailed application of the scheme had not been arrived at, because certain negotiations are now proceeding with the Egyptian Government, by which the Egyptian Company hopes to be enabled to provide independently for the ultimate redemption of its own capital. Having regard to the progress of the Company and to the uninterrupted growth of its undertakings, the Board felt justified in recommending a slightly higher dividend for the ordinary shares this year. They look forward with confidence to the healthy growth of the Company's business. The Chairman concluded by moving the adoption of the report and accounts.

**Mr. Thomas Lloyd** seconded the motion.

**Mr. W. N. Hibbert** said that, while the shareholders were indebted to the Board for the manner in which they had conducted the business, he might, as he did last year, throw out the suggestion that, as the shares in all the subsidiary companies were practically held by this Company, the reports of these various companies should be circulated among the shareholders of the Oriental. He further maintained that there should be a general amalgamation of all the companies into one large company, and by this means, he held, greater facilities would be placed in their power to earn money.

**Mr. Lea Smith** concurred with Mr. Hibbert in the desirability of seeing the reports of the subsidiary companies, and proceeded to complain of the directors underwriting the 6 per cent. preference shares without giving an opportunity to the shareholders to subscribe to the underwriting of the issue. The cost of the issue had been £4,170 for 50,000 shares, and as they had another 50,000 shares to issue, that would mean a total expenditure of over £8,000.

The **Chairman,** replying, said that the Company, as a holder of shares in the subsidiary companies, received one copy of the report of the subsidiary companies, and, should it be the wish of shareholders, they had no objection to have the document reprinted and circulated; but he was afraid shareholders would not agree to such an expense As to amalgamation, he might say they would find it was extremely difficult to get gentlemen abroad to confide all their interests to a central company. Their great aim was to get rid of a central Board, and to make the local company the unit of the work. He was of opinion that they would meet with the greatest opposition in Calcutta, Bombay, and elsewhere if they attempted to unit the companies there under one parent company, of which the central office and administration would be in London. Regarding the underwriting of the shares, complaints had been made that several gentlemen had not been permitted to take part in the underwriting. They must, however, remember they could not look to a broker to take the remnant of what other gentlemen left. They undertook to underwrite the issue at a time when the market was very bad.

The resolution was unanimously adopted.

A dividend of 6 per cent. per annum on the preference shares and a final dividend of 3½ per cent. on the ordinary shares issued, free of income tax (making 6½ per cent. for the year), were declared.

The proceedings concluded with votes of thanks to the chairman, directors, and the staffs abroad.

## INDO-EUROPEAN TELEGRAPH.

The ordinary general meeting of the Indo-European Telegraph Company, Limited, was held on the 27th inst. at Winchester House, Mr. C. Holland presiding.

The **Chairman** stated that the alterations in the regulations annexed to the last International Telegraph Conference did not materially touch the Company's interests, but certain reductions in

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the tariffs would affect their receipts to some extent. Such reductions were at international conferences settled primarily by the Governments concerned, and although the representations of the companies were always accorded a ready hearing, tariff alterations had to be looked upon from an international standpoint. However, he did not think that the Company's revenue would be seriously affected. They had decreased the loss of £18,735 sustained during the preceding year through the reduction in the rate to India by £4,789, owing to an increase in the traffic exchanged with South Russia and India. The direct Wheatstone working, which had proved so successful between London and Teheran, had now been extended to Manchester and Liverpool. Merchants and pressmen in these towns fully appreciated the fact that their telegrams were received without re-transmission from Teheran, a distance of 4,000 miles. Re-transmission always added to the possibility of errors. At the close of the present year the whole of the undertaking so far as the Russian section was concerned, passed to the Russian Government under the concession, and became absolutely their property. This section stood in the Company's books at £313,285. It would consequently be necessary to write off this item altogether. This would be done by charging it the reserve fund.

The report was adopted.

## DOVER ELECTRICITY SUPPLY.

The annual meeting of the Dover Electricity Supply Company was held at the Board-room, Park-street, Sir William Crundall, chairman of the Company, presiding.

The **Chairman** observed that the Company had practically earned a dividend of 8½ per cent., but could only pay 6 per cent., the equivalent of the 4 per cent. the Corporation were paying on the purchase price. He was confident that had the concern remained a private company a dividend of at least 10 or 11 per cent. on the ordinary shares would have been earned during the ensuing year. Dover was an exceptional town in that it had in prospect enormous improvements in regard to the port, which would no doubt mean that there would be a great consumption of electricity for power and lighting. The £7,714 capital expenditure during the year was chiefly caused by the continued and rapid expansion of the business and the more demand for electricity both for light and power. Half of this expenditure went in the way of mains and the other half for a new engine in order to cope with the increased demand for electricity. A Ferranti engine and alternator had been put down, and would no doubt effect a very large saving in coal. The directors recommended the Corporation to put down another engine in view of an increased demand. The profits for 1903 were at least 30 per cent. more than in 1902. The output was 12 per cent. more than in the previous year. In regard to the sale to the Corporation, it was expected that the transfer will take place about May 6 next. He believed the concern would pay its interest and capital instalment without touching the rates, thereby extinguishing the loan in 35 years. There was much new business in prospect for the concern. Arrangements had practically been concluded for lighting the Duke of York School. Then there was the power which they had arranged with the Harbour Board to supply to the new bridge, the capstan, and the cranes on the new works being constructed for the accommodation of the ocean liners. There were also a large amount of applications for private light. Messrs. Wiggins, Teape, and Co. had been induced to wire the Buckland paper mills, which were worked day and night. He concluded by moving the adoption of the report and accounts.

**Mr. Sellar** seconded the motion, which was carried unanimously.

On the motion of **Mr. Hobday**, seconded by **Mr. Cundell**, dividends of 5 per cent. on the preference shares and of 6 per cent. on the ordinary shares were declared and ordered to be paid.

**Dr. Parsons** moved a vote of thanks to the chairman for the very satisfactory report put before them. He thought the shareholders also owed a vote of thanks to the staff for their diligent attention to the business.

The motion was seconded by **Mr. Cundell** and carried.

After the meeting those present were shown the new Ferranti alternator of 400 kw. capacity, which brings the total kilowatt capacity of the works up to over 1,200.

## OSWESTRY ELECTRIC LIGHT.

At the annual meeting of this Company Mr. A. Wynne Corrie (chairman) presided.

The directors reported that the increase in the receipts for sale of current was larger than in any previous year, but the considerable extensions of machinery, etc., made last year had increased the expenses, and the full benefit of the extensions had not yet accrued to the Company in the consumption of current. The available balance of profit amounted to £345. 0s. 1d. The directors recommend the declaration of a dividend at the rate of 3 per cent. per annum (income tax paid by the Company), and that out of the balance a further sum of £100 be placed to the reserve fund. During the year a Bill was promoted in Parliament which would have injuriously affected the Company's interests. The directors were compelled to take steps to have a protective clause inserted. The costs connected with that had not yet been ascertained, and would be included in next year's accounts.

The **Chairman**, in moving the adoption of the report and statement of accounts, said that the increased sale of current last year as compared with 1902 represented £293, the biggest increase they had had in any one year. The parliamentary costs incurred were not expected to be very heavy.

**Mr. Smith**, in seconding the motion, remarked that the capital, paid up, came to £8,000, and the capital expenditure in respect of freehold land and buildings, and machinery, mains, meters, and other plant, to £10,464. Then they also paid £540 in respect of their provisional order and £240 for preliminary expenses. That made a grand total of £11,244. They owed their bankers £1,780, while there were other debts amounting to £900. Against that, they had written off in one way or another, instead of dividing it among the shareholders, from £1,300 to £1,500. That was in addition to the dividends they had paid, so that they had been able to pay that money out of revenue without issuing new shares, thus putting the shareholders in a much better position. During the year the directors had revised their scale of charges, and the charge for current now to anyone who chose to ask for an indicator was 7d. for the first hour and 3d. per hour afterwards. That meant that a person using the current for a two hours' maximum would get his current at 5d. per unit instead of 6d., and if for three hours at 4¼d. The directors had agreed to this with a view to encouraging those who were already using the light to use it for longer hours and those who did not use it to take it.

The motion was agreed to.

## RIVER PLATE ELECTRICITY.

The first annual general meeting was held this week at the Institute of Chartered Accountants, Moorgate-street.

**Mr. M. W. Mattinson, K.C.**, who presided, stated that the net revenue on the "running account" of £13,565 represented a full year's work at the La Plata and Tucuman stations and three months' work at the Buenos Ayres station, which had been sold to the German company. Before arriving at the amount mentioned the Board had made very adequate provision for possible bad debts. A sum of £1,500 had been received as interest upon the Company's uninvested cash balances during the year. It would be remembered that they raised a substantial sum by means of debentures with a view of putting the various stations into good condition, but it had not yet been possible to expend this money advantageously. A third of the preliminary expenses had been written off. There was an available balance of £8 828, out of which it was proposed to pay the full dividend on the preference shares for the whole year and to carry forward £2,828. The old company worked in four towns—Buenos Ayres, La Plata, Rosario, and Tucuman; but the station at Buenos Ayres had been sold for a sum which more than represented the original cost, even to the old company. He moved the adoption of the report, and the payment of a dividend of 6 per cent. on the preference shares.

**Mr. W. T. Western** seconded the motion.

The **Chairman**, in reply to questions, stated that the Board intended to use the greater portion of the funds which the shareholders had placed at their disposal in improving two of the stations.

The motion was adopted.

## LEAMINGTON AND WARWICK ELECTRICAL.

The directors, in their report for the year ended Dec. 31 last, state that the gross receipts for the year amount to £6,739. After deducting all expenses chargeable to revenue, including repairs and maintenance, and interest on debentures, there remains a profit of £1,810. To this has to be added £68 brought forward from the previous account, and after deducting the interim dividend of 2 per cent. paid in November last, amounting to £317, there remains an available balance of £1,561. The directors recommend that there be placed to depreciation and reserve fund £700, and that a dividend be paid at the rate of 5 per cent. on the ordinary shares, making, with the interim dividend, a total distribution of 7 per cent. for the year, leaving a balance to be carried forward of £68. The weather experienced during the past year has again been extremely unfavourable to tramway traffic. The capital expenditure during the past year in connection with the reconstruction of the lines and equipment for the supply of electricity amounted to £9,860. Of this amount £7,243 was incurred in the purchase of generating plant and machinery, £2,076 in laying mains for the supply of electrical energy, and £420 for legal expenses, &c., in connection with the promotion of the Warwick Electric Lighting Order, 1901. The local authorities have now approved the lowering of the road under two railway bridges on the tramway route, which is necessary to enable the Company to run double-deck cars after the reconstruction of the lines, and the directors hope to arrange the matter also with the railway companies at an early date. Tenders are accordingly being invited for the building of the power-house and offices, and it is intended to proceed with the work of reconstruction and equipment of the lines as quickly as possible.

## EASTERN EXTENSION TELEGRAPH.

The gross receipts for the half-year ended Dec. 31 last amount to £265,259, against £267,553 for the corresponding half-year of 1902. The working expenses, including £33,400 for maintenance of cables, absorb £142,419, against £121,869 for the corresponding period of 1902, leaving a balance of £122,840. From this is deducted £4,473 for income tax, £12,512 for interest on debenture stock, etc., leaving as the net profit for the half-year £105,854. After adding £71,036 brought forward from the previous half-year, there is an available balance of £176,890. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 5th prox., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1903. The balance of £41,890 has been carried forward. Further cable renewals have been carried out during the half-year under review,

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and the cost, amounting to £10,854, has been charged against the reserve fund. The further contract with the Netherlands Indian Government for laying some additional short cables in the Java seas has been satisfactorily carried out. The directors appointed representatives to make a tour of inspection of the Company's foreign stations.

### SUBMARINE CABLES' TRUST.

The report for the year ended April 15 last, to be submitted at the meeting on May 3, states that revenue for the year amounted to £24,583, and expenses to £1,170, leaving a balance of £23,413, to which is added the sum of £118 brought forward from the last account making an available balance of £23,531. After providing £19,314 to meet payment of the coupons, £4,156 has been transferred to the redemption fund, leaving a balance of £61 to be carried forward. In accordance with the trust deed, 36 certificates have been redeemed since the last report, by purchase in the open market, costing £4,156 as above. The owners of a majority of the capital stock of the Commercial Cable Company having sold and delivered their stock to the Mackay companies in change for preferred shares and ordinary shares in those companies, and the opportunity having been afforded to all other stock holders in the Commercial Cable Company to do the same, the trustees agreed, on behalf of the trust, that it was expedient in the interest of the certificate holders to sell and exchange the 299 shares of the Commercial Cable Company held by the trust, and to accept therefor preferred shares and common shares of the Mackay companies. The certificate holders will be asked to confirm such resolution.

### WILLANS AND ROBINSON.

At an extraordinary general meeting held at the Cannon-street Hotel on the 27th inst., Mr. George Wilson Anderson and Mr. James Courthorpe Peach were elected directors, their remuneration to be settled by a poll which will be taken on the 11th prox.

## NEW COMPANIES REGISTERED.

**Motor Improvements Company, Limited.**—Capital, £5,000. Objects: to manufacture and deal in motors and all kinds of self-propelled vehicles, accessories and components, etc. Registered office: 1, St. Mary-axe, E.C.

**British Electric Separating Company, Limited.**—Capital, £30,000. Object: to acquire the business of tin-strippers now carried on at Swansea by the British Electric Separating Company, Limited. Registered office: New Cut-road, Swansea.

**Reliance Cycle and Engineering Company, Limited.**—Capital, £1,000. Object: to carry on the business of manufacturers of and dealers in cycles, motorcars, telephones and apparatus, mechanical and electrical engineers, etc. Registered office: Howell Croft Works, Bolton.

**Hyderabad Electric Light and Traction Company, Limited.**—Capital, £10,000. Objects: to construct, maintain, develop, and extend or further the construction, equipment, extension, and development of tramways, etc. Registered office: Worcester House, Walbrook, E.C.

**Polymnia Syndicate, Limited (80,627).**—Capital, £5,000. Objects: to adopt an agreement with A. Fischer, to acquire any new inventions, licenses, or concessions relating to the manufacture or sale of phonographs and gramophones, etc. Registered office: 38 and 39, Billiter-street-buildings, E.C.

**British Textile Design and Electric Card-Cutting Company, Limited.**—Capital, £10,000. Objects: to acquire and work the rights for the patent automatic electrical jacquard card-cutting machine, jointly owned by O. Zerkowitz and Zerkowitz Inventions, Limited. Registered office: 23, Cheapside-chambers, Bradford.

**New Century Lock and Engineering Company, Limited.**—Capital, £500. Object: to acquire and carry on at St. George's Works, George-street, Eden-grove, Holloway, at 235, High Holborn, W.C., and elsewhere, the business of electrical, mechanical, and automobile engineers. Registered office: 235, High Holborn, W.C.

**Electro-Peat Coal Company, Limited.**—Capital, £130,000. Objects: to carry on the business of peat-coal, peat-fuel, peat-charcoal and fibrous peat, with or without the use of electric treatment or minerals or chemicals, paper and millboard manufacturers, contractors, merchants, carriers, shippers, importers, exporters, bankers, shipowners, miners, explorers, quarrymen, workers of and dealers in mineral substances, etc., and to adopt agreements between L. F. Kelly, for this company, and C. Johnson, trading as Johnson and Phillips, and (2) between A. E. Whalley and L. F. Kelly (the latter for this company).

**A.E.G. English Manufacturing Company, Limited.**—Capital, £150,000. Objects: to acquire any patents, patent rights, or privileges relating to electric lighting, and, in particular, to take over the rights for the United Kingdom in an invention known as the Nernst lamp; to adopt an agreement between the Allgemeine Elektricitäts-Gesellschaft of Berlin (vendor company), of the one part and this company of the other part; to construct, lay down, fix, and maintain cables, wires, accumulators, lamps, and other plant, works, and conveniences; and to carry on the business of producers and suppliers of electric light, mechanical engineers, electricians, suppliers of electricity for heat, motive power, and other purposes, manufacturers of electrical accessories, etc.

### Liens Registered.

**American Electrical Novelty and Manufacturing Company, Limited, London, W.C.**—Lien registered April 11, for £10,000 debentures; no trustees; charged on the undertaking and all the property, including the uncalled capital.

**Woking Electric Supply Company, Limited.**—Lien registered April 19, for £950 4½ per cent. debentures, part of £25,000; amount previously issued, £22,600; no trustees; charged on the undertaking and all the property, including the uncalled capital.

**Imperial Motor Company, Limited, London, E.C.**—Lien registered April 19, for £1,800 6 per cent. debentures, part of £5,000 authorised; no trustees; charged on the undertaking and all the property, including the uncalled and unpaid capital.

**Kent Electric Power Syndicate, Limited.**—A mortgage or charge on the company's assets, present and future, including uncalled and unpaid capital (if any), created April 9, 1904, to secure £1,000, has been registered. Holders: Hon. J. B. Lubbock and G. C. Curtis, both of 15, Lombard-street, E.C.

**"Belsize" Motorcar and Engineering Company, Limited, Clayton, near Manchester.**—Lien registered April 14, for £1,400 4½ per cent. debentures, part of £20,000; amount previously issued, £7,000; no trustees; charged on the undertaking and all the property, including the uncalled capital for the time being.

**Wolverhampton District Electric Tramways, Limited, London, W.C.**—Trust deed registered April 16, for £100,000 debenture stock, with power to issue further stock, ranking *pari passu* up to one-half the issued capital. Trustee: Electric and General Investment Company, Limited. Charged on the undertaking and property, present and future.

## PERSONAL.

We regret to learn that Mr. Percival Francis Orinks, an engineer at the Bristol Corporation's electric power station, met with a serious accident last week, a crank of one of the engines striking him a severe blow on the head, and causing severe concussion of the brain.

Mr. Thomas Parker has resigned his position as a director of Thomas Parker, Limited, electrical engineers, Wednesfield-road, Wolverhampton, and is succeeded by Mr. James Underhill. Mr. Parker is now engaged as consulting electrical engineer to the Metropolitan Railway Company for the conversion of the system on that line from steam to electricity.

The Leicester Town Council have increased the salary of Mr. A. Colson, electrical engineer and gas manager, from £1,250 to £1,500.

Mr. F. Thursfield, electrical engineer at Chester, having resigned, the salary offered was £300 per annum, rising by annual increments of £50 to £500. Mr. S. E. Britton, A.M.I.E.E., Motherwell, has been appointed. The final selection was between the successful candidate and Mr. S. D. Schofield, A.M.I.E.E., Shipley. The previous short leet of six included Mr. A. Dimmock, chief assistant, Chester, and Mr. H. Richardson, Dundee. The latter, we understood, had in the meantime received an offer of an increase of £100 in salary in order to induce him to remain in Dundee. Mr. Britton has been at the works of Messrs. Crompton and Co., Limited, and held positions under the Southampton, Barking, and Motherwell Councils.

The Lancaster Town Council have increased the salary of Mr. W. A. Teater, the electrical engineer, from £300 to £350 per annum.

## APPOINTMENTS VACANT.

**Shift Engineer,** Exeter. Salary, £2. 2s. per week. Applications by May 4 to Mr. Geo. R. Shorto, town clerk. See advertisement in last issue.

**Assistant Electrical Engineer,** Aldershot. Commencing salary, £80 per annum. Applications by May 2 to Mr. W. E. Foster, Council Offices. See advertisement in last issue.

**Engineer,** Levenshulme destructor works. Salary 30s. per week, house, coal, and gas. Applications to Mr. J. Ogden Hardicker, clerk, Northern Assurance-buildings, Albert-square, Manchester, by April 30.

**Draughtsmen.** The Metropolitan Asylums Board have vacancies for draughtsmen—one electrical and one mechanical, and three junior. Salary of electrical or mechanical draughtsmen £125 per annum, and of junior draughtsmen £75 per annum. Particulars may be obtained from the offices of the Board, Embankment, London, E.C. Applications by 10 a.m. on May 2.

**Foreman,** India, Government telegraph workshops, Alipore, Calcutta. Age not to exceed 30 years. Engagement for three years, with option of extension, if approved by Government. Salary, Rs.300 per mensem, rising by annual increments of Rs.25 to Rs.450 per mensem. A second-class passage provided from and to England at the expiration of three years. Applicant should be a man thoroughly conversant with light machine shop and tool-making work (the class of manufacture being electrical instruments), able to design and supervise the making of tools for special purposes, and set up automatic machines for screw-cutting, etc. A good knowledge of milling machines is also essential. Form of application and further particulars can be obtained by applying, in writing, to the Director-General of Stores, India Office, London, S.W., by May 10.

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## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tender for rails and other material.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Cleckheaton.**—The Urban District Council invite tenders for one 350-kw. steam generator. Specifications may be obtained from the Elect ical Engineer. Tenders by May 2.

**Royton and Crompton.**—The Urban District Council invite tenders for Section A of tramways—permanent way. Tenders by April 30. See advertisement in former issue.

**Birkenhead.**—The Corporation invite tenders for extension of feeder and distributing mains. Specification, etc., may be obtained from the Borough Electrical Engineer. Tenders by May 14.

**Brora (N.B.)**—The Committee invite offers for a complete installation to light the village with a minimum of 18 lamps. Length of overhead wiring 2,310 yards. Offers to Mr. John Ross, secretary.

**Aberdeen.**—The Electric Lighting Committee invite tenders for the supply and erection of surface-condensing plant, air-pump, and piping. Tenders by April 30. See advertisement in former issue.

**Neath.**—The Corporation invite tenders for electric light mains, feed pillars, and switchboards in their area. Specifications may be obtained from the Borough Engineer, Gwyn Hall, Neath. Tenders by May 16.

**Glasgow.**—The Corporation invite tenders for four sets of 800-kw. dynamo panels. Specifications, etc., may be obtained from Mr. W. A. Chamen, 75, Waterloo-street, Glasgow. Tenders by May 9. See advertisement in last issue.

**Bristol.**—The Electrical Committee invite tenders for one 750 to 1,000-kw. single-phase turbo-alternator. Specifications can be obtained from the City Electrical Engineer. Tenders by noon on May 16. See advertisement.

**Walthamstow.**—The Urban District Council invite tenders for the supply of tramcars. Specifications, etc., may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on May 20. See advertisement.

**Canterbury.**—The Lighting Committee invite tenders for the supply of about 1,800 yards of cable. Specification to be obtained from the Engineer, Electricity Works. Tenders by 10 a.m. on May 14. See advertisement.

**Hackney.**—The Council invite tenders for electricity supply mains (feeders and distributors). Specifications, etc., may be obtained from Mr. R. Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by May 26. See advertisement in last issue.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant: excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc. Tenders by May 17. See advertisement in last issue.

**Stoke-upon-Trent.**—The Corporation invite tenders for (Section A) electricity meters, (B) demand indicators, and (C) cut-outs. Specifications, etc., can be obtained from Mr. P. J. S. Tiddeman, Field-place, Stoke-upon-Trent. Tenders by 5 p.m. on May 13. See advertisement.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required for their steamer and ferries, including electric globes and carbons. Particulars from the Manager's Office, Egremont Ferry, Cheshire. Tenders by May 9.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for a number of four-ton electric wharf cranes for Clydebank Dock. Specifications may be obtained at 16, Robertson-street, Glasgow, from Mr. Geo. H. Baxter, mechanical engineer. Tenders by noon on May 23.

**Abergavenny.**—The Building Committee of Visitors of the Monmouthshire Asylum invite electrical lighting schemes for the asylum and tenders for carrying out the same. Particulars can be obtained from Dr. James Glendinning, medical superintendent. Tenders by 10 a.m. on May 24.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Poplar.**—The Council invite tenders for supply of cables and supply and erection of battery. Specifications, etc., may be obtained from the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders before 9 a.m. on May 7. See advertisement in last issue.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for 12 months from May 31. Specifications, etc., may be obtained from Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by 25th prox. See advertisement.

**Aberdeen.**—The Electric Lighting Committee invite tenders for the supply and erection of mild-steel coal bunkers, together with coal and ash conveyor of the endless chain bucket type, with accessories. Specifications can be had from the City Electrical Engineer. Tenders by May 14. See advertisement.

**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Bray (Ireland).**—The Urban District Council invite tenders for 12 months' supply of goods required at the electric light works, including cables, carbons, house wires, switches, lamps, holders, incandescent lamps, etc. Specifications, etc., may be obtained from the Town Clerk. Tenders by May 2.

**Hammersmith.**—The Borough Council invite tenders for the supply of two 1,500-kw. steam turbines or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters, capable of evaporating a total of 40,000lb. of steam per hour. Tenders by May 18. See advertisement in former issue.

**Middlesbrough.**—The Electric Lighting Committee invite tenders for extending the present boiler-house and engine-house, together with certain other works in connection therewith, at the electricity works, Snowdon-road, Middlesbrough. Specifications, etc., can be obtained at the Borough Engineer's Office. Tenders by 5 p.m. on May 3.

**Wallasey.**—The Urban District Council invite tenders for one independent counter-current jet condensing apparatus, with air and water lifting pumps, to treat 40,000lb. of steam per hour, and to give a vacuum of not less than 27in. Specifications, etc., may be obtained from the Engineer's Office, Seaview-road, Liscard, Cheshire. Tenders by May 7.

**Mexico.**—Tenders are invited by the Municipality of Sans Luis Potosi, Mexico, for the electric lighting of that city by not less than 150 arc lights. The system is to be established by the end of this year, the contract to be concluded for 15 years. The selected contractor will be required to deposit 5,000dol. Mexican as caution money. Tenders will be received up to May 15.

**Ayr (Scotland).**—The District Lunacy Board invite tenders for the following plant: (Section 1) boiler, pump, feed-water heater, piping, etc.; (2) building, chimney, flues, foundations, and iron roofing; (3) engines, dynamos, and main switchboard; (4) electric wiring and mains, etc. Specifications, etc., may be obtained from Mr. W. Maxwell Stewart, 55, West Regent-street, Glasgow. Tenders by May 20.

**Canterbury.**—The Lighting Committee invite tenders for the following: One Lancashire or dry-back marine boiler, superheater, steam-pipes, a 300-kw. steam dynamo, switchboard and connections, and extensions to economiser. Specifications, etc., may be obtained from Mr. Hammond, 64, Victoria-street, Westminster, S.W., after May 4. Tenders before 10.30 a.m. on June 1. See advertisement.

**Burslem.**—The Corporation invite tenders for water-tube boilers, steam-piping, pumps, water-softener, etc., engines, dynamos, balancer, and boosters, switchboard, cables (including laying), arc lamps, accumulators, and refuse destructor plant. Specifications, etc., may be obtained from Mr. A. Bremner, A.M.I.E.E., Market-buildings, Burslem, after 25th inst. Tenders by 12 noon on May 14. See advertisement in last issue.

**Manchester.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection on the southerly side of Dock No. 9, 20 movable electric cranes (with spare gear therefor) for cargo working purposes. Specifications, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders before 10 a.m. on May 25.

**Dublin.**—The Lighting Committee invite tenders for the supply and erection of a steam generating three-phase extra-high-pressure set of plant, consisting of Belliss engine and condensing plant, combined with alternators of the make of either Dick-Kerr, Electric Construction, Oerlikon, or Westinghouse, size 1,000 kw., 1,250 kw., or 1,500 kw., whichever can be delivered most quickly, steam and exhaust piping, and extension to switchboard. Tenders by May 9. See advertisement in last issue.

**London County Council Tramways.**—The London County Council invite tenders for the following switchgear—namely: (*a*) one extra-high-tension three-phase board, with operating table and instrument board; (*b*) one low-tension combined direct-current and three-phase board; (*c*) one combined extra high-tension and low-tension sub-station board; and (*d*) one extra high-tension and low-tension transformer board; and for the erection and connecting-up of the same at the Council's electricity generating station, Greenwich. Tenders by May 17. See advertisement in former issue.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

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## RESULTS OF TENDERS.

**Lincoln.**—The Corporation have accepted Messrs. Bruce Peebles and Co.'s, Limited, tender for the supply of a 220-kw. steam generating set.

**Broughty Ferry.**—The Corporation have placed a large order with the St. Helens Cable Company, Limited, Warrington, for dialite insulated cables.

**Ipswich.**—The Council have accepted the tender of Messrs. Johnson and Phillips, at £896. 5s., for the supply of 5,000 yards of lighting mains and 200 yards of cable for services.

**Woolwich.**—The Borough Council have accepted the tender of the British Thomson-Houston Company Limited, Rugby, for supply of B.T.H.-Edison electric lamps for the ensuing year.

**Swansea.**—The Corporation have accepted the tender of Messrs. J. Marles and Sons, Swansea, at £1,625, for the erection of electricity station and offices at the destructor works, Llangyfelach-street.

**Southend-on-Sea.**—The Corporation have accepted the tender of Messrs. S. E. Moss and Co., Hamlet-road, at £1,100, for extension of the engine and boiler houses at the electricity works, London-road.

**Keighley.**—The Corporation have accepted the tender of the British Thomson-Houston Company, Limited, Rugby, for eight double-deck cars equipped with two G.E. 58 six-turn motors and B. 18 controllers.

**Lancaster.**—The Town Council have accepted the tender of Messrs. R. W. Blackwell and Co., Limited, London, at £10,189, for the tramways extension to the Castle Station and for doubling the track in South-road to the Pointer.

**Grimsby.**—The Education Committee have accepted the tender of the District Electric Company, Wolverhampton, for wiring and supply of fittings for the electrical installation at the Alderman Dobson Schools in Harold-street, Grimsby.

**Dundee.**—The Town Council have accepted the tender of Messrs. Chamberlain and Hookham, Limited, Birmingham, for the supply of electricity meters for Dudhope power station, and of R. L. Ireland and Co, Dundee, for 4,000 tons Lassodie Mull dross coal.

**London, E.**—The Stepney Borough Council have accepted the tender of Messrs. B. E. Nightingale, Albert-embankment, S.E., at £12,921, for the erection of the second half of the electricity generating station at the Osborn-street Electricity Works, E.

**Todmorden.**—The Corporation have accepted the following tenders for the erection of the buildings, etc., required for electricity supply and refuse destructor purposes: Dryland and Preston, Littleborough, buildings and chimney; Pulman and Sons, Halifax, ironwork.

**Chester.**—The Town Council have accepted the tender of Mr. Morton Browne for the erection of a cable-shed, at £77, and that of Messrs. Berry, Skinner, and Co. to supply 1,000 porcelain (conical) silvered reflectors, complete with brass springs and washers, etc., at £42. 12s. 6d.

**Swansea.**—The Corporation have received the following tenders for open-type street arc lamps and accessories: Oliver and Co. (accepted); H. Coles; Union Electric Company, Limited; Johnson and Phillips; Brockie-Pell Arc Lamp, Limited; General Electric Company; Crompton and Co.

**Glasgow.**—The Corporation have accepted the tender of W. Harvie and Co., 24, McAlpine-street, Glasgow, at £936. 7s., for supplying and erecting electric lighting installation, embracing engines, dynamos, lamps, wires, fittings, etc., required at Crawford-street destructor works and stables, Crawford-street, S.S.

**Newport (Mon.).**—The Corporation have accepted the following tenders for tramrails and fishplates (British standard section and specification), and setts for tramway work: A. Penney and Co., Fenchurch-street, E.C., rails £5. 7s. per ton, fishplates £5. 17s.; J. Williams and Son, Newport, setts "Longstone," 5in. by 3in. £1. 4s. 6d. per ton, "Killiwen-Kilrush," 5in. by 4in. 19s. 3d.

**London, S.E.**—The London County Council have received the following tenders for three motor-generators for Southwark and Bermondsey tramways:

| | |
|---|---|
| British Thomson-Houston Company, Limited, Rugby (20 weeks) | £4,837 |
| Dick, Kerr, and Co., Limited, London (12 weeks) (accepted)... | 5,150 |
| British Westinghouse Electric and Manufacturing Company, Limited, London (12 weeks) ..... | 5,492 |

# BUSINESS NOTES.

## TRACTION.

**Preston-Blackburn Tramway Bill.**—This has been read a third time in the House of Lords.

**Scarborough.**—The date of the official opening of the tramway has been altered to Friday, May 6.

**Havana.**—The receipts of the electric railway for the week ended April 10 show an increase of £35.

**Preston-Horwich Tramway Bill.**—This Bill has been read a second time in the House of Commons.

**Darlington.**—The Local Government Board have sanctioned a loan of £100,000 in connection with the tramways.

**Croydon.**—The Tramways Athletic Club held its second annual dinner last Friday, followed by a smoking concert.

**Southport and Lytham.**—The Southport and Lytham Tramroads (Extension of Time) Bill has been read a third time in the House of Lords.

**Rowley.**—The Board of Trade have sanctioned the raising of a loan of £28,000 for the construction of the new tramway from Old Hill to Blackheath.

**Cardiff.**—The Tramways Committee have appointed a sub-committee to investigate the expenditure as dealt with by the auditor's and electrical engineer's reports.

**Cambridge.**—The Town Council are considering the proposal of the Cambridge Electric Tramways Syndicate with reference to the electrification and extension of the tramways.

**Folkestone.**—It is reported that Mr. Merz, who was asked to report upon the various systems of tramway propulsion, does not recommend any other system for Folkestone than overhead.

**British Electric Traction Co.**—The receipts of the Associated Companies for the past week amounted to £22,091, against £25,388, on a mileage of 397, against 373½ miles last year.

**Wolverhampton.**—The work of laying the electric tramways along the Willenhall-road to Dean's-road was completed by last Friday. There was a constant service of cars on Saturday.

**Bradford.**—It is expected that the contract for taking over the Shipley tramway will be completed on May 2. The Tramways Committee recommend the immediate coupling of the Bradford and Shipley lines at Thackley.

**Bishop Auckland-Spennymoor.**—The United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, have published notice that the Board of Trade has made a provisional order for the construction of these tramways.

**Ipswich.**—We understand that efforts are being made by the Corporation to modify the conditions of the contract which was recently entered into with the British Electric Equipment Company for the overhead work of the tramways.

**Luton.**—The Tramways Committee, having inspected the proposed routes, reported the result to the Council, with certain suggestions for alternative routes. A further inspection of routes is to be held on the 12th prox., when it is expected that a definite decision will be arrived at.

**Soothill.**—This Bill, having complied with the House of Lords Standing Orders, has been certified for second reading. The Wakefield and District Light Railway Company and the Yorkshire Electric Tramways Construction Syndicate, Limited, have deposited a petition praying to be heard against the Bill.

**North-Eastern Railway.**—It is reported that, owing to the success of the Benton line, the Tyneside electric train system is to be considerably extended in a week or two's time by the opening of the line from Newcastle Central Station to Whitley Bay, a distance of 12 miles. Trains will be run at short intervals.

**Bath.**—The Council adhere to their resolution that the tramways company be held to their agreement not to run cars along the Manvers-street route after 11 o'clock at night, excepting Saturdays, when the hour should be 12. The company desired that the clause should be altered to 12 every night and 11 Sundays.

**Rochdale.**—At a joint meeting last Saturday of the Health, Paving and Sewering, and Gas and Electricity Committees it was decided to recommend an extension of the electricity works so as to secure the extra current required for tramway traction. The estimated cost is about £15,000. Land is already available for the purpose.

**Glasgow.**—Following the example of the Great Central and Midland Railway Companies, the Caledonian Railway Company contemplate an experiment with the zone system of railway tickets to meet the competition of the Corporation's electric tramway. The extension of the Corporation tramways from Carntyne to Parkhead Cross was opened for traffic on Sunday.

**Littleborough.**—At a meeting of the Urban District Council on Wednesday great dissatisfaction was expressed at the lack of information from Rochdale in regard to the electrification of the tram service in their district. The Electric Committee have been in communication with the Rochdale Corporation with a view to accelerating the start of the work of reconstruction.

**Railway Conversion.**—It is announced that operations will shortly be commenced with a view to using electricity on the Newport Pagnell branch of the London and North-Western Railway—a stretch of about four miles. The system proposed is similar to that already adopted on the Lancashire and Yorkshire Railway. It is estimated that after the initial expense there will be a saving of 50 per cent.

**Southend.**—The committee's estimate for the light railways fund to March 31, 1904, was £14,841, and the approximate expenditure £16,771. The estimated traffic receipts and other income were £15,000, and the approximate income £16,165. The estimates for the ensuing year are: light railways—estimated expenditure to March 31, 1905, £18,597; estimated traffic receipts and other income, £18,000; electric lighting—estimated expenditure to March 31, 1905, £11,775; estimated income, £13,025.

**Exeter.**—The Tramways Committee recommend provision be made in the specification for laying down wood pavement in Queen-street from High-street to the railway bridge. The city surveyor and the electrical engineer have submitted to the committee plans, draft quantities, and specifications of the following: (Contract No. 1) permanent way and paving, including copper bonding; (2) electrical equipment; (3) feeders; (4) double-decked motorcars. The committee recommend that tenders be at once invited.

**Ipswich.**—A further important development of the Corporation tramways will be inaugurated on Monday next. Nearly a dozen special tramcars will leave the Cornhill for Derby-road Station every day, and a similar number will await the arrival at Derby-road of trains from Felixstowe. These special cars are in addition to the ordinary 10 minutes' service each way. Facilities for travelling between the centre of Ipswich and the seaside will, with the developments in contemplation, be greatly improved.

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**Aberdeen.**—At the meeting of the Tramways Committee it was reported that arrangements were almost completed for the summer system of cars in the Ferryhill district, which will include a new circular route, *vid* Crown-street and Ferryhill, on to Holburn-street, and thence back to Castle-street, and *vice versâ*. There will also be a regular service of cars running direct between the Duthie Park and Castle-street.

**London, Camberwell, and Dulwich Tramways Bill.**—A committee of the House of Commons has found the preamble to this Bill not proved. The widenings of Rye-lane proposed by the company were considered inadequate by the Camberwell Borough Council. Mr. Erskine Pollock, K.C., stated that at the last meetings of the Highways Committee and the Parliamentary Committee of the London County Council it was resolved to recommend the Council to purchase the whole of the system of the company in August next under Section 43 of the Tramways Act, 1870.

**Bury.**—Major Druitt last week inspected the tramway system on behalf of the Board of Trade. He expressed his satisfaction with both the cars and the track, and he fixed the speeds for the various portions of the route as follows: Market-street, eight miles per hour; Princess-street, eight miles (with compulsory stop at Spring-street); King-street, eight miles; Rochdale-road to Heap Bridge, 12 miles; Heywood-street, 12 miles; Spring-street, 10 miles; and Frederick-street, 10 miles. For the curves a rate not exceeding four miles was fixed. The section from the theatre to Heap Bridge has commenced running, and other routes will be opened shortly.

**Mansfield Trams.**—Notice has been given on behalf of the Mansfield and district light railway promoters that it is proposed to forthwith proceed with the work of construction of the above tramways, and plans showing where it is proposed to have a single and where a double track have been deposited. The powers obtained from the Light Railway Commissioners, which expire in the middle of May, cover routes to Pleasley, Nottingham-road, Mansfield Woodhouse, and Hucknall Huthwaite, connection being afforded to the latter place with the larger proposals of the Nottingham and Derbyshire schemes. The plans show the division of the scheme into eight sections, but the promoters intend at present only to deal with three.

**Proposed Electric Tramway.**—The Fife Electric Power Company, who are developing an extensive scheme for the distribution of electric power in Fife, have just let one of their contracts for a generating station at Town-hill, Dunfermline, to Messrs. Bruce Peebles and Co., Edinburgh. An immediate start is to be made with its erection, and it is hoped that the company will be in a position to supply both power and light by next winter. The company have also under consideration the supply of power for a scheme of electric tramways between the new naval base, Dunfermline, and Kelty, the ground of which has already been surveyed by the engineers of the company, and the electric lighting of Dunfermline, as well as the supply of power to one or two of the large collieries in the district.

**Leicester.**—Detailed information was given at the last meeting of the Town Council as to the progress of the tramways. Many of the tracks have been completed, and the lines on the Aylestone-road, Humberstone-road, East Park-road, and to Clarendon Park will be finished at an early date. The electric equipment of the lines is making satisfactory progress, and the Lero power station, with its equipment, and the erection of the main and district car-sheds, are also rapidly approaching completion. It is intended to open the Belgrave, London-road, Highfields, and Clarendon Park routes for electric car service before Whitsuntide, and shortly afterwards the electric service will be commenced on the Aylestone-road, Humberstone-road, West-end, and East Park-road sections.

**King's Norton.**—The laying of the new tramway between Birmingham and Cotteridge, King's Norton, is rapidly approaching completion. So far as the District Council is concerned their work is practically finished, but they are waiting for the completion of the reconstruction of the canal bridge at Breedon Cross by the Worcestershire County Council before the line can be prepared for inspection by the Board of Trade. This it is hoped will take place towards the end of May, so that the line may be opened by June 1. At the outset eight cars will be placed on the route, and there will be through journeys from Cotteridge to John Bright-street. Current will be supplied from the City of Birmingham Tramway Company's generating station at Bournbrook, and to whom the line is leased.

**Newcastle.**—In accordance with the request of the Tyneside Tramways Company, a deputation of their directors was on Tuesday accorded an interview with the Tramways and Parliamentary Committees, with a view to coming to some compromise on the question of running powers. On behalf of the company, it was stated that they wished to maintain good relations with the Corporation, and, if possible, they were desirous of an amicable arrangement being come to, which would save the expense of a long enquiry. They would rather accept less by an agreement than go to Parliament, and possibly force more out of the Corporation. They would be pleased to be informed of all the points of difference which the Corporation considered to be of vital importance. Some little discussion took place after the deputation retired, but eventually the matter was adjourned to a special meeting to be held to-day.

**Nottingham.**—A joint meeting of committees of the Nottingham Corporation has considered the scheme for opening up the Sneinton district. The proposed route is from the King Edward-street and St. Ann's Well-road junction along Bath-street, and round by Sneinton Market into Manvers-street, which will have to undergo a process of widening. The line will then proceed along Sneinton Hermitage and Colwick-road as far as the railway crossing. Returning rails will branch off from Manvers-street and run along Fisher-gate on to London-road as far as Trent Bridge. The cost of the scheme in round figures will be £100,000, and it received practically the unanimous support of the committees. It is anticipated that nearly two years must elapse before the lines can be got into working order. The matter has to receive sanction of the Council, and parliamentary powers have to be obtained, besides the raising of the money.

**Great Northern and City Railway.**—Since the opening of this railway for public traffic the weekly earnings have been as follows: Feb. 20, £852; Feb. 27, £888; March 5, £949; March 12, £952; March 19, £965; March 26, £976; April 2, £983; April 9, £990; April 16, £908. This gives a total of £8,463 for the nine weeks, or an average of £940 per week. It has been stated that these comparatively meagre returns are partly attributable to the lack of an understanding with the Great Northern Railway Company. There are rumours that the company intend to apply for powers to extend their line north of Finsbury Park. It is suggested that a satisfactory solution would be provided by a junction with the Great Northern main line, which was an important part of the original Great Northern and City scheme, the Great Northern authorities to electrify a section of their new suburban lines north of Finsbury Park, thus securing an excellent new through route to the City.

**Berlin Elevated and Underground Electric Railway.**—The official returns have been issued relating to the working results for 1903. The line carried 29,628,463 persons in 1903, as compared with 18,813,994 passengers in 1902, while the short level section associated with the undertaking transported an additional 2,507,649 persons, as against 1,227,010 in the preceding period. The total working receipts amounted to £190,903, and the expenses to £100,126. After providing for the interest on the bonds, which amounts to £390,000, and making provision for reserve and renewal funds, there remains a net profit of £57,523. It is proposed to pay a dividend at the rate of 3½ per cent. for the year on the share capital of £1,500,000. In the preceding year the railway was worked by the contractors, who guaranteed and paid 4 per cent. interest on the share capital for 1902, at the end of which the railway was transferred to the proprietary company. In comparing the figures with those of the previous year, it must, of course, be remembered that the entire line was not in operation during the entire period.

**Portsmouth.**—Some misgivings are expressed regarding the proposed alteration of the tram routes because of the extra traffic that must flow through Greetham-street and over the S curve in Somers-road. This is considered the most dangerous point in the entire system, and it has been suggested that the property at the two corners should be acquired and demolished. The financial year, which closed on the 31st of last month, has been a prosperous one for the Corporation tramways, and it is expected the accounts will show a net profit of some £14,000 or £15,000. There has been a steady increase in the mileage run, the passengers, and the receipts. In spite of the cheaper fares, the gross receipts have leapt up by over £10,000 more than in 1903, the total for the year just closed being £94,000. The passengers numbered 18,204,426, which is over 1¾ millions more than in 1903, and they paid 11·62d. per mile. The result is all the more satisfactory when it is remembered that the expenditure has been much heavier than in the previous year, and the Tramway Committee have had to maintain the whole of the lines, the cost of which fell on the contractors in 1903.

**Dewsbury and District Tramways.**—A formal inspection of the electric tramways in the Dewsbury district by representatives of the British Electric Traction Company and members of the local authorities through whose districts the lines pass has been made. The tramways have been open for some months, and so far have been well patronised. From Dewsbury there is a double line to Cleckheaton *via* Heckmondwike, with branches from Millbridge to Hightown on the one hand, and to Birkenshaw on the other. At the latter place the tramways almost join up to those of the Bradford Corporation. The two Batley sections join the Spen Valley system at Staincliffe and Heckmondwike. There is a service of steam trams along Bradford-road from Dewsbury to Gomersal. These belong to the traction company, and it is intended to equip them electrically and extend the system to Birkenshaw. There will then be direct communication between Dewsbury and Bradford. As powers have been obtained by the Dewsbury and Ossett Corporations from the Board of Trade to lay down tramways in their areas, and the Soothill Nether District Council are seeking similar powers, there will probably be a through service from Dewsbury to Wakefield, as lines are now being laid from the latter to Ossett. These are expected to be ready for opening shortly. The Board of Trade have granted a provisional order for the construction of tramways in favour of the Corporation.

**Bideford, Westward Ho!, and Appledore Railway.**—A Board of Trade enquiry was held last week to hear objections to the confirmation of an order issued by the Light Railway Commissioners with reference to this railway. The proposal was to extend the railway to Appledore in the north, and to make two loop lines for changing engines at the Bideford end. Mr. Sidney Morse appeared for the promoters, the British Electric Traction Company; and Mr. Wedderburn, K.C., was for the Bideford Corporation, the objectors. Mr. Wedderburn said that the objections which were raised were not only important to the Corporation and inhabitants of Bideford, but raised the question whether the Light Railway Commissioners could override an Act of Parliament. He contended that where parties went before Parliament and obtained certain powers or rights, no one except Parliament could dispose of those rights. In this case there was no objection to the Appledore extension, but what the Bideford Corporation objected to was the erection of two loop sidings at the Bideford end of the line for the purpose chiefly of changing engines, and his second contention was that the promoters could not do that without the consent of the Bideford Corporation. Evidence was given by Mr. Soares, M.P., and the mayor and town clerk of Bideford on behalf of the objectors, who stated that the proposed loop lines would entail danger to the general public. Mr. Morse said that on the question whether a light railway order should override an Act of Parliament, an Act giving certain powers did not prevent any promoters from

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going for further powers after. Evidence for the promoters was given by Mr. Sellon, C.E., and the decision of the Board was reserved.

**The Underground Railway.**—A Select Committee of the House of Commons has considered the Metropolitan District Railway Bill. Mr. Freeman, K.C., explained that the object of Clause 22 was to enable the company, when they had converted their existing line to electrical traction, to try as an experiment the charging of fares for zones. The company expected to have electrically-propelled trains in a few months, and instead of the present 10-minute service there would probably be a service every 1½ minutes, and later on possibly every minute. Of the zone fares, 50 per cent. would be 2d., 32 per cent. 3d., 15 per cent. 4d., and 2 per cent. 5d. A small number, comparatively—viz., 117 for short journeys—would involve a slight increase on the present fare, 47 would remain absolutely unaltered, and 738 would involve a decrease which in some causes would be considerable. As heavy luggage would disorganise a 1½-minute service, the company asked to be relieved of the obligations of carrying passengers with luggage, and to be treated like a tube railway, passengers on which were entitled to carry not more than 28lb. This provision would apply only to persons travelling at zone fares. People coming, say, from Ealing would not be subject to this restriction. The committee decided to insert a provision that the company should run at least two convenient trains daily each way, stopping at every station, in which passengers should be conveyed with an amount of personal luggage not exceeding 120lb. for first-class passengers and 60lb. for third-class passengers without extra charge for luggage. A further amendment directed that the clause permitting the charging of zone fares should not apply to local fares on the City lines. The committee sanctioned the extension till August, 1906, of the time for the construction of the deep-level line, beneath the company's existing railway from Earl's Court to the Mansion House, on which line it is intended to run express passenger trains. Opposition to this portion of the Bill was unsuccessfully offered by the London County Council, in order to obtain the insertion of a clause similar to that enacted in the case of the Tube Bills with respect to the running of workmen's trains. The Bill, as amended, was ordered to be reported to the House.

**London County Council.**—The Council having decided to make temporary arrangements with the City of London Electric Lighting Company for the supply of electrical power for the working of certain short lengths of tramways, about three miles in length, in the districts of Southwark and Bermondsey, authorised the Highways Committee to take the necessary steps for obtaining the plant and equipment required to enable the proposed arrangements with the company to be carried out. The committee have reported the result of the tenders they invited for the supply of the three motor-generators required. We give particulars of these tenders in another column. The receipts of the Council's tramways for the past week show an increase of £1 464. The Stoke Newington Borough Council have decided to write the Board of Trade that they offer no objection to the laying of the conduit system for the trams by the London County Council, subject to a stipulation as to any repaving of the High-street that might be needed. A Select Committee of the House of Commons under the chairmanship of Mr. Compton Ricketts has commenced the consideration of the London County Council Tramways and Improvements Bill. The Bill is an omnibus one, and in addition to the elimination by the House of the proposal to construct a tramway over Westminster Bridge and along the Victoria-embankment, a number of other tramways schemes have also been omitted from the measure voluntarily. As it stands, the Bill relates to nine routes, which the committee will deal with separately. Petitions against the Bill have been presented by the Charing Cross, Euston, and Hampstead Railway Company, who have a tube railway under a portion of the route now in course of construction; by the Holborn Town Council, the road authority for a small portion of the route on the eastern side near Oxford-street; by Messrs. Maple, Messrs. Shoolbred, the proprietors of Meux Brewery, frontagers; and by Lord Gort, owner of property in the narrow part of the road between Percy-street and Hannay-street. In opening the case for the Council, Mr. Erskine Pollock, K.C., dealt first with the proposal to construct a tramway down Tottenham Court-road. The scheme was for the continuing of the existing tramway from the end of Hampstead-road, down the Tottenham Court-road, to a point immediately north of Oxford-street, where a road widening was effected some years ago. Counsel thought that that would be a very convenient position for a tramway terminus. Evidence in support of the Bill having been given, the committee adjourned.

## LIGHTING AND GENERAL.

**Mansfield.**—Applications for electricity to date number 133.

**Kettering.**—The electricity works are to be opened at 4.45 p.m. on May 7 by Mr. Andrew Carnegie.

**Cheshire Electricity and Power Gas Bill.**—This Bill has failed to pass the committee of the House of Commons.

**Blackpool.**—It is expected that the Electricity Committee will be able to show a profit of £2,000 for the last year's work.

**Carnarvon.**—An enquiry has been held into an application of the Town Council for sanction to borrow £17,000 for electric lighting.

**Heckmondwike.**—The electricity department made a profit last year of £267, £200 of which is to be applied to a redemption fund.

**Bridlington.**—It has been decided to extend the Corporation electric cables to include 19 additional streets, at a cost of over £1,115.

**Dover.**—The first year's working of the electric lighting undertaking as a municipal concern is estimated to realise a profit of nearly £1,300.

**Barnstaple.**—The Council have sealed a mortgage for the loan of £5,400 from the Huddersfield Corporation for purposes of electric lighting.

**Sunderland.**—Permission has been given to the Pearson Fire-Alarm Company to place a switchboard in the station at a rental of £7. 10s. per year.

**Lancashire Electric Power Bill**—Lord Lauderdale's Committee has passed this Bill and extended the powers under the 1900 Act for another two years.

**Govan Combination Hospital.**—The clerk has been instructed to make up a report for next meeting in regard to the question of electric lighting at the hospital.

**Huddersfield.**—The borough electrical engineer's last report shows that since last month the number of consumers has increased by seven, and lamps connected by 352.

**Cuba Submarine Telegraph Co.**—The directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares, free of tax, for the half-year to Dec. 31.

**Perth.**—The Property Committee have agreed to recommend the Town Council to contribute £40 towards the introduction of the electric light to St. Paul's parish church.

**Brighouse.**—Messrs. Lacey, Sillar, and Leigh have been instructed to prepare specifications for the commencement of the electric lighting scheme which the Corporation have in hand.

**Huddersfield.**—The Bill to confirm the Huddersfield (extension to Golcar) electric lighting provisional order was presented to the House of Lords on Friday last, and read a first time.

**Sales of Plant.**—Particulars of sales of various electrical plant, of an electric installation suitable for country house, and of one 10-hp. and two 20-h.p. electric motors, appear in another column.

**Derbyshire and Nottinghamshire Electric Power Bill.**—The opposition to this Bill has been withdrawn, and it has been referred to the consideration of the Committee on Unopposed Bills.

**Gainsborough.**—The Bill confirming an order authorising the Urban District Council to supply electricity within the limits of their district has passed the examiner of the House of Commons.

**Kirkby-in-Ashfield.**—The Bill confirming an order enabling the Urban District Council of Kirkby-in-Ashfield to supply electricity in their district has passed the examiner of the House of Commons.

**Poplar.**—Electric mains are to be extended to meet the demands for current at Orchard-place, Blackwall. The estimated cost of this work was £2,214, and the estimated revenue from probable consumers £856 per annum.

**Board of Trade.**—The Commercial Intelligence Branch of the Board of Trade will be moved from 50, Parliament-street, S.W., on Saturday, April 30, and will be opened at 73, Basinghall-street, E.C., on Monday, May 2.

**Agency.**—Messrs. J. C. Lyell and Co., 55, Victoria-street, S.W., have been appointed sole agents for London and district for Messrs. C. H. Andrews, Limited, of Stockport, for the sale of their electric motors, dynamos, and fans.

**South London Electric Supply Co.**—The company reports having sold during the quarter ended Lady Day 2,120,539 units, realising £18,600. The figures for the corresponding quarter in 1903 were 376,227 units, realising £7,305.

**Canterbury.**—The delegates of the Canterbury Farmers' Club and East Kent Chamber of Agriculture to the Central Chamber have been instructed to support any movement in favour of better telephonic communication in country districts.

**Leamington and Warwick Electrical Works Co.**—The profits of this company for 1903 after providing for interest on debentures, were £1,810. A dividend of 5 per cent. is proposed on the ordinary shares, making 7 per cent. for the year.

**Bethnal Green.**—We understand that at the next meeting of the Borough Council the Electricity Committee will recommend that the proposed large electric supply scheme for the borough (referred to in our issue of April 1) be proceeded with.

**Tunbridge Wells.**—At a largely attended private conference of Tunbridge Wells public bodies a resolution was passed in favour of the retention of the electric light under municipal control, which is said to fairly represent the general opinion in the town.

**Stirling.**—The last report by Mr. A. C. Hanson, electrical engineer, shows that the total number of equivalent 8-c.p. lamps connected for private individuals was 12,946, and that the number connected for all purposes was 14,110, as compared with 10,414 at the same period last year.

**Ulster Electric Power Bill.**—The Belfast Corporation and others have made a satisfactory arrangement with the promoters of the Bill. The Bill was consequently withdrawn from the Select Committee in order that it might be placed before the Committee on Unopposed Measures.

**Whitstable.**—We understand that a committee has been appointed by the Urban District Council to consider and report as to the advisability of arranging for an electric lighting installation for the town and as to the best course of procedure to be adopted to secure such installation.

**Worksop.**—The electric light undertaking shows an income of £2,171, compared with £840 last year. The total revenue expenditure of the year was £1,428, and repayment of loans exactly the same amount, a total expenditure of £2,856, the deficit being £685, as compared with £1,050. 8s. 9d.

**Telephone Conference.**—The Lord Mayor has consented to open at the Guildhall on Wednesday, May 18, a conference of representatives of local authorities in the London telephone area with reference to the proposed purchase by the Government of the National Telephone Company's undertaking.

**Weybridge.**—Mr. Bilney, solicitor, has been instructed to take steps to obtain an injunction restraining the Urban Electric Supply

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Company from supplying energy to Walton for the undertaking in the Weybridge district and from breaking up the roads in the parish and relaying cables for the purpose.

**Porth.**—An extensive fire broke out at Porth (Rhondda Valley) on Monday night in the premises of Messrs. Thomas and Evans. The firm generate their own electricity for lighting purposes, and also supply the current for the chapel, and it is feared that the whole of the valuable electric plant has been destroyed.

**Eastern Extension, Australasia, and China Telegraph Co.**—The directors have declared a dividend for the quarter ended Dec. 31 of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent, making a total distribution of 7 per cent. for the year 1903. The dividend and bonus will be paid on May 5.

**Acton.**—The surveyor and the electrical engineer are preparing plans and specifications for a transforming station, such building to include provision for three sets of transforming plant, and also plans for the erection of a house providing accommodation for the resident engineer and committee room, at a cost not exceeding £500.

**York.**—The Electric Lighting Committee of the Corporation made a gross income for the year ending March 31 of £9,114. The ordinary working expenditure was £4,964, leaving a net revenue of £4,149. The amount chargeable for interest and sinking fund was £3.799, which leaves a net surplus of £350 to carry to reserve fund account.

**Barnet.**—The North Metropolitan Electric Lighting Company have consented to allow the Urban District Council the power of taking over the second provisional order for the electric lighting of the town at the expiration of a period of 14 years instead of 21 years, as proposed by the company. The agreement with the company has been approved.

**Brush Electrical Engineering Co.**—The directors recommend, subject to audit, payment of the full 6 per cent. dividend on the preference shares for the year ended Dec. 31, 1903, placing £7,000 to general reserve, £6,500 to depreciation reserve, and carrying forward £3 057. 11s. 5d. The transfer books will be closed from April 28 to May 10, 1904, inclusive.

**Bedlington.**—The Local Government Board have asked the Council, in view of the expiry of the provisional order to the electric lighting company on Aug. 2, what steps were being taken in the matter. Consequently the clerk has been instructed to write to the company in order to ascertain whether it was intended to provide Bedlington with electric light.

**Whitchurch.**—The South Wales Electrical Power Company, Limited, having been granted permission to lay their cables to the Melingriffith Works, Whitchurch, and the Phœnix Brickworks, the Heath, Whitchurch, the Whitchurch Parish Council have resolved to write to the District Council to enquire what steps, if any, would be taken to light Whitchurch by electricity.

**Hull.**—At the last meeting of the Corporation Property Committee it was decided to determine the committee's agreements with the National Telephone Company and the Post Office, with the object of ultimately subscribing to the Corporation telephone. Mr. Brown (chairman, Telephones Committee) said the system would be ready within the docks by about the middle of June.

**Shoreditch.**—The Electricity Committee of the Borough Council have been advised that it will be desirable at an early date to change the pressure of supply in Kingsland-road. For this purpose it will be necessary to lay a third wire, at a cost, including labour, etc., of about £300. The committee have given instructions for the specification to be prepared and tenders invited from the usual firms.

**Keyham.**—The equipment of the Midland Company's new harbour is of the most modern kind, and the cranes to be used will be worked by electricity. The wagons in and about the sheds and sidings will also be moved by electrically-worked capstans. To provide for both electric power and lighting a large power-house and Mond gas installation have been put down not far from the goods warehouse.

**Edinburgh.**—The Electric Lighting Committee's estimated expenditure for next year is set down at £49,335, as against an estimated expenditure of the current year of £46,945, and an actual expenditure for last year of £41,498. 17s. 3d. The estimated revenue for next year is £124,050, compared with an estimated revenue for the current year of £108,835, and an actual revenue last year of £103,364. 19s. 4d. The capital expenditure is estimated at £53 455.

**Walton-upon-Thames.**—The Board of Trade have issued an electric lighting provisional order with a view of the same being included in a Confirmation Bill about to be introduced into Parliament to the Urban Electric Supply Company, Limited, Broad Sanctuary-chambers, Tothill-street, Westminster, authorising them to supply electrical energy for public and private purposes within the whole of the urban district of Walton-upon-Thames, as constituted at the commencement of the order.

**Wireless Telegraphy between the Andamans and Burma.**—Mr. W. G. Newton, superintending engineer, P.W.D., left Rangoon on March 23 in the R.I.M.S. "Minto" for Port Blair and the Burma lighthouses. A party of 30 men of the telegraph department will be left at Table Island to erect a mast for the wireless telegraphy installation to connect the Andamans with Burma. Similar erections are in course of construction at Port Blair, Diamond Island, Elephant Point, and Amherst.—*Indian Engineering.*

**Grays.**—Mr. Long, the electrical engineer, in his last report states that the receipts of the electrical department during the year were: from private consumers, £1,681; street-lighting, £923—total, £2,604. The expenditure amounted to £1,518, but there was required for interest and loan repayments £1,159, leaving a deficit for the year of £73. It has been decided that the consumers shall have the option of being charged either at 7d. or 3d. per unit on the maximum demand system (instead of 7d. and 4d. as before), or at a uniform rate of 5d. per unit.

**Buralem.**—Both the electricity and destructor works are to be erected and completed under the supervision, as to the buildings, of the borough surveyor, and as to the destructor and electricity plant, of the borough electrical engineer. Application is to be made for sanction to borrow £11,000 for the purpose of providing a refuse destructor and the purchase of the site. The borough surveyor has been instructed to obtain tenders for the erection and fitting up of the proposed new destructor from Messrs. Horsfall, Meldrum, Manlove and Alliott, and Needham and Frowde.

**Stepney.**—The annual accounts of the Borough Council's electricity works for the year ended March 31 last are very satisfactory. The Council have again been able to reduce their average price obtained for electricity to 2·66d. per unit in the case of private supply and 2·35d. taking the whole of the supply, and notwithstanding this very low charge an additional surplus has been made. These results have been obtained as the result of or in spite of (according to the view held) the rigid use of the demand indicator system with the high initial price of 8d. per unit.

**West Coast of America Telegraph Co.**—The gross receipts for the year 1903 amounted to £35,707, as against £34,293 in 1902, showing an increase of £1,413. The working expenses, £28,381, as compared with £24,295 for the previous year, show an increase of £4,086, largely due to the cost of repairing cables. After providing £6,000 for the interest on the 4 per cent. debentures and £800 for the interest on the 4 per cent. income bonds, there remains a balance of £526, to which is added the sum of £571 brought forward from 1902, making £1,097 to be carried forward.

**Telephonic Communication in Ireland.**—Mr. Wyndham stated on Monday that a considerable number of applications for the extension of the trunk telephone system in Ireland had been received, and a comprehensive enquiry was now being made as to the possibility of meeting these demands. The plans now in preparation included one for an extension to Killarney. The difficulty in the way of the extension of the trunk system in the South of Ireland had been the large expenditure involved owing to the length of the lines. The traffic and revenue on the existing lines were small.

**Fulham.**—The Borough Council having fully considered a report of Mr. Arthur J. Fuller, the borough electrical engineer, on extensions for the coming winter, have now ordered a 750-kw. Curtis turbine set from the British Thomson-Houston Company, to be delivered and complete on temporary foundations by October next. The engineer has also been instructed to prepare a scheme for the consideration of the Town Council on the basis of the maximum demand during the next few years what will be required by the borough, and we gather that such extensions will probably entail an expenditure of £100,000.

**Dundee Power Scheme.**—At Tuesday's meeting of the Tramways Committee a report by Mr. Richardson, the engineer, dealing with the proposals to utilise the head of water at Lintrathen as a means of generating electrical energy was discussed. It was stated that to generate electrical energy on anything like an adequate scale would involve an expenditure of not less than £120,000. Even at a much lower figure than that, it was pointed out that current could be generated and distributed by steam power in the city more economically and efficiently. The committee resolved to postpone consideration of the whole subject.

**Wolverhampton.**—On Monday the Mayor (Alderman L. Johnson) started the working of the new refuse destructor, which has been erected by the Corporation in connection with a scheme comprising the erection of an eight-cell destructor, with steam-raising plant for producing power for electrical and other purposes, at a total estimated cost of £13,580. The scheme includes, in addition, four water-tube boilers, a chimney shaft, inclined roadway, tipping platform, fanhouse, and economiser, together with lavatories, and the necessary electric lighting, water supply, and drainage. The destructor has been erected by Messrs. Manlove, Alliott, and Co., of Nottingham.

**Stock Exchange.**—The Stock Exchange Committee have appointed May 5 special settling day for National Telephone Company, Limited, provisional certificates (fully and partly paid) of a further issue of £1,000,000 4 per cent. debenture stock; and have ordered the undermentioned securities to be quoted in the official list: National Telephone Company, Limited, provisional certificates (partly paid) of a further issue of £1,000,000 4 per cent. debenture stock, and a further issue of £89,593 4 per cent. debenture stock; and Underground Electric Railways Company of London, Limited, £3,599,268 5 per cent. profit-sharing secured notes (fully paid provisional certificates). Applications have been made to the committee to allow the following securities to be quoted in the official list: Hove Electric Lighting Company, Limited, further issue of 2,000 shares of £5 each, fully paid, Nos. 13,001 to 15,000; and Metropolitan Electric Supply Company, Limited, further issue of 5,015 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 71,107 to 76,121.

**New Issues.**—The Newcastle-upon-Tyne Electric Supply Company, Limited, are offering to their shareholders 17,991 5 per cent. preference shares of £5 each at 10s. premium, and a similar number of £5 ordinary shares at £1 premium. It is stated that since 1898 the profits have risen from £8,140 to £44.567 per annum, while the number of units sold has advanced from 803 789 to over nine millions during the same period. In the current year it is expected that 15 million units will be disposed of, and in 1905 25 millions is the optimistic official estimate. The company has on its books all the large engineering firms operating in the Tyne district, while it possesses the North-Eastern Railway contract for the supply of power for that section of their system now in process of electrification. Subscriptions are invited for an issue by the Urban Electric Supply Company, Limited, of 4½ per cent. first mortgage debenture stock to the amount of £200,000 at the price of £98 per cent. An issue has been made of £1 shares in the Electro-Peat Coal Company, Limited. Particulars of the company will be found in another column.

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**Cardiff.**—In order to save an estimated expenditure of £6,000 on laying cables, a recommendation has been made by the electrical engineer (Mr. Arthur Ellis) that an electric lighting sub-station be erected at the docks. The Council have now agreed upon the purchase of a site, assuming that the consent of the ground landlord be obtained to the alteration of the property for the purpose intended. Mr. Ellis, in his last report, stated that the net profit on the electric lighting for the past year was approximately £2,500, an increase of 41 per cent. as compared with last year.

**Watford.**—An enquiry will be held into the Urban District Council's application for sanction to a loan for purposes of electric lighting. Mr. C. P. Ayres, in consultation with Mr. Colebrook, is to prepare the necessary plans and sections at once to enable the Council's application to proceed. The committee have approved of the substitution of a 400-kw. set for a 300-kw. set, and the electrical engineer has been authorised to visit certain towns and to advise the Council as to the best type of steam alternator to be purchased, and that a special committee be summoned as soon as possible.

**Barry.**—A Bill to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, came on Monday before Mr. Campion, one of the examiners of the House of Commons, for proof of compliance with Standing Orders. There was no opposition at this stage, and the necessary formal proofs having been given, the examiner decided that the orders had been duly complied with. The Bill will accordingly be reported for second reading. It contained an order amending the Barry Electric Lighting Order, 1901, so that Section 6 of that order shall have effect as if it had commenced on the passing of the present order.

**Batley.**—The Corporation electricity works have now been supplying current since the beginning of August last, and there are 45 consumers taking current for light, and 22 for power and heating. Over 20 motors are connected to the mains, with a total of 120 h.p. The price for current is charged on a sliding scale, varying between a maximum of 6d. per unit and a minimum of 3d. for lighting, and 3d. and 1d. for power and heating. During the quarter ended March 31, the average price for lighting has been 4·29d. per unit and 2·3d. per unit for power. Large consumers have obtained the light as low as 3½d. to 4d. per unit, and power and heating have been supplied as low as 1·18d. to 1·5d. per unit, which, comparatively, are very low.

**Warrington.**—An enquiry has been held into an application of the Town Council to borrow £5,000 for electric lighting purposes. The town clerk, Mr. J. Lyon Whittle, explained that the application included £836. 10s. 11d. paid in excess of the amount wanted for buildings; £119. 16s. 1d. paid in excess for street-lighting; £3,033. 9s. 2d. for extensions to mains which had been laid down; and £1,000 for other extensions. Mr. Mathias gave evidence, and it was stated that the electricity undertaking was making a profit. The gross profit for the year had been £4,433. 0s. 10d., and the net profit £154. 15s. 3d. The latter sum goes towards the reduction of a debit balance of the previous year of £495. 8s. 3d., which left the sum of £340. 13s. outstanding.

**Southend.**—The electrical engineer says in his report: "It has been the practice to charge new consumers at the flat rate of 4½d. per unit for their first quarter's consumption. This, in my opinion, is too great a concession. It is necessary to instal machinery before it is actually required, and, therefore, new consumers should bear their full share of our stand-by charges. All new consumers should pay their full rate unless they earn a rebate, as by this means only shall we in future be able to make a further reduction to our long-hour and, therefore, paying customers." The borough accountant's statements show that the estimate for the electric lighting fund for the year ended March 31, 1904, was £8,725, and that the approximate expenditure had been £9,424. The estimated income was £8,400, and the approximate income £9,844.

**Rochdale.**—Dr. Kennedy sums up his report on the proposed dust destructor distinctly in favour of the erection of the new destructor as close to the present electrical generating station as possible. It is expected that the question will be submitted to the Town Council in a definite form at the next meeting. The electricity works now show a profit. The receipts for the year amount to £7,542, against £4,330, an increase of £3,212. To the total received the Tramways Committee, of course, contributed very largely, paying £2,500 for current for traction purposes. They are supplied practically at cost price. Expenses have, of course, risen in the department with the increased turnover, but the rise is less than £1,000 and the net result is a surplus of £622. This amount is to be carried forward. Twelve months ago the department showed a deficit of £1,492, and in 1902 of £2,385.

**Underground Telegraphs.**—A letter from the Postmaster-General to the secretary of the Edinburgh Chamber of Commerce is included in the annual report to be submitted at the annual meeting of the chamber to-morrow stating that the line of pipes for the underground cable is now run continuously from London to Carlisle, and that a section of 19 miles has also been laid over the Beattock incline in Scotland. It had been expected by the 31st ult. that a double line of pipes from Manchester to Leeds would have been completed, and that the permanent cable would have been ready for use as far as Warrington. These expectations had not, however, been realised owing to a wayleave difficulty having arisen in regard to a short section of the route in each case, and it was hoped that the difficulties would soon be overcome and these sections of the work completed. Provision had been made in the estimates of the current financial year for a very considerable extension of the line.

**Lothians Electric Power Bill.**—This Bill is before a committee to proceed as an unopposed measure. This result has been brought about by the adjustment and insertion of clauses protecting the interests of the counties affected, the Corporations of Edinburgh and Leith Gas Commissioners, the Edinburgh and District Water Trustees, the Water of Leith Purification and Sewage Commissioners, and the North British and Caledonian Railway Companies, together with a general clause for the protection of coalowners. Under the Bill the promoters seek power to supply electric energy within an area consisting of the greater part of Mid-Lothian, with the exception of Edinburgh and Leith, and the parishes of Stow and Fala and Soutra, the western half of Haddingtonshire, and an adjacent portion of the counties of Lanark and Peebles. Generally speaking, the area marches on its western side with the eastern boundary of the area sanctioned under the Scottish Central Electric Power Act of last year. It is intended to erect generating stations at different parts of the authorised area for the supply of electric energy and light to manufacturers, coalowners, and local authorities.

**London Gazette.**—The partnership between William Blenheim and Harry Meade, carrying on business as W. Blenheim and Co., 3, Grange-road, Egham, Surrey, electricians, has been dissolved by mutual consent. William Blenheim will continue the business. The first meeting in the estate of Charles Manners Downie, electrical engineer, 4, Bloomsbury-street, London, and 28, Heathfield-road, Crouch Hill, Middlesex, will be held at 12 noon on May 3 at Bankruptcy-buildings, Carey-street, London. A general meeting of the members of the Electrical Power Storage Company, Limited, will be held at 4, Great Winchester-street, London, E.C., on May 13, at 12.30 p.m., to have an account laid before them showing the manner in which the winding up has been conducted and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator. (This refers to the old company of this name incorporated in 1882, and of which the capital was repaid in the liquidation thereof in 1889.) The Cleveland and Durham County Electric Power Company, Limited, is to be wound up voluntarily. George Dudley Prince, 5, Great George-street, Westminster, has been appointed liquidator. The Board of Trade have, after modification, confirmed the Kent and East Sussex Light Railway (General Powers) Order, 1904, amending the Cranbrook and Tenterden Light Railway Order, 1899.

**London County Council.**—The County Council on Tuesday agreed to lend the Battersea Borough Council £10,249 for electric lighting works. Sanction to borrow £17,650 for electric light installation and £40,000 for electric installation and meters was given to the Stepney Borough Council. The Highways Committee's recommendation that £5,000 be voted for the purchase of The Gables, East-hill, Wandsworth, for the erection of a sub-station for the electrical working of a portion of the Council's tramways was agreed to, also another recommendation of the same committee as follows: (*a*) that expenditure not exceeding £15,000 be authorised in connection with the supply, delivery, and laying of (1) the high-tension cables, and (2) the low-tension cables, required in connection with the reconstruction for electrical traction of certain short lengths, situated in the metropolitan boroughs of Southwark and Bermondsey, of the London County Council tramways; (*b*) that the offers of Messrs. Siemens Bros. and Co., Limited, and the British Helsby Cables, Limited, respectively to supply, deliver, and lay at the schedule rates under their existing contracts with the Council, (1) the high-tension cables, and (2) the low-tension cables, referred to in the foregoing resolution, be accepted. Tenders for the erection of the superstructure of the first portion of the (London County Council tramways) electricity generating station at Greenwich, were referred to committee for consideration and report.

**Gillingham.**—The engineer in his last report states that 1,587 8-c.p. lamps had been connected since the last meeting, making a total of 10,085 8-c.p. lamps, with 169 consumers, and that applications had been received for 203 8-c.p. lamps. Tenders for the purchase of the old machinery have been received from the following: Thomas Johnson, Wigan; I. Levy and Son, Old Kent-road, London; Thompson and Son, Millwall; A Very and Co., Dover. The Electric Light and Baths Committee have further considered the memorial from traders using electric light. The following reply will be sent: (1) That the present maximum charge of 7d. per unit combined with the minimum charge of 2d. per unit compares favourably with the charges made by other towns in the South of England; that, where circumstances warrant a reduction in the price, the question of charge will be further considered. (2) That Gillingham is not exceptional in charging 78 days per quarter, as in most places a charge is made for 91 days. (3) That although the consumers referred to only take supply for an average of 64 days per quarter, the interest on capital expenditure and depreciation on the plant required to supply them has still to be paid for the remaining 27 days per quarter. During the 27 days the plant is standing idle as far as they are concerned, but in the case of licensed victuallers and private houses the plant is in use for the whole period, or, in other words, is earning money. The Local Government Board is being urged to expedite the holding of the enquiry with reference to the proposed borrowing by the Council of the further sum of £20,000.

**Kingston.**—The Guardians have passed the required formal resolution consenting to the installation of electric lighting for the infirmary buildings, in accordance with plans approved by the Local Government Board, but subject to such modifications as that Board may hereafter direct; also to the expenditure for such purpose of a sum not exceeding £2,250, and to the borrowing of such sum or such part as may be necessary. At the recent enquiry into the application by the Corporation for permission to borrow a further loan of £15,850 for purposes of electric lighting, the borough electrical engineer (Mr. J. E. Edgcome) said the application included not only what had been spent, but so far as they knew what may be required for the next three years. The work for which the excess expenditure had been incurred had been carried out since November, 1902, and had been completed about the beginning of September last year. The existing capacity of the works was 600 kw., equivalent to 22,000 lamps of 8 c.p. running at one time. The number of lamps at present connected was equal to 28,665 of 8 c.p., of which about two-thirds were burning sometimes together. The motors connected at present were equal to about 26 h.p. After the present loan had been expended on the contemplated extensions the capacity of the works would be increased to 800 kw., or 7,333

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additional 8-c.p. lamps running at one time. He calculated that would last for the next three years, unless they got an abnormal number of customers. Mr. H. Burstall, consulting electrical engineer, and Councillor J. M. Francis, vice-chairman of the Lighting Committee, said they believed that the expenditure was necessary in order to efficiently carry on the undertaking.

## PROVISIONAL PATENTS, 1904.

APRIL 15.

**8632. Improvements in or relating to the decoration of articles by the electro-deposition of metals.** Walter Kenyon, Bank-buildings, George-street, Sheffield.

**8642. Improvements in or connected with trolleys for overhead electric tramways.** Arnold Grant Livesay, 23, Richmond-mount, Headingley, Leeds.

**8656. Improvements in electric arc lamps.** Frank Proctor, 38, Wilberforce-road, Finsbury Park, London.

**8657. Improvements in printing telegraph receivers.** James Dundas White, 50, Clanricarde-gardens, London.

**8663. Improvements in switches for electromotors.** Harold George Jeken, 24, Basinghall-street, Leeds.

**8669. The application of a new and improved insulator for use in electric, kindred, and other trades.** Daniel Gillies, 18, John-street, Sunderland.

**8686. An improved galvanic battery.** Philippe Delafón, 53, Chancery-lane, London.

**8693. Improvements in or relating to electric arc lamps.** Ganz und Co., Eisengiesserei-und Maschinenfabriks Akt. Ges., 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, May 9, 1903, being date of application in Germany.) (Complete specification.)

**8694. Improvements in or relating to alternating-current arc lamps.** Ganz und Co., Eisengiesserei-und Maschinenfabriks Akt. Ges., 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, July 24, 1903, being date of application in Germany.) (Complete specification.)

**8699. Improvements in and relating to windings for dynamo-electric machines and in methods of, and apparatus for, forming the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8703. Improvements in electric switches.** Rudolf Zwack and Lorenz Kottmair, 7, Southampton-buildings, Chancery-lane, London.

**8714. Improvements in electric switches.** Henry James Gore, 322, High Holborn, London.

**8715. Improvements in and connected with electric circuit cut-outs.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Johnston and Claude Johnston, United States.) (Complete specification.)

**8722. Process and apparatus for preventing snow settling upon aerial conductor wires.** Eduard Lob and Alexander Feigelberg, 40, Chancery-lane, London. (Complete specification.)

APRIL 16.

**8731. Improvements in automatic electric circuit breakers.** Hugh Swanton, 62, White Horse-street, Stepney, London. (Complete specification.)

**8737. Improvements in and connected with mechanically-replaced annunciator movements for telephone switchboards.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

**8745. Improvements in the trolley pulleys of electric tramcars.** George Anthony Binns, Penny Bank-chambers, Halifax.

**8777. An improvement in the attachment of globes or shades to electric lamp fittings.** Joseph Silvers Williams Thomas and John Northwood, Glass Works, Brierley Hill, Staffs.

**8802. Improvements in or relating to the construction of rotary magnets and other bodies carrying detachable weights or loads.** James Bonelle Willis, 46, Lincoln's-inn-fields, London.

**8819. Improvements relating to incandescent electric lamp fittings.** Sandor Löti, and Rudolf Latzko, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**8826. Improvements in safety appliances for electric circuits.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany.) (Complete specification.)

APRIL 18.

**8848. Improved means for securing shades on the holders of electric incandescent lamps.** Charles Wellington Crocker, Lloyds' Bank-buildings, Bristol.

**8891. Improvements in or relating to telephones.** Percy Adolphus Vaile, 24, Southampton-buildings, Chancery-lane, London.

**8903. Pressure-controlled electric switches.** Benjamin Hyde, 46, Lincoln's-inn-fields, London. (Complete specification.)

**8912. Improvements in line selectors of intercommunication telephone apparatus.** Franz Wallech, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 25, 1903, being date of application in Germany.) (Complete specification.)

APRIL 19.

**8922. Improvements in automatic electric switches for controlling motors and circuit breakers.** William George Haywood and Sydney George Brounger, 56, High-street, Bloomsbury, London.

**8956. Electric candle nozzle.** Frederick Thomas, Harry Jones, and Sydney Thomas, 189, Drummond-street, Hampstead-road, London.

**8960. Improvements in and connected with automatic short-circuit lever switches.** Ernst Hiller, 33, Cannon-street, London.

**8965. Improvements in section insulators for overhead trolley wires.** Siemens Bros. and Co., Limited, Joseph Fitzalon Simpson, and Herbert Christopher Wheat, York Mansion, York-street, Westminster, London. (Complete specification.)

**8966. Improvements in the manufacture of electrical apparatus.** Albert Parker Hanson, 32, Oswaldestre House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 20, 1903, being date of application in Denmark.) (Complete specification.)

**8984. The manufacture of positive electrodes for galvanic batteries.** Philippe Delafon, 53, Chancery-lane, London.

**8986. Improvements in electrically-propelled road vehicles.** La Société Anonyme l'Eléctrique, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 14, 1904, being date of application in France.) (Complete specification.)

**8991. Improvements in self-winding electric clocks.** Frank T. Talcott and Benjamin F. Kerr, Fife House, Kingston-on-Thames.

**8992. Telephone and telegraph system.** Thomas W. Gleeson and Robert Hamilton, 56, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 1, 1903, being date of application in United States.) (Complete specification.)

**8999. Improvements in means for protecting the live parts of electric switches or the like.** William McDevitt, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**9008. Improvements in self-registering electrically-operated sectional targets.** George Armstrong Peters, 4, South-street, Finsbury, London.

APRIL 20.

**9103. Improvements in electric igniting devices for miners' safety lamps and the like.** Charles Aubrey Day, 321, High Holborn, London. (Fabrik Elektrischer Zünder, G.m.b.H., Germany.)

**9115. Improvements in and relating to electric boosters.** The British Thomson-Houston Company, Limited, and Sydney Woodfield, 83, Cannon-street, London.

**9116. Improvements in reflectors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States).

**9117. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9123. Improvements in electric arc lamps.** Charles Edwin Foster, Edwin Rudolph Grote, and Milton Victor Ely, Palace-chambers, Westminster, London. (Complete specification.)

**9133. Improvements in and relating to monophase collector motors.** Georges Meller, 7, Southampton-buildings, Chancery-lane, London.

APRIL 21.

**9190. Improvements in arc lamp electrodes.** William Stone Weedon, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, April 21, 1903, being date of application in United States.) (Complete specification.)

**9208. Improvements in or relating to overhead conductors for supplying electrical energy.** Oswald Jones, James Proctor, Kyd Clark, and Tinsley Waterhouse, 46, Lincoln's-inn-fields, London.

**9215. Improvements in electric switches.** William Wilson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, April 21, 1903, being date of application in United States.) (Complete specification.)

APRIL 22.

**9226. Continuous-burning arc lamp with amalgam electrodes.** Georg Hoffmann, 17, Eisenacherstrasse, Berlin, W., Germany. (Complete specification.)

**9238. An improved joint for coupling up telegraph and telephone wires and the like.** Elias George Wright, 44, Woodbridge-road, Guildford, Surrey.

**9248. Improvements in the manufacture of guards, frames, or shades for electric lamps.** William Henry Stockham, 37, Leyton-road, Handsworth, Staffs.

**9255. Improvements in or relating to electrometers for motor vehicles and to the fixing or supporting of the same.** The Romanoff (London) Syndicate, Limited, 139, Queen Victoria-street, London. (Hippolyte de Romanoff, France.)

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**9303. Improvements relating to electrical control of winding engines for the prevention of accidents.** Thomas Campbell Futers, 18, Buckingham-street, Strand, London.

**9306. Improved apparatus for the automatic regulation of electric current.** The Aktiengesellschaft Brown, Boveri, et Cie., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 23, 1903, being date of application in Switzerland.) (Complete specification.)

**9307. Improvements in alternating-current meters on Ferraris principle.** Emanuel Morck, 46, Lincoln's-inn-fields, London. (Complete specification.)

**9310. Improvements in or relating to electric burglar and fire alarms.** Henry Birkbeck, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Solomon Schwarzschild, William S. Dodd, and James F. Johnson, United States.) (Complete specification.)

APRIL 23.

**9340. Improved means for carrying overhead trolley wires of electric tramways.** Francis Morris, 65, Chancery-lane, London.

**9372. Improvements in armatures for dynamo-electric machinery.** Arnold Frank Hills, David Urquhart, and Alfred Edward Honey, 4, South-street, Finsbury, London.

**9373. Improvements in brushes for dynamo-electric machinery.** Arnold Frank Hills, David Urquhart, and Alfred Edward Honey, 4, South-street, Finsbury, London.

**9375. Improvements in and relating to electrical resistances.** Elise Vedovelli, *nee* del Castillo, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 19, 1903, being date of application in France.) (Complete specification.)

**9377. Improvements in electric treadles or contact makers for railway signalling and the like.** Sidney Prescott Wood and McKenzie and Holland, Limited, Palace-chambers, Westminster, London.

**9385. Improvements in apparatus for the automatic regulation of current in electric lighting installations.** Aktiengesellschaft Brown, Boveri, et Cie., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 25, 1903, being date of application in Switzerland.) (Complete specification.)

**9386. Improvements in and relating to electric jacquard card-cutting, electric weaving, and the like.** Oskar Zerkowitz, 27, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 12, 1904.*

1903.

**3620A. Dynamos.** McElroy. (Date applied for under Patents Rule 9, Feb. 16, 1903.)

**6477. Electro-therapeutic high-frequency apparatus.** Phelps and Bowie. (Post-dated April 17, 1903.)

**8447. Means for electrically operating ships' steering gear.** Kühn.

**8566. Electrical combined with compressed air or other motive fluid system of driving, especially applicable to locomotives and motor carriages of electrical railways.** Sahulka.

**8670. Alternating electric current motors.** Carolan. (General Electric Company.)

**8774. Wireless telegraphy.** Wheatley. (Lewis and Armitage.)

**11607. Bases for incandescent electric lamps.** Carolan. (General Electric Company.)

**12313. Electric meters.** Carolan. (General Electric Company.)

**13226. Enclosed electric arc lamps.** Hamilton-Adams.

**13358. Electric couplings.** Shepherd.

**14168. Systems of electrical distribution.** Le Tall. (Cooper-Hewitt Electric Company.)

**14169. Systems of electrical distribution.** Le Tall. (Cooper-Hewitt Electric Company.)

**14174. Systems of electrical distribution.** Le Tall. (Cooper-Hewitt Electric Company.)

**14380. Contact breakers for induction coils.** Van Raden and Robinson.

**15059. Electrical winding apparatus.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

**24909. Luminous vapour electric lamps and methods of making the same.** Steinmetz. (Date applied for under International Convention, Nov. 17, 1902.)

**26239. Combined trolley arm and brake controllers for electric tramcars.** International Trolley Controller Company and Kynoch.

**26352. Vacuum arc lamps with external air-cushioned regulating device.** Emonds.

**27712. Electric glow lamps with metallic filaments.** Abel. (Siemens und Halske Actiengesellschaft.)

**28699. Electric telegraphy.** Rugh.

**28806. Sockets for incandescent electric lamps.** Bakeley and Schrage.

**28807. Sockets for incandescent electric lamps.** Bakeley and Schrage.

1904.

**306. Trembler for induction coils.** Blake.

**3913. Process of and apparatus for the generation of electric energy.** Keyzer.

**4660. Electric contact breakers or tremblers for ignition coils.** Cohen and Cohen.

**6305. Electric arc lamps.** Beck.

**6679. Fuses for electric blasting.** Render.

**6843. Terminal attachment for the conducting wires of electrical machines and apparatus.** Stuser.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¼-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5¼-6 |
| —— 5 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5-5¼ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 101-106 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3¾-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 90-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-106,751 .. | 2 | .. | ¼-¾ |
| —— Non. Cum., 5 per cent. Pref. ..... | 2 | .. | 1-1¼ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 96-99 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 72-77 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5¾ |
| Crompton and Co. ..... | 5 | .. | 13-14 |
| —— 5 per cent. Debentures..... | 100 | .. | 96-98 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 5 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures..... | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1½-1¾ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2¾-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-9¾ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11½-12¼ |
| —— 4½ per cent. Preference ..... | 5 | – | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | – | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 18¼-19¼ |
| —— 4 per cent. Debentures..... | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 14¼-15¼ |
| Telegraph Construction and Maintenance..... | 12 | – | 34-37 |
| —— 5 per cent. Bonds ..... | 100 | – | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | – | ⅞-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | – | 113-116 |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 11½-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9½-10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary..... | 5 | – | 10¾-11¼ |
| —— 7 per cent. Preference ..... | 5 | – | 10¼-10¾ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | – | 6¾-7¼ |
| —— Nos. 20,001-30,000 ..... | 5 | – | 6¾-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12½-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 7-7¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5¼-5½ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 102-104 |
| Chelsea Electricity Supply ..... | 5 | – | 6-6¼ |
| —— 4½ per cent. Debentures ..... | 100 | – | 106-109 |
| City of London, Ordinary..... | 10 | – | 10¼-10¾ |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | – | 7-8 |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 5¾-6¼ |
| —— 5 per cent. Cum. Pref. ..... | 5 | – | 5¾-6 |
| —— 4½ per cent. First Mort. Deb..... | 100 | – | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | – | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11¼-12¼ |
| —— per cent. Debenture Stock Red ..... | 100 | – | 102-105 |
| Kensington and Knightsbridge and Notting Hill ..... | 100 | – | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary ..... | 5 | .. | 1-1½ |
| —— 6 per cent. Pref..... | 5 | .. | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | .. | 94-97 |
| Metropolitan Ordinary ..... | 10 | – | 18¼-19¼ |
| ——4½ per cent. First Mortgage Debenture Stock .... | 100 | .. | 109-113 |
| ——3½ per cent. Mortgage Debenture, Red. ..... | 100 | .. | 86-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | .. | 98-101 |
| —— Preference ..... | 4 | .. | 100-103 |
| Notting Hill Electric Lighting ..... | 10 | .. | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs ,Nos. 1-500 (Reg.).. | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 3. -14,310..... | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock ..... | 100 | .. | 96-99 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 98-101 |
| Smithfield Markets Electric Supply, Ltd., rd., 1-12,000.. | 5 | – | 3-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 85-90 |
| South London, Ordinary ..... | | – | 3¼-3¾ |
| St. James's and Pall Mall, Ordinary, 101-20,080 ..... | 5 | – | 14-15 |
| —— 7 per cent. Pref. ..... | 5 | – | 8-9 |
| —— 3½ per cent. Deb. ..... | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 4¼-4¾ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4¾-5 |
| Westminster, Ordinary ..... | 5 | – | 12½-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251..... | 5 | – | 5-5¼ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 92 95 |
| —— 4 per cent. Pref. | 100 – | 98-101 |
| —— ,, ,, deferred | 100 – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 – | 109-112 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 122-125 |
| —— ,, ,, ,, '96 | 100 – | 120-123 |
| —— ,, ,, ,, '01 | 100 – | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10 10¼ |
| —— Ordinary, 1-50,000 | 10 – | 4 13/16-4 15/16 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — – | 93¾-10¼ |
| Waterloo and City, Ordinary | 100 – | 89-92 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 4¼-5¼ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 – | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1¼-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 97-102 |
| British Columbia Electric Railway Co., Ord., Nos. 1-20,000 | 100 – | 99-102 |
| —— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 | 10 – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 – | 102-104 p.c. xd |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 8¼-9 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 9⅞-10¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 114-117 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅝-2¾ |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 – | 5¼-5⅜ |
| —— "B" 5 per cent. Cm. Pf., 1-27,500 | 5 – | 4¾-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 104-107 |
| —— Prov. Cert., all paid | 100 – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅞-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 – | 101-104 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 10¼-10½ |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 100-101 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-13¼ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18¼-19¼ |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 – | 108-111 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¾-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8¼ 8⅜ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11¼-11⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 – | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 – | ¾-1 |
| New General Traction, Ordinary | 5 – | ⅜ |
| —— 6 per cent. Cum. Pref. | 5 – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12¼-12½ xd |
| —— 5 per cent. Cum. Pref. | 10 – | 9¼ 9⅞ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,152 5 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 103-105 |
| —— Deferred Stock | 100 – | 88 91 |
| —— 6 per cent. Cum. First Pref. | 10 – | 10 12 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 10-12 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5¼ |
| —— 5½ per cent. Deb. Stock, Red. | 100 – | 97-99 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 101-103 |
| Oriental Telephone and Electric Company | 1 – | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 23 | 1,230 | 978 | + 301 | +11,544*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 16 | 207 | 311 | – 104 | + 118 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 23 | 37 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 24 | 1,023 | 985 | + 38 | – 81 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 23 | 268 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 22 | 889 | 806 | + 83 | + 104 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 21 | 556 | 423 | + 133 | + 66 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 23 | 313 | 295 | + 18 | – 326 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 24 | 1,794 | 1,752 | + 42 | – 252 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 20 | 1,165 | 950 | + 215 | — | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 23 | 3,925 | 3,297 | + 682 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 21 | 844 | 726 | + 118 | + *6h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 22 | 5,076 | 4,477 | + 599 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 23 | 1,035 | 732 | + 303 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 24 | 318 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 23 | 1,945 | 1,639 | + 305 | + 80 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 23 | 198 | 184 | + 14 | + 272 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 23 | 6,538 | 7,073 | – 535 | – 1,073*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 24 | 2,778 | 2,971 | – 193 | – 1,364*h* | 6⅜ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 21 | 441 | 436 | + 5 | – 184 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 15 | 210 | 262 | – 52 | – 103 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 23 | 195 | 185 | + 10 | – 140 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 24 | 126 | 93 | + 33 | + 81*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 22 | 3,885 | 3,732 | + 153 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 22 | 1,031 | 784 | + 247 | | | | | | | | | | | |
| Dundee City Tramways | ,, 20 | 832 | 752 | + 80 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 23 | 753 | 588 | + 165 | + 220 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 23 | 14,935 | 13,293 | +1,642 | +59,239*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Halifax Corporation | ,, 20 | 2,554 | 2,994 | – 440 | – 39 | 31⅔ | 30¼ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 9 | 1,546 | 1,186 | + 360 | + 8,914 | 34 | 34 | March 31 | 56,631*h* | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | ,, 23 | 2,026 | 1,637 | + 389 | + 497 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 23 | 467 | 345 | + 122 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 21 | 149 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 20 | 281 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 23 | 5,532 | 4,887 | + 645 | + 1,821 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 16 | 9,954 | 10,120 | – 166 | + 3,116 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 24 | 1,618 | 1,631 | – 13 | + 142*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | Mar. 12 | 10,129 | 8,604 | +1,525 | +84,720 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | April 16 | 143 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 23 | 11,700 | 11,341 | + 359 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 24 | 116 | 59 | + 57 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 23 | 3,487 | 2,876 | + 611 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 23 | 464 | 287 | + 176 | + 347 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 23 | 1,774 | 1,403 | + 371 | + 564 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 4 | 118 | 119 | + 29 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | Mar. 17 | 409 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | April 25 | 3,331 | 3,135 | + 745 | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 25 | 4,556 | 4,042 | + 514 | – 156 | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 21 | 919 | 864 | + 85 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 20 | 277 | 225 | + 51 | + 63 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 22 | 531 | 269 | + 262 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 24 | 1,170 | 1,020 | + 150 | – 115 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,937,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 23 | 679 | 595 | + 85 | + 13 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |
| West Ham Corporation | ,, 21 | 754 | — | — | — | 1¾ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 20 | 551 | 518 | + 33 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Tramways and Light Railways Association.**—The meeting called for to-day on the subject of "Running Powers" has been postponed. The fresh date will be notified by the secretary in due course.

**The Institution: Students' Section.**—The annual general meeting of the Students' Section, for the election of committee for the session 1904-5, will be held at 92, Victoria-street, S.W., on Wednesday, May 18, at 7.30 p.m. Nominations for committee representatives of extra-collegiate students should be sent in to the Students' hon. secretary by the 11th inst.

**McMillan Memorial Fund.**—The amounts received to May 3, 1904, inclusive, for the above fund total £1,482. 10s. 5d., made up as follows: members, £837. 1s. 4d.; associate members, £231. 13s. 6d.; associates, £231. 4s. 10d.; students, £49. 10s. 3d.; foreign members, £18. 17s.; subscriptions from non-members, £114. 3s. 6d. This is still £500 short of the amount desired, and we trust that further contributions will be quickly forwarded.

**The St. Louis Exhibition.**—The long-talked-of exhibition at St. Louis was inaugurated last Saturday, President Roosevelt, on an electric signal from the scene of the function, setting the machinery in motion by a switch. It is stated that the total sum expended in connection with the exhibition amounts to £10,000,000. Among the national exhibits of foreign countries, those of Japan are the most complete. There was a large throng at the opening ceremony, though the inhabitants of New York have not manifested any great interest so far. It is expected, however, that interest will greatly increase when the magnitude of the undertaking is realised.

**Portsmouth Telephone Service.**—The accounts relating to the first year's working of the Corporation's telephone system disclose a highly satisfactory state of affairs. The income aggregated £6,588, and the working expenses, including £1,100 for staff, £800 for maintenance and repairs, £576 royalty to the Post Office, and £587 paid to the Government for trunk calls, totalled £3,899. This leaves a balance of £2,689, equivalent to a dividend of over 9 per cent. on the capital investment of £29,000. Deducting £1,464 paid in reduction of principal and for interest, there remains a net profit of £1,225, which the Corporation have judiciously decided to utilise as the foundation of a reserve fund. The Telephone Committee and its officers are to be congratulated upon such a successful result.

**The Carnegie Institution (New York).**—Dr. L. A. Bauer has been made director of the department of international research in terrestrial magnetism, the establishment of which was authorised at the last annual meeting of the trustees of the Carnegie Institute, and has commenced the work of organising. It is intended that the department shall investigate problems of international concern and benefit, its object being to supplement, not to supplant, existing institutions. The initial undertaking of the department will consist of the complete reduction, discussion, and corollation of the existing observatory data, and the publication of the results in suitable form, so as to exhibit the present state of our knowledge, reveal the gaps and suggest future and supplementary investigations. Those having certain phases of work already in hand will be invited to associate themselves with the department.

**The Royal College of Science.**—On Thursday of last week his Majesty laid the foundation stone of the new Royal College of Science at Dublin. In an address describing the origin and objects of the new building, the Vice-President of the Department of Agriculture and Technical Instruction stated that the college was now the principal institution connected with the system of technical instruction which the Department had been commissioned to organise for Ireland. Its function was to supply advanced instruction in science as applied to agriculture and industry, to train teachers for technical schools and for secondary and intermediate schools in which science is taught, and to conduct research. His Majesty alluded to the necessity for scientific training in connection with commercial and industrial life, and complimented the authorities upon the provision of modern equipment. His Majesty also expressed his gratification at the co-operation of the representative public bodies, which was indispensable to complete success.

**Electricity in Mines.**—At the forty-seventh annual meeting of the South Wales Institute of Engineers, held at Cardiff, Mr. E. M. Hann (general manager of the Powell Duffryn Company), the new president, after alluding to the reluctance of the British capitalist to invest his money in home industries, referred to the rapid development of electricity for the transmission of power in the past few years. He remarked that groups of collieries evidently afforded a more promising field for self-supply than a single mine, and it would interest members to hear that the Powell Duffryn Company had decided to put down at a central point among their Aberdare pits a modern three-phase plant of about 4,500 h.p. to supply about 85 motors at seven different pits. Mr. Griffiths gave an explanation of a new electrical cut-out, of which he is joint patentee, called the "Sentinel control," which claims to obviate the necessity of replacing the melted fuses. The Sir W. T. Lewis prize for the best essay was awarded to Mr. H. D. B. How, the subject being "Electrical Winding."

**Glasgow Local Section.**—The fourth annual report of the committee of this Local Section, which is to be presented to the general meeting on Tuesday next, shows a satisfactory state of progress. The committee complain, however, that the members do not attend the meetings so regularly as they should do. The papers, though few in number, have been of high standard, and have resulted in good discussions. The net increase in the membership for the past 12 months is four. The committee's list of office bearers for the new session is as follows, and, as no fresh nominations have been received, the various gentlemen named are elected to the positions in question: past-chairmen—Lord Kelvin, G.C.V.O., etc., Prof. Magnus Maclean, D.Sc., Mr. Henry A. Mavor, Mr. W. A. Chamen; chairman—Mr. Robert Robertson; vice-chairman—Prof. Francis G. Baily; hon. secretary and treasurer—Mr. E. George Tidd; ordinary members of committee—Prof. A. Gray, LL D., and Messrs. M. T. Pickstone, Wm. W. Lackie, J. M. M. Munro, John Macfee, Sam Mavor, A. W. Stewart, E. T. Goslin (representing associate members), J. R. Stothert (representing associates.) Some interesting papers have been offered for the next session, but the committee are still wishful to obtain more original contributions on which valuable discussions may take place.

**The Tariff Commission and Engineering.**—The Engineering and Machinery Committee of the Tariff Commission, consisting of Sir Andrew Noble, the Hon. Charles Parsons, and Messrs. Francis Elgar, George Flett, W. Harrison, H. D. Marshall, and A. W. Maconochie, M.P., completed arrangements last week for taking evidence from a selection of representative witnesses without regard to their views on the fiscal question. In addition, the committee are circularising all manufacturers in these trades

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with the object of obtaining information, which will, if desired, be treated as confidential, upon the state of the industries, and the features and developments connected with them, during the period 1899-1903, so as to ascertain the effect of tariffs. Suggestions are also invited in regard to the defence of home commerce, if any be considered necessary. It is desired to obtain special information relating to the particular trades, the enquiry being supplementary to the general one addressed to manufacturers in all trades.

**London Traffic Commission.**—Evidence was tendered last week by Mr. Granville C. Cuningham, general manager of the Central London Railway. He submitted that the traffic to be provided for was mainly a traffic towards the heart of London and out again, and not a traffic through from one side of the City to the other. Elongated double-track loops extending from the outskirts to the centre of the City would be the fundamental idea for the construction of such a complete system. Such a loop as the one proposed by the extension of the Central London to Liverpool-street, and then back by the Strand, Piccadilly, and Knightsbridge-road to Hammersmith, and thence to Shepherd's Bush, gave a fair notion of what was required. In designing such a system, it was, of course, intended that existing railways should, as fair as possible, form a part of it. The public usefulness and the financial success of any tube system would depend chiefly upon the rate of fare charged. Regarded from the point of view of the working community, he considered that the best system consisted of low fares for long distances, and not low fares for short distances.

**The Institution Presidency.**—At its meeting on the 28th ult. the President of the Institution of Electrical Engineers, Mr. Gray, outlined a departure in regard to the presidency for the ensuing year, which the Council consider advisable in consequence of the death of Mr. McMillan. In order to secure a continuity of policy, it is proposed to nominate a past-president for the interval between the election and the commencement (some time in November) of the next session, when the new president will assume office, occupying it until the end of the session. The Council have decided to nominate Mr. Gray for re-election during the first period, and Mr. Alexander Siemens to succeed him upon the opening of next session, until which date there will thus be a president and a president-elect. Mr. Gray expressed his confidence, which will doubtless be reciprocated by the members, that they would appreciate the advantages accruing from such an arrangement. He observed that there would be opportunities for the President, President-elect, and the new Council to exchange views with the object of attaining the result contemplated by the Council in introducing the new presidential scheme, whilst the forthcoming conversazione would enable him to informally present his successor.

**Royal Institution.**—The annual meeting of the members of the Royal Institution was held on the afternoon of May 2, Sir James Crichton-Browne, M.D., treasurer and vice-president, in the chair. The annual report of the Committee of Visitors for the year 1903, testifying to the continued prosperity and efficient management of the institution, was read and adopted, and the report on the Davy-Faraday research laboratory of the Royal Institution, which accompanied it, was also read. Seventy new members were elected in 1903. Sixty-two lectures and 20 evening discourses were delivered in 1903. The following gentlemen were unanimously elected as officers for the ensuing year: president—the Duke of Northumberland; treasurer—Sir James Crichton-Browne; secretary—Sir William Crookes; managers—Dr. Henry E. Armstrong, Sir William Abney, Mr. Shelford Bidwell, Sir Alexander Binnie, Mr. J. H. Balfour Browne, K.C., the Hon. Sir Henry Burton Buckley, Sir Thomas A. De la Rue, Bart., Dr. J. A. Fleming, Sir Victor Horsley, Lord Kelvin, Dr. Ludwig Mond, Sir Owen Roberts, Sir Thomas Henry Sanderson, Sir Felix Semon, and Mr. W. H. Spottiswoode; visitors—Dr. J. Mitchell Bruce, Mr. J. B. Broün-Morison, Dr. F. Clowes, Dr. Mackenzie Davidson, Mr. W. B. Gibbs, Mr. Francis Fox, Mr. C. E. Melchers, Mr. R. Mond, Mr. J. Callander Ross, the Hon. Walter Rothschild, Mr. Maures Horner, Mr. A. A. Campbell-Swinton, Mr. J. J. Vezey, Dr. G. Johnstone Stoney, and Mr. G. P. Willoughby.

**The Junior Institution of Engineers.**—A visit of this institution took place on April 29 to the Cassland-road Higher-Grade Board School, Hackney, to inspect the heating and ventilating systems installed there. A particularly noticeable feature was the process of filtration at the air supply, or main intake. A special device in the form of two large drums slowly revolving, on the peripheries of which are laced a layer of fibrous matting, is provided for this purpose. The drums revolve in water, and offer to the impinging air a continuously saturated surface. The friction caused by the fibrous matting through the water, and the water disturbance associated with it, causes the fibres to release the dust, smuts, etc., gathered, and all the sediment thus trapped is passed through the waste-pipe to the drain. After being dealt with in this manner the whole of the air passes through two disc fans driven by an electric motor of 17 b.h.p. The duty of these fans represents the propulsion of something like 20 tons of air into the building per hour, and a commendable and striking characteristic is the general freedom from draughts. To warm this enormous weight of air a Cornish boiler is employed, generating steam at low pressure, and feeding a series of heating batteries distributed at the bases of the rising flues to each room, and which were noticed in the main air-duct. Condensed water is returned to the boiler, but the level of the ground prevents this being done by gravity, and consequently an automatic pump and receiver is in circuit with the heating mains. The average change of air is about 11 times per hour. Messrs. Stott and Co. fitted the installation.

**St. Louis Electrical Congress.**—The following papers have already been promised for Section A, which deals with "Theory": Foreign—Prof. Dr. Paul Drude, "Metallic Conduction"; Prof. Dr. W. Jaeger, "Electrical Standards"; Sir Oliver Lodge, F.R.S., "Ions"; Prof. H. Nagaoka, "Magneto-Striction"; Prof. Dr. J. J. Thomson, F.R.S., subject to be announced; Prof. J. S. Townsend, F.R.S., "The Theory of Ionisation by Collision"; Mons. J. Violle, "Secondary Standards of Light"; Mr. C. T. R. Wilson, F.R.S., "Condensation Nuclei"; Prof. P. Zeemann, "Magneto-Optics." American—Prof. H. T. Barnes, "The Mechanical Equivalent of Heat as Measured by Electrical Means"; Dr. Carl Barus, "Atmospheric Nuclei"; Dr Louis A. Bauer, "The State of our Knowledge regarding the Earth's Magnetism"; Prof. D. B. Brace, "Magneto-Optics"; Prof. H. S. Carhart and G. W. Patterson, jun., Ph.D., "The Absolute Value of the E.M.F. of the Clark and Weston Cells"; Prof. C. D. Child, "The Electric Arc"; Dr. K. E. Guthe, "Coherer Action"; Prof. E. P. Lewis, "Electrical Discharges in Gases"; Prof. L. T. More, "Electro-Striction"; Prof. E. Fox Nichols, "The Unobtained Wave-Lengths between the Longest Thermal and the Shortest Electrical Waves yet measured"; Prof. E. L. Nichols, "Standards of Light"; Harold Pender, Ph.D., "Magnetic Effect of Moving Charges"; Dr. M. I. Pupin, "Electrical Theory"; Dr. Edward B. Rosa, "Alter-

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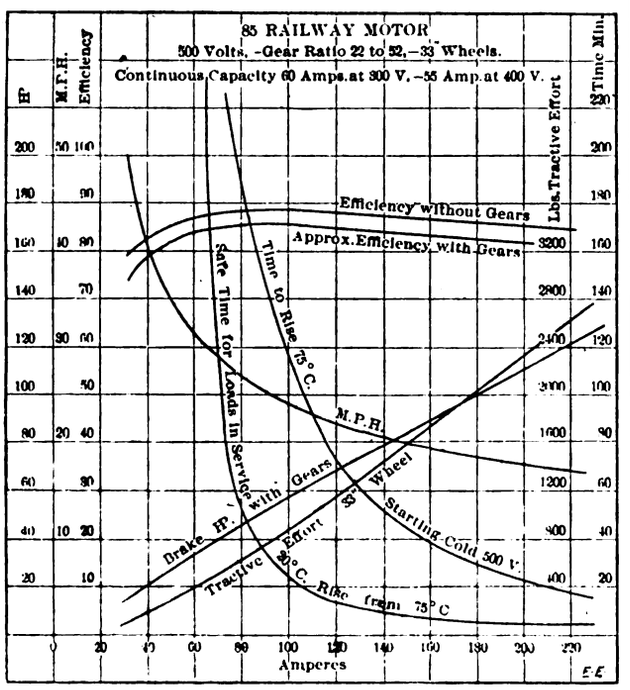
nating-Current Measurements"; Prof. E. Rutherford, "Radioactive Change"; Prof. J. C. McLellan, "Radioactivity of the Atmosphere"; Prof. J. Trowbridge, "Electrical Discharge in Gases"; Prof. A. G. Webster, "Electrical Theory."

**A New Railway Motor.**—The curve given below shows the characteristics of a new railway motor recently standardised by the Westinghouse Company for suburban and interurban service. The motor is rated at 75 h.p., but the curves herewith are of more value in showing what




it can do. After a 10 or 12-hour run with a load of 60 amperes at 300 volts, or 55 amperes at 400 volts, the temperature rise is guaranteed not to exceed 75deg. C. when tested in a shop. Under a moving car with the increased air cooling the rise will not exceed 55deg. C. The diameter of the armature is 15¾in., and it is wound with former-made coils. The commutator, which has 117 sections, is 12in. in diameter and 4¾in. in width. The motor complete with gear and gear case weighs approximately 4,500lb., of which the armature and shaft weigh approximately 995lb. Four such motors with a car weighing from 20 to 25 tons unloaded are considered suitable for an interurban line with a schedule speed of 25 miles per hour if stations occur at intervals of from 1½ to 2 miles. With 36in. wheels and standard gear ratios a maximum speed of 45 miles per hour may be maintained.

**British Association.**—This year the annual meeting of the British Association for the Advancement of Science is to be held at Cambridge under the presidency of the Prime Minister, the Right Hon. Arthur James Balfour, M.P., D.C.L., F.R.S. The dates fixed for the meetings are from Aug. 17 to 24, inclusive. The preparations for the same are being made by an executive committee representing the University of Cambridge, the borough, the Cambridge Philosophical Society, and the County Councils of Cambridgeshire and the Isle of Ely. It is hoped that the meeting will be one of special interest both to the members of the association and to a large number of Colonial, American, and foreign visitors who are being invited to take part in the discussions in the various sections. Arrangements are being made for holding the meetings of the sections as far as possible in the university departments concerned with the sectional subjects, and visitors will thus be enabled to see the facilities which are now available in Cambridge for scientific study and research. It is expected that the Committee on Terrestrial Magnetism and Atmospheric Electricity (a section of the International Conference on Meteorology) will meet at Cambridge under the presidency of Sir Arthur W. Rücker during the session of the association. The following are the names of the members who have been nominated by the council for the office of president of the various sections: Section A (Mathematical and Physical Science), Prof. Horace Lamb, F.R.S.; Section B (Chemistry), Prof. Sydney Young, F.R.S.; Section C (Geology), Aubrey Strahan, F.R.S.; Section D (Zoology), W. Bateson, F.R.S.; Section E (Geography), D. W. Freshfield; Section F (Economic Science and Statistics), Prof. W. Smart, LL.D.; Section G (Engineering), Hon. C. A. Parsons, F.R.S.; Section H (Anthropology), Henry Balfour, M.A.; Section I (Physiology), Prof. C. S. Sherrington, F.R.S.; Section K (Botany), Francis Darwin, F.R.S.; Section L (Educational Science), the Bishop of Hereford. Papers to be read before these sections should be sent to the general secretaries at Burlington House on or before July 18, and should be accompanied by an abstract of their contents. At two evening meetings discourses will be delivered: on Aug. 19 by Prof. G. H. Darwin, M.A., LL.D., F.R.S., on "Ripple Marks and Sandunes"; and on Aug. 22 by Prof. H. F. Osborn, M.A., on "Recent Explorations and Researches on Extinct Mammalia."

**Electric High-Speed Railways.**—Mr. Denninghoff, who has had charge of the company for the investigation of electrical high-speed railways in Germany, recently delivered an interesting lecture on the subject. As the lecturer has been connected with the well-known Marienfelde-Zossen trials, his remarks had additional weight. He pointed out that on Oct. 6, 1903, when the speed of 125 miles per hour was reached for the first time, just 74 years had elapsed since, in a competition of four locomotives at Liverpool, Stephenson obtained the prize, this resulting in the decision being taken to run the Liverpool-Manchester Railway with steam-engines instead of with horses. The first railway constructed in Germany—namely, that connecting Nürnberg and Fürth—was run at a maximum speed of 31 miles per hour, while in 1865 a maximum speed of 47 miles and in 1895 figures as high as 62½ miles per hour were obtained, this being the maximum speed authorised in Germany. After giving a short account of the development of electric railways in Germany, and of the course of the Marienfelde-Zossen high-speed trials, Mr. Denninghoff showed that the air resistance varied as the square of the speed. Thus it was 12·6lb. at a speed of 62 miles per hour, and rose to 42·5lb. per square foot for the maximum speed obtained after 125 miles per hour. If the surface of the car was 108 square feet, this was equivalent to an air resistance as high as 4,580lb., to overcome which at that speed 1,500 h.p. would be required. The air resistance could be reduced by 10 to 15 per cent. by using cars with pointed or wedge-shaped fronts. Taking into account the resistance other than air, a speed of 62 miles per hour corresponded to a total resistance as high as 1,820lb. This converted into horse-power is equivalent to 310 h.p. An increase of the speed to 125 miles per hour brings this figure up to no less than 1,700 h.p. On account of the rapid increase of cost of working entailed by these higher speeds, Mr. Denninghoff thinks that 94 miles per hour is likely to be the practical limit for some time to come. This speed would enable a journey between Berlin and Hamburg to be made in two hours (as against 3½ hours), and that between Berlin and Cologne in four instead of in nine hours. In regard to the endeavours now being made to improve the speed of steam

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locomotives, 75 miles per hour appeared to represent a practical limit, lest the weight of the locomotive became prohibitory. In fact, a locomotive allowing of this speed would have a weight as much as 140 tons, whereas the whole train used on the electric traction high-speed trials weighed only 96 tons.

**Resonance Inductors.**—A long article is contributed by Dr. Georg Seibt to the *Elektrotechnische Zeitschrift* on the subject of resonance inductors, in which the author points out that the production of quick electrical vibrations has become an important question due to the advent of wireless telegraphy. The most serviceable method hitherto employed consists in the discharge of electricity at a high potential through an air-gap, whereby natural vibrations are set up. But if a capacity such as is frequently used in practice be taken, and an attempt made to charge the same by means of inductors and continuous-current interrupters or alternating current and transformers of the types used in connection with Röntgen-ray work, the following disadvantages generally arise. The active potential falls very rapidly at no load, the consumption of current is exceedingly large, and the spark shows a tendency to inactivity due to arcing at the poles of the spark-gap. Some experiments which the author made in the electrical laboratory at Charlottenburg suggested a way in which these defects might be remedied. In order to study the resonance he varied the capacity of the exciter circuit within very wide limits, and incidentally observed that the efficiency of the inductor stood at a maximum, in regard to length and condition of the spark obtained, with a certain load on the capacity. The phenomenon, while not being very marked, was sufficiently so to justify an investigation. This led not only to a simple explanation of the phenomenon, but also to some valuable results affecting the construction and working of the inductors. It was found especially advantageous to loosely couple the primary with the secondary circuits, and to adjust the system so as to obtain resonance between the induced and natural oscillations. Loose coupling has been unconsciously employed by many, but ineffectively, because the condition of resonance was not simultaneously fulfilled. By the expression loose coupling, it is meant here that each of the two coils possess a magnetic field or the inductor is fed by a machine whose output is within the capacity of the inductor. The self-induction of the machine may be regarded as uncoupled, so that even with an excellent transformer free from leakage the arrangement as a whole is loose coupled. On the other hand, by rigid coupling is meant that all the lines which cut the one coil also cut the other, the self-induction of the machine being negligibly small. This state of things occurs when a well-designed transformer is supplied from a central station having a large output. The influence of the coupling is exerted in three directions. Firstly, the duration of oscillation at which resonance occurs is largely dependent on the same; secondly, the looser the coupling the sharper the resonance; and thirdly, the peak values of the curves vary with the coupling. The author enters fully into the theory of resonance inductors, and deducts therefrom the important points to be observed in designing this class of apparatus. He also discusses the respective merits of alternating and interrupted direct currents for feeding the inductors. From observations made when employing interrupted currents he deems it advantageous to reduce the time of closing the circuit to a minimum, working rather with less primary self-induction. It is at the same time pointed out that alternating currents are much to be preferred, both from an electrical point of view and consideration of reliability, for the purpose in question.

**Modern Transformers.**—In the *Zeitschrift für Elektrotechnik* there is appearing a series of articles by Josef Löwy dealing with modern practice in the construction of electrical apparatus. Recent improvements in transformer designs are included. One of these relates to a type constructed by the Berliner Maschinenbau-Aktiengesellschaft for three-phase working, in which the windings are so arranged that no interference occurs due to the magnetic fields generated by the respective phases. An excess load on one phase entails no reaction on the other phases as a consequence. This transformer consists of a rectangular core, *a* (see the accompanying Fig. 1), provided with cross-

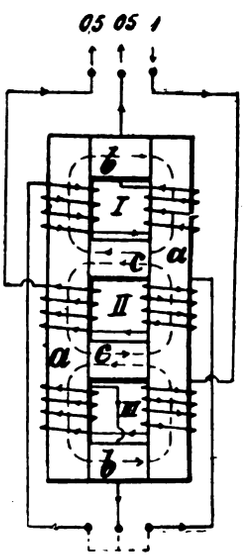


FIG. 1.

pieces, *c*, parallel to the yokes, *b*. Each primary and secondary phase is divided into two sections of winding, arranged opposite to each other on the core as shown. A similar transformer for two-phase current is built by the Union Elektricitäts-Gesellschaft. This transformer has three cores, *a b c* (Fig. 2),

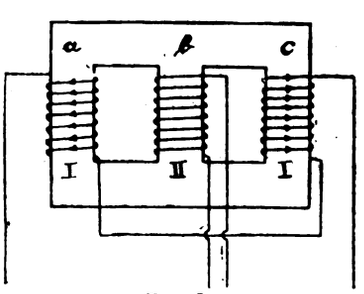


FIG. 2.

connected by yoke pieces. The windings of the one phase are arranged in two equal sections on the outer cores, *a c*, while the windings of the second phase are disposed on the centre core, *b*. Referring to the connections, it is obvious that the magnetic lines generated by the one phase in the cores *a* and *c* are opposed to each other in the core *b*, through which they complete their circuits. Hence their effect on the windings of phase 2 is neutralised. It is also clear that the lines generated by the windings of phase 2 in the core *b*, whose magnetic circuits are completed through the cores *a* and *c*, tend to strengthen the induction produced by phase 1 in one of the latter cores, and to weaken it by a corresponding amount in the other, the resultant effect being nil.

**The Wagner Single-Phase Motor.**—Amongst the various designs for single-phase motors there are now several which seem likely to invade the domain of the direct-current motor for traction purposes. Under ordinary conditions the single-phase induction motor has given considerable satisfaction for constant speed driving in

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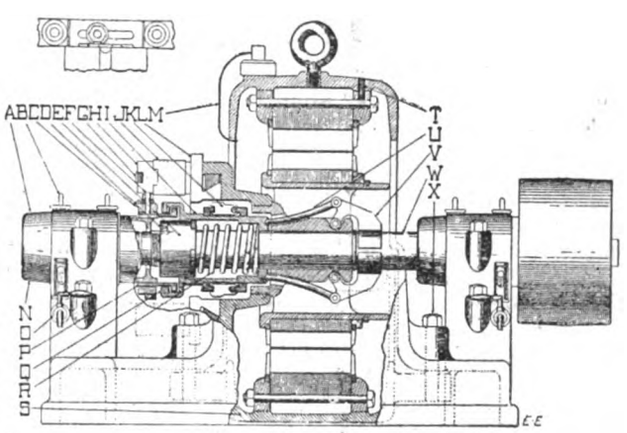
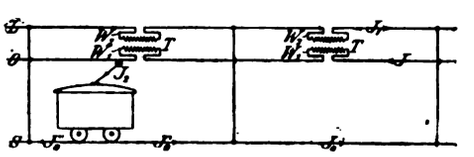
factories and workshops where large starting torques are not needed. A motor of this kind, with special arrangements for a good starting torque, has been built by the Wagner Electrical Manufacturing Company for some years, and it has achieved great success in the States. The motor consists essentially of primary or stationary element, commonly referred to as the "field," and a secondary or revolving element, commonly referred to as the "armature." These elements are entirely independent of each other. The current from the source of supply is fed into the field, and this induces all current set up on the armature windings. In general terms, the armature may be said to be of the well-known direct-current form, a progressive winding being connected to a radial commutator in the usual direct-current armature fashion. Brushes are provided which, under usual circumstances, are short-circuits through the rocker arm carrying them. In addition to these brushes, there is placed within the annular opening of the commutator a short-circuiting device, centrifugally controlled, the purpose of this device being to completely short-circuit the commutator and armature windings when the armature has attained a predetermined speed of rotation. The motor is designed to operate in two distinct ways—first, with one combination of elements at starting; and, second, with another combination of elements in the running condition. In starting, the induced currents of the




armature windings are given a directional control through the brushes, which results in the rapid acceleration of speed up to what may be termed the normal operating speed. At this point the centrifugal device comes into play, forcing the short-circuiting links into the annular commutator opening. Simultaneously the brushes are removed from the commutator, and thereafter the armature revolves, performing its function in a manner quite similar to the ordinary polyphase motor. After six years' trial the motor has done good service in a large number of central stations, and the manufacturers state that not more than half-a-dozen renewal commutators have been needed These were needed on some 30-h.p. motors which were required to start and stop a very large number of times daily. The motors are able to develop a full-load starting torque with a current only from 30 to 50 per cent. in excess of that taken when running at full load.

**Earthed Returns for Alternate-Current Railway Working.**—In a contribution to the *Elektrotechnische Zeitschrift* Dr. Behn-Eschenburg discusses the fall of potential in earthed rail returns when alternating currents are employed, and the means available for reducing this leakage, or its effect upon telegraphs and telephones using earth returns. A remedy which at once suggests itself consists in the choice of a periodicity for the current by which the instruments are not influenced. The effect of the self-induction of the track rails increases the loss for higher periodicities with the same current. It would, therefore, seem advantageous to reduce the periodicity to a minimum. At the same time it is well known that the human ear is not susceptible to the vibrations set up by low periodicities, so that disturbance so far as the telephone is concerned could be easily avoided. On the other hand, the relays used for the telegraphs, signal bells, and telephones on railways are especially sensitive to these low periodicities, and consequently liable to be affected by the same. The human ear is capable of detecting vibrations from about 16 to 16,000 periods per second. The mean periodicity of the vibrations produced by the voice is about 400, while the alternating currents in vogue employ periodicites of from 16 to 60. The vibrations due to the commutator segments of direct-current machines used for working tramways range from 500 to 1,000 per second. To the fact that these vibrations approximate in number those produced in speaking, is due the comparatively marked disturbance of telephone apparatus by tramways worked with direct current. The author goes on to describe in detail some experiments carried out in the laboratory attached to the Maschinenfabrik Oerlikon in order to determine the effect of different periodicities on different telegraph and telephone apparatus. He then proceeds to deal with the practical means available for preventing leakage from earthed returns. One of these consists in the system introduced by the Maschinenfabrik Oerlikon, whereby the current in the track rails is transferred to an auxiliary conductor, the track rails, in fact, only carrying the return current over a short section upon which the moving train happens to be, being for the rest conveyed by the auxiliary conductor. The advantages




offered by such an arrangement over an insulated return may be called into question. A decisive answer is found in the simplification enabled by the use of the wheels of the train as collectors. The arrangement is shown diagrammatically herewith. Parallel to the track rails, S, in which the fall of potential is to be compensated, an auxiliary conductor, L, is provided, electrically bonded at intervals with the track rails. By means of these connections the track rails and auxiliary returns are divided into a number of linked sections. In certain of the sections of the auxiliary conductor the secondary windings, $W_2$, of ordinary transformers are placed, whose primary windings, $W_1$, are connected in series with the overhead conductor, O. Several possible modifications of this arrangement are referred to by the author, who also enters into the theory of its working, showing the ratio which should exist between the dimensions of the windings, $W_1$ and $W_2$. He points out, incidentally, that a transformer should be used whose self-induction is very high compared with the non-inductive resistance of a section of the auxiliary return, and that an E.M.F. must be generated by this transformer equal to the fall of potential over the section. The total loss of pressure in the overhead conductor is thereby increased by the amount lost in the auxiliary return. In conclusion, the author gives the results of some careful experiments with the system, showing that a reduction in proportion to the total current of $\frac{4}{100}$ can be made in the current conveyed by the track rails. That is to say the current in the track rail can be reduced to one-twenty-fifth of the total. This device is not unlike, in principle, the negative boosters used in the return current feeders of direct-current lines.

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## GLOUCESTER ELECTRIC TRAMWAYS.

The formal opening of the Gloucester electric tramways took place on Tuesday. With regard to the history of tramways in Gloucester, in 1878 an order was granted to the Gloucester Tramways Company, Limited, empowering them to work about 3½ miles of tramways within the city. The rails were laid, and the line was opened for traffic in 1879. The original company was not a financial success, and in 1881 the whole undertaking was purchased by the City of Gloucester Tramways Company, Limited, for £16,000. The new proprietors appeared to have been more fortunate, for regular, though small, dividends were paid for some years.

About five years ago the company apparently came to the conclusion that an up-to-date service, combined with mechanical traction, was necessary and advisable, for in 1899—without approaching the Corporation in any way—they made an application to the Light Railway Commissioners for an order authorising them to construct and work light railways in and near the city, in place of the existing horse trams, and with extensions. An enquiry was held, and the Corporation conditionally acquiesced in the application. Long negotiations ensued between the company and the Corporation with reference to the terms upon which the former should be allowed to run cars throughout the city, but the parties were unable to come to an agreement, and after 12 months the negotiations were broken off.

In 1901 the late Mr. Samuel Bland reopened the question, and, after some considerable discussion, the tramways company consented to sell their undertaking, together with their interest in the light railway order—which at that time had not been finally granted—to the Corporation for the sum of £26,000. The order was finally granted to the Corporation as regarded the portion of the routes inside the city, and to the county as regarded the part outside. A dispute then arose with the County Council, but eventually both portions of the order were transferred to the city. In December, 1902, Messrs. Robert Hammond and Alfred Dickinson were appointed consulting engineers to prepare a scheme, in conjunction with the local officials, for equipping and working the light railways.

The first rail to be lifted in the demolition of the old tramway and the first of the new rails to be deposited on the track of the new enterprise were handled by the retiring mayor and mayor nominate respectively on Nov. 9 last, and in less than six months the main lines forming the greater part of the system are open for traffic, while but a few weeks are now required for the completion of the whole scheme. When one bears in mind the solid nature of the construction, the length of route, and the adverse weather conditions of the winter season, the citizens, Corporation, and contractors are to be heartily congratulated on the successful issue of a notable work.

### The Track.

The contract for the rails and track construction was secured by Mr. George Law, of Kidderminster. The original contract was estimated to amount to £47,655. 11s. 2d. for the city and £8,450 for the county, but various additions have been made in the course of construction. The rails have been supplied under a sub-contract by the Barrow Hematite Steel Company, Limited, the Corporation having specified for rails and materials of approved British manufacture, are in 50ft. lengths, and weigh 90lb. to the yard. They are 6in. deep, and have an under bearing surface of 6in. The top surface of the rail is 3in. wide, and the groove in which the flange of the car wheel runs is 1in. deep and 1in. wide, the wheel flange being ½in. deep. The fishplates are 2ft. long and weigh 50lb. per pair, each pair being secured by six bolts of 1in. diameter. The rails are bonded with bonds of the solid copper type, supplied by the British Electric Equipment Company, Limited. Special track work, points, and crossings are of cast steel, supplied by Messrs. Askam Bros. and Watson, Sheffield. The points are cast in lengths of 8ft. 8in. They are laid in pairs, one being fixed and the other movable. The movable points are fitted with rubber spring buffers, so as to move automatically.

Where wood paving is laid, the rough concrete has been floated with a layer of fine concrete ½in. in thickness mixed in proportion of 3 to 1. Upon this, jarrah wood blocks have been laid, and in the centre of the city the wood paving has been laid across the entire width of the carriageway. In other parts the track has been paved with granite setts and solidified with cement grouting. The new setts have been supplied from Mr. Law's Carnarvon quarries, and also from Guernsey and Ireland. The whole of the rails and track materials have been water-borne by coasting vessels and delivered at the Gloucester Docks. Mr. Law has had as many as 600 men of all grades employed on the work of construction, and the contract has been carried out under the personal supervision of his engineer, Mr. E. Kenworthy. Mr. W. Ridler has been chief clerk of the work under the Corporation, and has had with him six assistants. The work has been supervised by the city surveyor (Mr. R. Read) in the city, and by the county surveyor (Mr. R. Phillips) in the county.

In addition to the contract for the track construction, Mr. Law has carried out supplementary contracts for lowering the roadways under the Worcester-street, London-road, Barnwood, and Chequers railway bridges. The gradients encountered in the nine miles of route are nowhere bad, the most severe being 1 in 23 on the approaches to the Barnwood railway bridge. The radius of the sharpest curves is not less than 40ft.

### The Cars.

The rolling-stock consists of 30 double-decked four-wheeled cars. The first contract, which was secured by the Brush Electrical Engineering Company, Limited, was for the supply of 20 cars, which are sufficient for the maintenance of a normal 10 minutes' service on all routes, but this was supplemented with an order for 10 additional cars in order to cope with special occasions. Each car is 25ft. long over all, and the width over all is 6ft. 6in. The height from the rail level to the highest point of the roof deck is 9ft. 8in., whilst the clear height inside at the centre is 6ft. 9in. The length of each platform is 5ft. 3in., the body of the car, as measured between the "corner posts," being 13ft. 6in. These dimensions give an inside seating capacity of 18 and outside seating for 23 passengers—a total of 41.

The floor frames are built of well-seasoned pitch pine and oak in combination with iron flitch plates, to attain maximum strength in association with minimum weight. Trap-door openings give convenient access to the motors and bearings for inspection and oiling. The main floor has been laid with ⅞in. matched Baltic pine boards, and is stripped with hard teak wood, ¾in. by ⅝in., screwed by brass screws, arranged longitudinally inside the car and transversely on the platforms. Collision buffers, made of 3in. by 5in. steel angles, are secured to the ends of the platform timbers to protect them from injury in case of accident, and these are slotted and pins provided to facilitate the hauling of the cars in case of emergency. The body framing consists of a combination of pitch pine and ash, with panelling of mahogany. There are four windows on each side and two at each end, all being fixed. Both windows and doors are glazed with best British polished plate glass. Glazed casements with figured oak frames are provided at opposite corners of the cars, with bevelled-edge mirrors above. Over each side window are arranged hinged ventilators, having oak frames glazed with best quality decorated and coloured glass. The interior seats are arranged longitudinally, and are of perforated birch veneer, supported by ash framing. A pedal sand-box is fixed at each end of the car. The roof, ribs, and horizontal members are of ash, the ceilings inside the cars are of millboard, and the platform ceilings of polished pitch pine. The upper deck is ⅞in. Baltic pine, laid on bearers above the roof, and in the passageway between the seats are fixed hardwood wearing strips laid transversely. Strong wrought-iron roof railings, 3ft. 6in. high, supported by the necessary stanchions, are enclosed to the height of the lower rail by boards, and to the top rail by wire netting. The roof seats are of approved rainproof pattern, with reversible seats and backs. Access to the car is provided by the new patent steel steps approved by the Board of Trade, this

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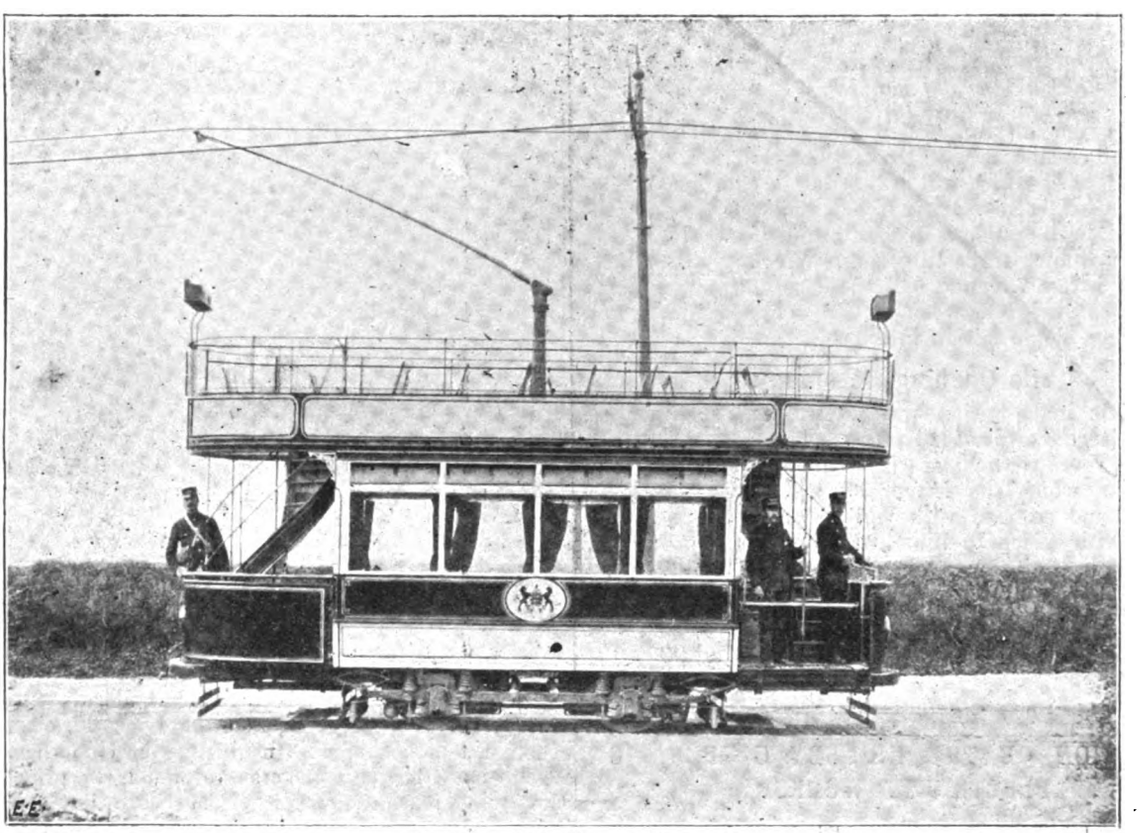
step being always kept up at the driver's end, and only let down at the terminus for passengers to load after those disembarking have alighted from the rear platform. The rear step will also be raised when the car has its full complement of passengers. The "tip-up" step arrangement is the design of Mr. A. Dickinson, and has given great satisfaction where used. A substantial polished brass tube stanchion is fixed in the centre of each step, rising to the canopy, thus forming separate openings for simultaneous access of passengers to the interior and roof of the car without jostling. The stairway at each end of the car, giving access to the roof, is made of sheet steel for the side stringers and risers, and wood treads faced with step-iron to prevent slipping. The stairway is so arranged as to give an unobstructed view to the driver, and is so placed as to conduce to the greatest convenience, safety, and rapidity in the loading and unloading of the upper deck.

The cars are mounted on Brush standard four-wheel trucks. The wheel base is 6ft. 6in. long, and is adapted to the severest curves to be found on any of the tracks. The wheels are 2ft. 6in. in diameter, and the axles 4in. diameter. The tyres are $\frac{7}{8}$in. in width and $2\frac{1}{2}$in. deep, with a flange, $\frac{1}{2}$in. deep by $\frac{5}{8}$in., of rolled steel. The lifeguards attached to the trucks are of the Tidswell type. The electrical equipment of the cars has been carried out by Messrs. Dick, Kerr, and Co., Limited. Each car is fitted with two four-pole, series-wound, single-reduction iron-clad motors. Each motor is built to work at a line pressure of 500 volts. The insulation of the completed motor between any part of the electrical circuit and the frame is such as to withstand the application of 2,000 volts alternating current without showing any sign of breaking down. The electrical equipment also includes on each car two series-parallel controllers, complete with interlocked reversing switch, and cut-out plugs, the necessary switches and fuses for two lighting circuits, and two canopy or emergency switches with automatic cut-outs. The controllers are so designed as to give easy acceleration to the car and an equal division of work between the two motors and for the cutting out of either motor and working with one alone. Only one controlling handle is supplied to each car, and it is so arranged that it is impossible to detach it from the controller except when the controlling and reversing switches are in the "off" position. Each car is also fitted with an efficient hand brake, which applies a cast-iron block to each wheel, and which can be operated from either platform. The canopy or emergency switches are designed for any sudden interruption of the working current, and to completely cut off all the car equipment from the line circuit in case of need.

The lighting equipment consists of 12 16-c.p. incandescent lamps arranged in two groups, the wiring being so arranged that in whatever direction the car is travelling the head light and the trailing platform are in circuit. Electric signal bells are fixed in each canopy, so connected that they can be operated from several places inside and on the top of the car. The trolleys are of the swivelling type, the standards 5ft. 6in. in height. The trolley poles are of special tapered tube steel, light but of sufficient strength. An up pressure of 18lb. is applied to the trolley wire. The head is of an improved spherical type fitted with gunmetal trolley wheel with easy-running graphite bearings.

### The Generating Plant.

The additions to the power equipment of the electric lighting works were designed for a car service of from five to ten minutes on the various lines throughout the city,



View of one of the Gloucester Tramcars.

the scheduled speed, including all stoppages, being seven miles per hour. The average amount of current required to drive a car is about 16 amperes, and that figure was adopted as a basis for calculation. Assuming the voltage of the line to be 550, the average power required to drive 20 cars is 176 kw. Owing to the comparatively small margin of power for lighting purposes at the time of determining the traction necessities, it was decided that a 200-kw. traction set was required, and two such sets suitable for working either a traction or lighting load were ordered, one set being reserved as a stand-by. The contract for the supply and fixing of this plant was obtained by the General Electric Company (1900), Limited, the price, including English-made dynamos and Willans engine, being £3,464. 17s. 4d. Although the normal full load is 200 kw., each plant is capable of giving 240 kw. for two hours continuously. The dynamos are compound wound. In the new plant is included the provision of a negative booster—a machine intended to compensate for the drop in pressure from the rails to the works. The contract for the condensing plant and pipe work was secured by Messrs. Summers and Scott, Gloucester, for the sum of £890. The switchboard and instruments (the latter by Evershed and

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Vignoles) are supplied by Messrs. J. G. Statter and Co., the contract price being £1,174. 8s. 5d., and the battery of accumulators and reversible booster are supplied by Messrs. Crompton and Co., Limited, at £1,551. 11s. An extension of the electricity works generating station to the designs and plans of Mr. A. H. Dancey, Gloucester, the architect of the original structure, has been carried out by Messrs. Byard and Sons, Gloucester, at a contract price of £1,887. It has been determined, subject to any subsequent revision, to supply current from the electricity works for electric traction at a charge to the tramway undertaking of 1¼d. per unit.

Until the work is completed it is impossible to say what the total cost will be. A general average for electric tramway construction equipment is £10,000 for each mile of single track, which would involve a total outlay on the present undertaking of £150,000, but there is reason to believe that this amount will more than cover the total cost, even if the generating plant and power station, which is properly a capital charge on the electricity supply department, the tramway purchase, and all subsidiary contracts for road and bridge improvements be included.

The general manager of the city tramways, who was appointed in December last, is Mr. E. Edwards, of Bradford, and the chief traffic inspector is Mr. E. Stephens, late manager of the Gloucester horse tramways. The staff when completed will comprise 40 motormen and 40 conductors, who will each be on duty for a week of 56 hours, each man having one clear day off in every seven. The service of cars will commence with the early morning workpeople's cars, the first of which will leave the termini in time to reach the works' centre at six o'clock and will continue till 11 o'clock. Each section is divided into half-mile ½d. stages, 1d. fares including three ½d. stages. Workpeople's tickets are issued before 7 a.m. at half the usual rates, and school children are carried between certain hours at ½d. for any distance on a single section in the city.

### The Opening Ceremony.

The civic inauguration was a complete success, and attracted large crowds of spectators, while the streets along the line of route were hung with flags and bunting. The leading car, which the Mayor himself drove, was gaily decorated and studded with vari-coloured electric incandescents with which to illuminate the lettering and the general outline of the car in the evening. The second tram was driven by Councillor Ralph Fream, the chairman of the Tramways Committee of the Corporation. A banquet was given by the Mayor (Alderman Tom Blinkhorn) in the evening.

## DESCRIPTION OF THE GRIMSBY CORPORATION ELECTRICITY WORKS.*

BY WALTER A. VIGNOLES, M.I.E.E.

The early history of electric lighting in Grimsby may be dealt with very briefly. After a considerable amount of preliminary discussion, a provisional order was obtained in 1894. In 1896 the then borough engineer, Mr. Marshall Petree, A.M.I.C.E., prepared a preliminary report, and in 1897 the usual visits to other towns took place. In January, 1898, Dr. A. B. W. Kennedy, F.R.S., was asked to draw up a scheme, and his report was presented in June, recommending a three-wire, direct current system. It was decided to proceed with the work, and Dr. Kennedy accordingly prepared specifications; tenders were asked for and accepted; the foundation stone of the works being laid in October, 1899, by the chairman of the Lighting Committee, Mr. Alderman Dobson.

*System.*—The system of supply adopted is the three-wire, continuous current, the pressure at the consumers' terminals being 230 volts and 460 volts across the outers, the middle wire being earthed at the station through a recording ammeter. This system has a great many advantages, an important one in this case being that the same machines (except the balancers) can be used for 460 to 520 volts for lighting, and 500 to 550 volts for traction purposes.

*Buildings.*—These have already been described in the paper by the borough engineer, and it is not proposed to repeat the description. The chimney has been made large enough to serve the refuse destructor in addition to the electricity works. It is 180ft. high, octagonal in form, tapering from 13ft. at the base to 11ft. inside at the cap. The site is adjacent to the Great Northern Railway, and a siding has been brought to the works for delivering coal and materials. This finishes on a line carried over the coal bunkers, which allows the coal to be delivered into the bunkers with the minimum amount of labour.

*Boiler-House Plant.*—The boiler-house is arranged to contain six boilers; at present there are in use four Lancashire type, 28ft. by 8ft., with 960 square feet of heating surface, arranged to work at 160lb. pressure; they were constructed by Messrs. E. Danks and Co., of Oldbury. There is also a five-drum Stirling boiler made by the Stirling Boiler Company, of Edinburgh; the heating surface being 3,230 square feet, and the normal evaporation 13,000lb. of water per hour.

*Economiser.*—A Green's economiser is fitted, containing 36 sections of eight pipes each, capable of raising 18,000lb. of water per hour from 60deg. to 200deg. F.

MR. W. A. VIGNOLES, M.I.E.E., BOROUGH ELECTRICAL ENGINEER, GRIMSBY.

*Automatic Stokers.*—The Stirling boiler is fitted with Erith's underfeed stokers, and the Lancashire boilers are being fitted with stokers made by the Underfeed Stoker Company. The two stokers are similar in principle, the coal being fed into the fire from below, but the method of feeding is different in the two cases—in the Erith type the coal is fed in at intervals of one to three minutes by a steam ram; in the other type, the coal is fed in continuously by a worm. Another difference is that the Erith stokers work with a larger air pressure, both requiring forced draught when working, except at light loads. The stokers will burn the cheapest slack without making any smoke, and if the difference in calorific value of the fuel is allowed for, better efficiency is obtained when working with the automatic stokers than when hand firing, and if the price per unit generated is considered, a large saving is made in the cost of fuel.

*Machinery.*—The engines, dynamos, condenser, steam-pipes, economiser, feed pumps, etc., were supplied under contract by Messrs. Mather and Platt, Limited, of Manchester. Four Weir feed pumps are provided, and these can take water either from the feed tanks or direct from the town supply. The feed tank can be supplied with water through a 4in. valve and pipe from the well without pumping, and the hot water from the air-pump is discharged into this tank. A centrifugal well pump, driven by a Mather and Platt enclosed type motor, is provided to fill the feed tank if the level of the water in the well falls, and this pump can also be used for draining the sump. The feed pipes are in duplicate, and the boilers can

* Paper read before a district meeting of the Incorporated Association of Municipal and County Engineers at Great Grimsby.

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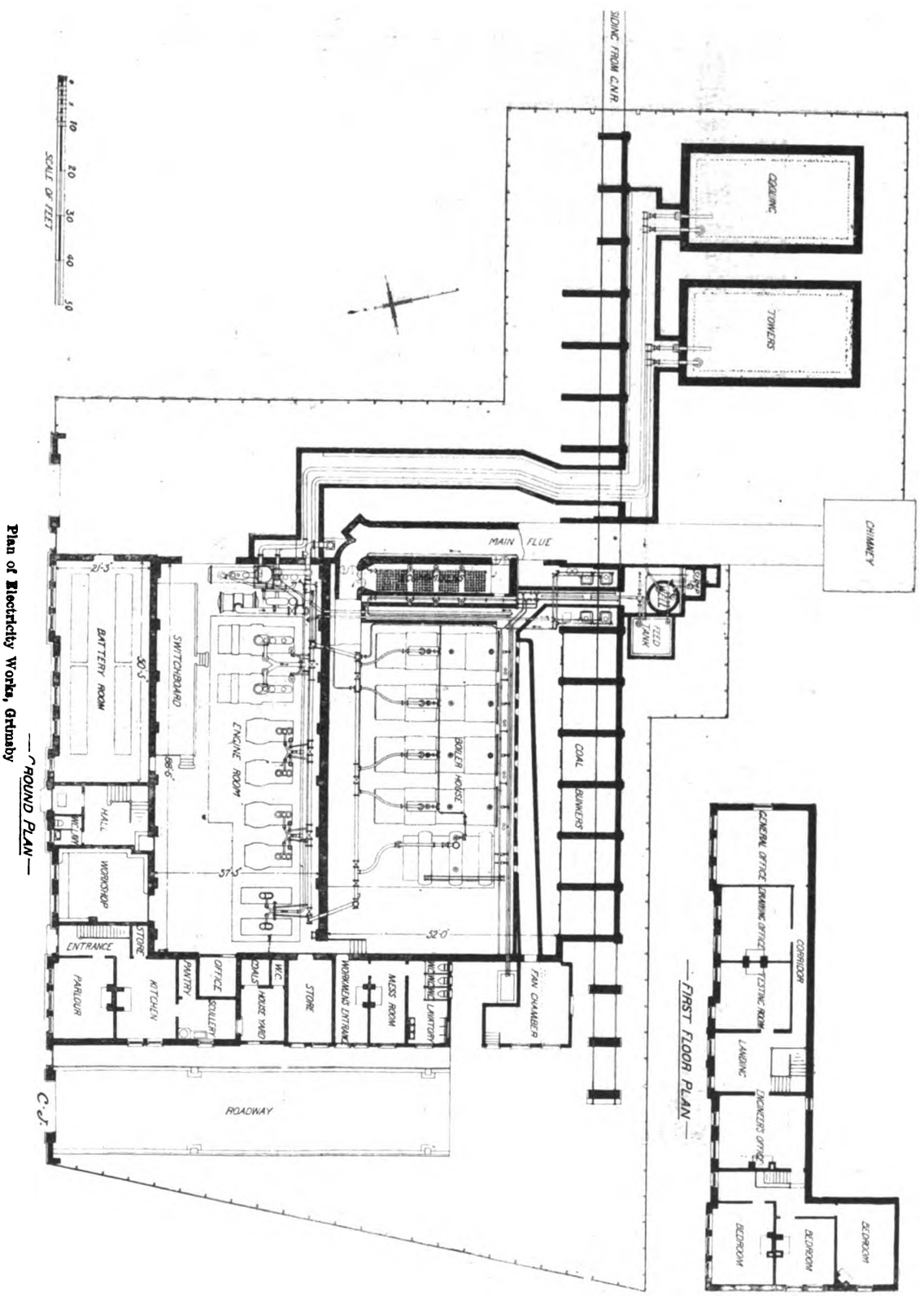
be fed direct or through the economiser. The steam-pipes to the feed pumps are in duplicate, an auxiliary range being connected by a tee and valve to such boiler, and the duplicate set of pipes being connected to the main steam range in the boiler-house. With regard to the main steam-pipes, a ring main is provided, one side being in the boiler-house, with valves between the connection to each boiler, the other side is in the engine-room. The engines are in pairs, with two connections to the steam range, the valves being arranged in such a way that each engine can obtain steam in two different directions. The engines can work either condensing or non-condensing, an automatic valve being fitted on the atmospheric exhaust to lift if the vacuum should fail. Two condensers—one by Mather and Platt, the other by W. H. Allen, Son, and Co.—are in use. Each is designed to give a vacuum of 25in. when dealing with 17,000lb. of steam per hour, or, say, 800 i.h.p. These are of the surface-condensing type, and a compound engine is supplied in each case to drive the air and circulating water pumps direct. The cooling water is provided by two large Klein towers, each capable of dealing with sufficient water for condensing 17,000lb. of steam per hour. The dimensions of each are approximately 20ft. by 40ft. by 60ft. high. There is land available for the erection of additional towers as the demand arises.




Plan of Electricity Works, Grimsby

*Engine-House Plant.*—The engines and dynamos at present erected are two 75-i.h.p. compound engines, each driving two dynamos generating current at 230 to 260 volts, used for balancing the three-wire system; four 150-i.h.p. to 180-i.h.p. compound engines, driving dynamos generating current at 460 to 520 volts as shunt machines; and two 350-i.h.p. to 400-i.h.p. triple-expansion Belliss engines, driving four-pole Westinghouse dynamos. These dynamos are also compound-wound for traction, and for

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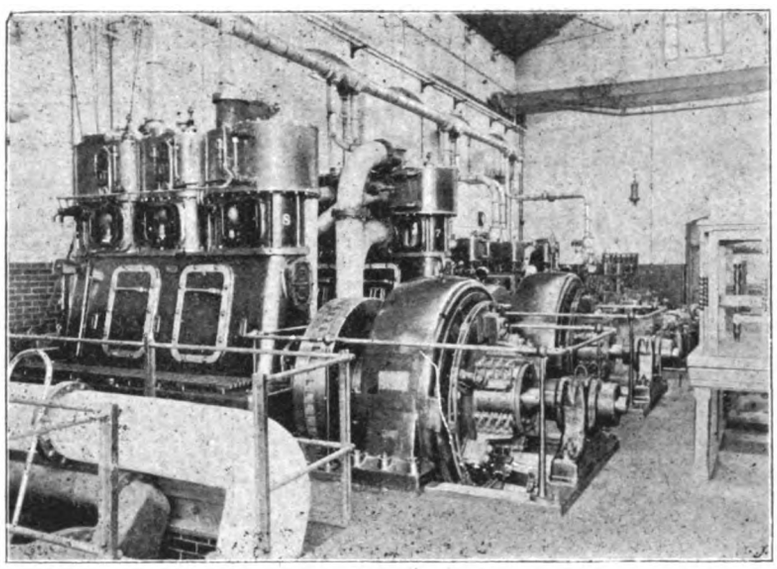
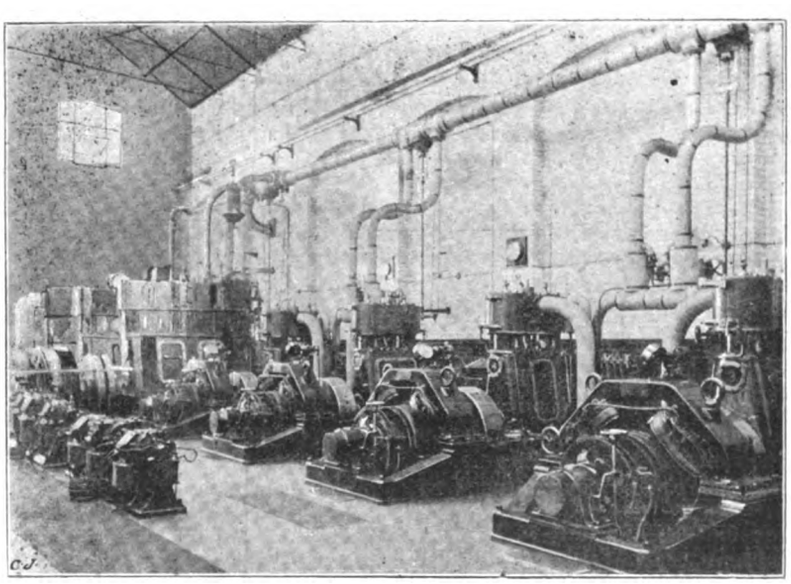
this work generate current at 500 to 550 volts. All the engines are of Messrs. Belliss and Morcom's well-known high-speed enclosed type, with forced lubrication, and the dynamos driven by the 75-h.p. and 150-h.p. engines are Messrs. Mather and Platt's four-pole type, with armature windings sunk in the core. The engine-room is about 90ft. by 36ft., is well lighted, and lined with white glazed bricks. A feature about the room, common to all of Dr. Kennedy's stations, is the unobtrusiveness of the steam-pipes. These are all against one wall, leaving the centre of the room clear.



Engine Room, Electricity Works, Grimsby.

*Switchboard.*—The switchboard has been constructed by Messrs. Kelvin and White, and is very similar to boards put up at Buxton and Stirling. A voltmeter panel is arranged under the clock; to the left are two balancer panels, with plug arrangement and locking shutters, to enable any of the four machines to be run off the positive or negative side. Two battery panels are fixed to the left of these. Each contains two battery-regulating switches, with an arrangement for charging or discharging the cells by means of a booster. A space is left on the gallery for an extension panel. To the right of the clock are panels for the 150-i.h.p. and 350-i.h p. sets. The lower half carries the equalising switch for the series windings, and an interlocked set of plug bars to prevent any machine being switched on to the lighting and traction bars at the same time. A handle for working the regulating switches on the series winding is fixed at the left of the lower panel, and the switches and resistances are under the switchboard gallery. On the extreme left the traction feeder panels are fixed, and a separate panel carrying the instruments required by the Board of Trade for making certain tests. The shunt resistances and dynamo switches are under the gallery, the leads to the shunt switches being brought up columns to a handrail, on which the shunt switches are fixed. The leads from each dynamo are brought through two single-pole fuses (fixed under the gallery) to a Ferguson and White double-pole automatic cut-out on the switch-board; from this they are connected through plugs to the 'bus bars. No feeder fuses are provided on the board, but the feeders can be disconnected by means of a switch on the board, a small fuse across this switch at the back of the board taking the spark in switching off. There are no fuses connected in the battery circuit, but each battery can be disconnected from the 'bus bars in case of emergency by a double-pole switch at the bottom of the battery panel. Two booster sets for battery charging are provided, each fitted with two dynamos or boosters driven by one motor, the three machines being mounted on one bedplate.



Engine Room, Electricity Works, Grimsby.

The output of each booster is 60 amperes at from 10 to 70 volts, and the motor takes current from the main 'bus bars at from 460 to 520 volts. The first set was made by Messrs. Thomas Parker, Limited; the second by the Newton Electrical Company, of Taunton.

*Battery.*—On the north and west sides of the station are the offices and the resident engineer's house, and a battery-room 50ft. by 20ft. The latter is lined with white glazed bricks, and in it are erected four Tudor batteries (two positive, two negative), with a total capacity of 1,200 ampere-hours. The rates of discharge are as follows:

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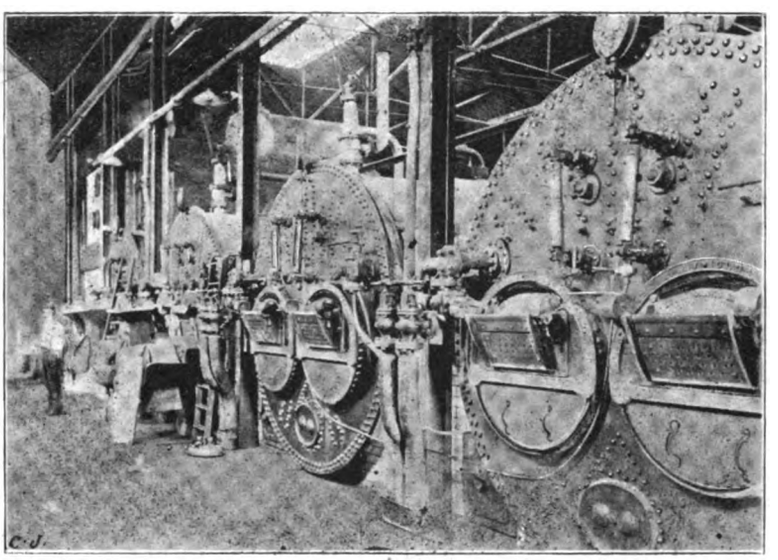
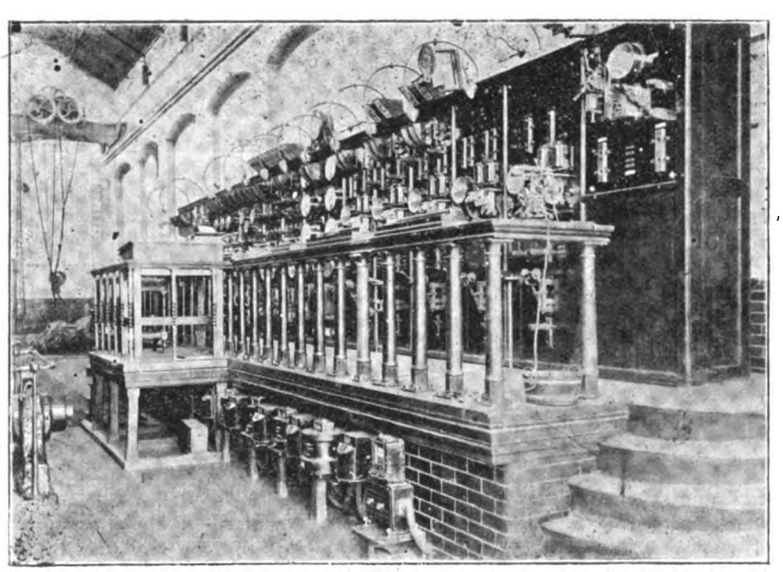
60 amperes for five hours, 90 for three hours, and 120 for half an hour. A large workshop and the usual men's quarters complete the ground floor. On the first floor are the offices, meter-testing rooms, etc.

*Mains.*—Under the switchboard gallery is a large space in which, as described above, are fixed resistances, cut-outs, etc. From this a subway leads under the building and finishes in a manhole in the street. The feeders are brought into the station along this subway. The contract for the mains was placed with the British Insulated Wire Company, and the work has been carried out by them on their solid system, the cables being in all cases insulated with paper and lead-covered. The distributing cables are triple concentric, and about 10 miles of these have been laid. Two concentric, feeders were laid from the station under the original contract, the sectional area of these being ·75 and ·35 square inch. The former connects to three feeding points by ·12, ·25, and ·35 square inch branch feeders, the latter to two feeding points by ·12 and ·25 square inch branch feeders. Since the original contract was completed it has been found necessary to increase the number of feeders, owing to the increase in the load, and last year two additional feeders, ·5 and ·12 square inch section, were laid, the cables in this case being made by the Anchor Cable Company, and are connected in each case to only one feeding point. These feeders are connected to the outers, the middle wire being connected throughout the system, and brought back to the station from three points by means of single cables, each ·1 square inch in section. Fuses are arranged on the feeders, in the street and at the station, and on the distributors, so that in case of a short-circuit the district on which it occurs is isolated. Pilot leads are carried back to the station from the distributor side of the feeder fuses, and are connected through indicating lamps to the middle wire. These lamps will light up if the system is connected. An extinguished lamp, therefore, indicates the circuit which is disconnected.

*Balancing Station.*—To assist in balancing the three-wire system, an underground station has been built at Riby-square. This measures 20ft. long by 10ft. by 8ft. high inside; it is lined with glazed brick, the floor being tiled. The whole of the building is enclosed in Val de Travers asphalt (as it is below subsoil water-level), this having been put on outside the walls and under the concrete floor. An automatic machine is fixed in this sub-station to balance the two sides of the system. This increases the steadiness of the light all over the town, and reduces the amount of work on the switchboard at the works. The total cost of the sub-station, including the plant, was £743, and sufficient room has been left to fix a second machine later on if it is required.



Boiler House, Electricity Works, Grimsby.



Switchboard, Electricity Works, Grimsby.

*Arc Lamps.*—Eighty arc lamps are erected in Victoria-street, Cleethorpe-road, Freeman-street, Hainton-street, Albert-street, Oxford-street, Victor-street, Osborn-street, and the Bull Ring. These were made by the Gilbert Arc Lamp Company, and are connected in series of 10 across the outers on 460 volts. Service boxes are arranged on the distributors, and the ends of the circuits connected into these. The switches, automatic cut-outs, and line resistances are in the base of the posts. Starting resist-

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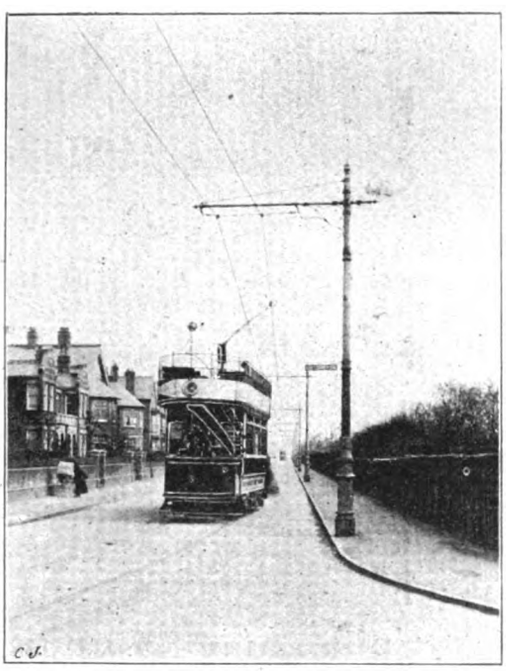
ances arranged to cut out in two steps are provided to reduce the starting current. The lamps are erected on cast-iron posts made by Messrs. Mackenzie Bros. Central carriers, posts with short bracket arms, and brackets fixed on houses are used. The wiring of the station has been carried out by Messrs Crowther and Co. to the specifications and plan of the author. The engine-house and boiler are lighted by Gilbert arc lamps suspended from the roof, and also by auxiliary incandescent lighting. The arc lamps are arranged with disconnecting ceiling roses, so that they can be lowered for trimming without disturbing any leads. The subways are lighted by bulkhead lights, and in front of the station are two arc lamps, with incandescent lamps as an alternative. A separate station-lighting switchboard is provided in the engine-room, arranged so that the station lights can be connected to either side of the three-wire system. The lights can by means of change-over switches be connected in case of emergency to the battery, so that light can still be obtained when the main switchboard is entirely disconnected, the lamps over the latter being permanently connected direct to the battery.



Tramways outside People's Park, Grimsby, showing Side-Pole Construction.

Tramways at Old Market Place, Grimsby, showing Centre-Pole Construction.

The works were opened for use on Jan. 1, 1901; supply to private consumers commenced on Feb. 13; and the lighting of the streets on March 31 of the same year. The number of consumers at the start was seven, and the number of lamps in private houses the equivalent of 386 8-c.p. On March 1 of this year the number of consumers was 344; and the number of lamps in shops and private houses, and motors, the equivalent of 26,599 8-c.p. The plant in the station has a capacity of 900 kw., or, in other words, is capable of dealing with from 35,000 to 40,000 lamps wired, in addition to providing 220 kw. for the use of the tramways company.

The author acted as resident engineer under Dr. A. B. W. Kennedy during the construction of the works, and, upon their completion, received the appointment of borough electrical engineer.

## ELECTRIC PUMPING PLANTS.

Messrs. Ernest Scott and Mountain have in hand the machinery for some interesting pumping plants for which electrical driving has been adopted. The first of these is for the Consett Iron Company, and is required to deal with the water supply for the whole works. In order to economise water, the company are constructing large reservoirs below the main intake of the water supply, into which all available surplus water will be returned. These reservoirs are situated about 200ft. below the upper part of the works, and the three pumps to be supplied by the firm are to be placed at the reservoirs. They are each constructed to deliver 1,500 gallons per minute into the second reservoir, situated on the high ground above the works. The pumps are of Scott and Mountain's well-known three-throw ram type, of special design, the rams being 18in. diameter and the stroke of the pumps 22in. The pumps are driven by three independent electric motors, each constructed to develop 130 h.p. on the brake at a speed of 500 revolutions. The motors will drive the pumps through cotton ropes, and both pumps and motors are to be arranged so that they will deal with the water at an increased head of 300ft. should this be required. The electric current for driving the motors will be supplied from two direct-coupled engines and dynamos, which will be placed near to the boilers and about 1,000 yards away from the pump house. Each of these plants will develop 550 b.h.p., or an equivalent electric output of 370,000 watts. The plant also includes all the necessary switchboards and starting switches for the motors and testing arrangements for ensuring the satisfactory working of the whole scheme.

Another plant for the Weardale Company is arranged to deal with a large quantity of water at Croxdale Colliery, near Durham. The estimated flow will amount to about 1,200 gallons per minute, and in order to provide a margin of power the plant is arranged with three sets of pumps, each of which will be capable of delivering 600 gallons per minute from the bottom of the shaft to the surface, the total head being about 650ft. These pumps are of Scott and Mountain's three-throw mining type, and are each driven by a continuous-current electric motor of 140 h.p. The pumps will be placed close to the bottom of the shaft, and will all deliver into one rising main. The machinery at the bank for generating the electric current will consist of a horizontal compound steam-engine developing 600 h.p., this engine being fitted with a heavy flywheel grooved for the driving ropes. The generator will be of the continuous-current type, with double armature, the machine having a central driving pulley, this arrangement enabling either half of the machine to be worked independently if required The total output of the generator will be 400,000 watts, or an equivalent of 530 h.p.

The equipment of the Old Silkstone Colliery at Dodworth, near Barnsley, consists of a Scott and Mountain enclosed compound high-speed engine, capable of developing 220 b.h.p. This engine will be coupled direct to a Scott and Mountain continuous-current dynamo, having an output of 150,000 watts, or the equivalent of 200 e.h.p. The underground plant consists of three electric motors—two being of 10 h.p. and one of 25 h.p. The two 10-h.p. motors are for driving three-throw pumps, which will deliver to the main pumps at the shaft bottom, and the third motor—*i.e.*, the 25-h.p. motor—is for operating hauling gear at present driven by steam.

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In connection with this work, we understand that Messrs. Scott and Mountain hope to get most of it completed before they remove to the new works which they are building at Gateshead, where they will have a largely increased capacity and better facilities for carrying out their work.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

685. A compound-wound motor in use for driving a printing machine has a peculiar characteristic. It does its work all right, but on stopping and testing the poles with a compass the writer finds they have reversed—*i.e.*, the working magnetism is opposite to the residual magnetism. Particular care has been taken that the dynamo is not connected up differentially, as the connections have been changed every conceivable way, but with the same result — the poles invariably reverse when starting or stopping; in both cases immediately on opening or closing the double-pole switch.—F. M.

686. A coil of a Brush 10-ampere arc lighter being burnt out, it was found that the seven or eight layers of wire nearest the core were completely charred, but there was nothing to show where the burning started. After running on full load for a few days an adjacent coil was burnt out in exactly the same way. Is there any reason for this? Also, are the coils hand or machine wound?

### ANSWERS.

*Question No.* 678.—Describe a system of book-keeping for the meter department of a central station supplying about a thousand consumers.

*Best Answer to No.* 678 (*awarded* 10*s.*).—The best system of book-keeping for the meter department of a central station is a combined book and card system. The following system has been widely adopted, and proved to work very satisfactory. On receipt of new meters from the makers, they are entered up in a meters received book as shown below, and then placed on shelves specially kept for untested meters.

METERS RECEIVED BOOK.

| Date received from makers. | Maker. | Maker's number. | Owner's number. | Size — Amperes | Size — Volts | Date returned to makers. |
|---|---|---|---|---|---|---|
| | | | | | | |

The meters are then tested, and if found satisfactory are given an owner's number, these numbers being consecutive, and are for ease in tracing meters for future reference. The tests are then entered up into a meter tests register, a separate page being allotted to each meter, with sufficient space for several tests.

METER TESTS REGISTER.

Type of Meter..... Owner's No. .....
Capacity..... .....Amps.....Volts Maker's No.....
onstant..... Date received.....

| Date of test. | Starting current. | Current applied, amps. | Current recorded. — Revs. | Time in secs. | Watts. | K. | Error % | Dial test. Error % | Insulation resistance. | Remarks. | Tested by. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

The meter is also entered into a meter register, and a meter outwards card is made out and attached to the meter. The meter is then placed on shelves specially kept for tested meters.

METER REGISTER.

Owner's No. .....
Maker's No. ..... Maker.....
Size..... Amps. ..... Volts.

| Name. | Address. | Date sent out. | Date returned. |
|---|---|---|---|
| | | | |

FRONT OF CARD.

(*Initials of Works.*)

METERS OUTWARDS.

Owner's No..... Maker's No..... Maker .....
Capacity ..... Pressure ..... Reading when issued .....
I hereby certify that I have examined and tested this meter, and find it to be in good order.

.....
Head of standardising department.

Date .....

This form to be attached to meter when issued.

BACK OF CARD.

Meter fixed at
Name .....
Address .....
District .....
Date..... By .....
Reading when fixed..... Poles .....

This form to be filled in by the installation inspector and returned to the head of the standardising department.

Noted.....
Head of standardising department.

Noted.....
Installation inspector.

When the installation department requires a meter, an order is sent to the standardising department stating particulars and requirements, size, voltage, etc. The standardising department then issue a meter and enter it into the meter outwards book. When the meter has been fixed the outwards card will be returned by the installation inspector with the back filled in with name, address, etc., and these are then entered into the meter outwards book.

METER OUTWARDS BOOK.

| Date. | Name. | Address. | District. | Maker. | Maker's No. | Owner's No. | Capacity. | Voltage. | Reading when fixed. | Stock-book folio. | Inspector's book folio. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

From this book the meters are entered into the meter register, which acts partly as an index, and also shows clearly how long a meter has been out at any particular address, and how long since purchased; and by comparing this with the meter test book, information can be obtained as to the constancy off accuracy, which is very useful. When a meter is removed from a consumer's premises, the installation inspector fills up and attaches a meter inwards card to it and returns it to the standardising department.

FRONT OF CARD.

(*Initials of Works.*)

METERS INWARDS.

Owner's No..... Maker's No..... Capacity .....Amps.
Reading..... ..... Cause of removal.....
Removed from (Name).....
Address.....
District.....
Date..... By .....

This form to be affixed to meter at time of removal, and the meter returned to the standardising department.

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BACK OF CARD.

I hereby certify that I have examined and tested this meter, and find it to be in.....condition.

(*If in bad condition state defects below.*)

.....

.....

.....

.....

.....

Head of standardising department.

Date.....

This meter is immediately entered into the meter inwards book, which is practically the same as the outwards book, and from this book is again transferred to the meter register under the column, date returned. The meter is then placed on the untested meter shelves to await test. When tested the result is entered on the back of the inwards card, and if the meter is satisfactory the test is entered under its number in the meter tests register, where will be found the previous tests and dates of tests. An outwards card is then attached, and the meter is ready for reissue. If the meter is faulty and has to be returned to the makers for repairs, a meter repairs card is made out and attached, and at the same time the particulars are entered into the meter repairs book, and when returned is checked off and date of return entered.

FRONT OF CARD.

Meter returned to works for repairs from (owner's name).

Owner's No. ..... Maker's No. ..... Maker.....

Size ..... Amperes. Pressure ..... Volts.

Defect :

Cause (if known) :

.....

Head of standardising department.

Date .....

This form to be affixed to meter before it is returned to makers.

BACK OF CARD.

(For use of maker of meter only.)

*Nature of Repairs*

*Cost to be borne by*

Date.....

This form to be filled in by the makers and affixed to the meter before it is returned to .....(Owner's name)

METER REPAIRS.

| Owner's No. | Maker's No. | Date sent for repairs. | Date returned. | Defect. | Cause. | Cost borne by | Nature of repairs. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

The meter, after being entered in the repairs book as returned from makers, is put on the shelves for untested meters, and goes through the before-mentioned course. By this system a perfect check can be kept on every meter, which is very necessary in case of complaints from consumers as to accuracy. Every meter coming into the standardising department should be tested before reissue, even if just new from the makers, as carriage is liable to affect the accuracy, and a more perfect check is possible in the case of complaints. This system, if carried out systematically, is very simple, and takes very little time, and will very soon save hours when necessary to trace any meter either as to destination or test.—W. R. A.

*Answer to No.* 678 (*awarded* 7*s.* 6*d.*).—The best system of book-keeping for the meter department of a central station is undoubtedly the card system, as it allows of the removal of dead matter and the insertion of fresh without disturbing the rest, which is impossible with the ordinary book system. The cards required will be as follows: (1) meters received from makers; (2) meters ordered; (3) new defective meters returned to makers; (4) test cards; (5) meters issued; (6) meters returned off circuit; (7) daily report; (8) stock cards; (9) readers; (10) ; eet index; (11) index cards.

All the cards should be 8 by 5 size except the index cards, which may be 5 by 3. They should all be ruled on both sides, and be tab cards with 10 series tabs and of various colours, which will be found a convenient way of distinguishing the different size and makes of meters.

1. *Meters Received.*—These cards are shown in Fig. 1, the tabs of the cards being used to show the card number,
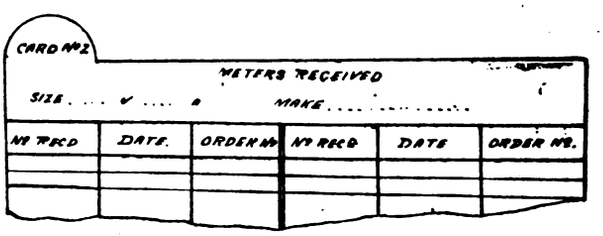
FIG. 1.

the size and volts being shown by a guide card, and the make by the colour of the card.

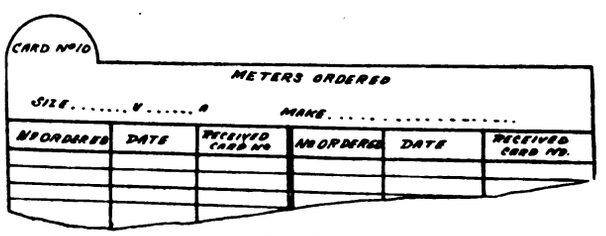


FIG. 2.

2. *Order Cards.*—These are shown in Fig. 2, and differ from the meters received cards only in the ruling, the separation of the makers and sizes being the same.

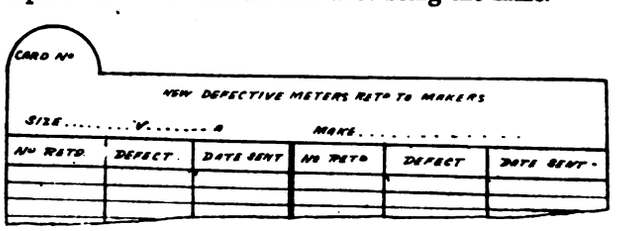


FIG. 3.

3. *New Defective Meter Returned to Makers.*—Fig. 3 shows these cards, which again are similar to No. 1 except in ruling.

4. *Test Cards.*—We now come to the cards on which are recorded the tests made on the meters. The ruling of this

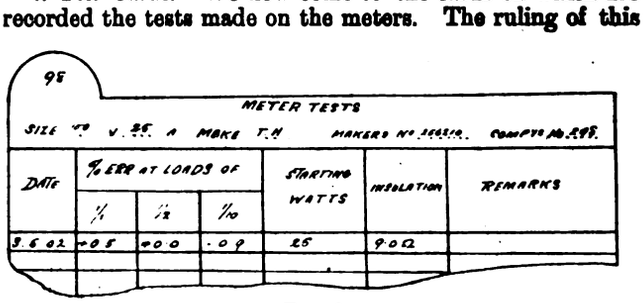


FIG. 4.

will, of course, vary with the tests made, but Fig. 4 gives a generally useful ruling. The tabs of these cards should be numbered with the company's own serial meter number, the last two figures of each 100 only being put down, and

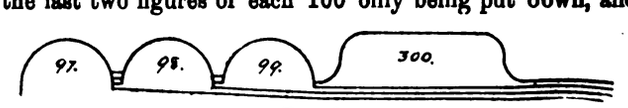


FIG. 4A.

guide cards used for the even hundreds. See Fig. 4A, which shows cards for meters 297, 298, 299, and 300.

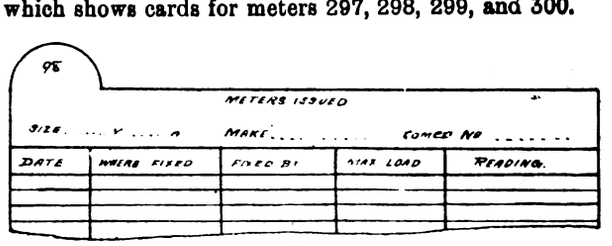


FIG. 5.

5. *Meters Issued Cards.*—These are shown in Fig. 5, and their tabs should be numbered with the meter numbers, like the test cards.

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6. *Meters Returned off Circuit Cards.*—These cards (Fig. 6) are numbered in the same way as the last two.

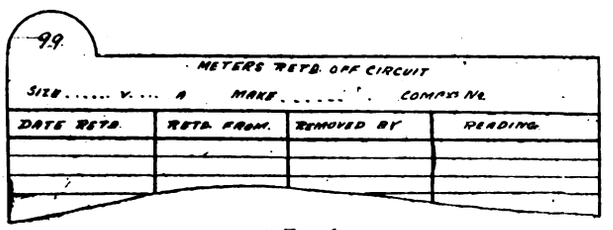


FIG. 6

7. *Daily Report Cards.*—These are in pairs, perforated down the middle (Fig. 7), and when filled up, one half

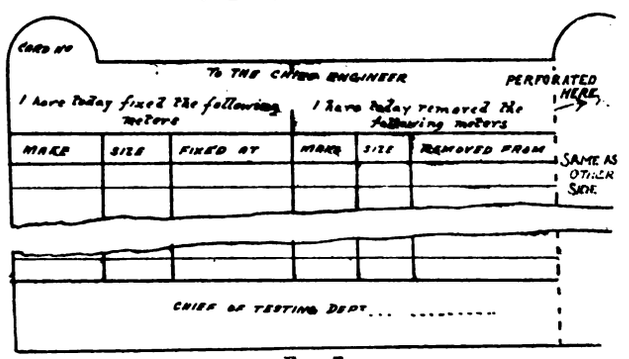
CARD No
TO THE CHIEF ENGINEER
PERFORATED HERE
I have today fixed the following meters
I have today removed the following meters
MAKE | SIZE | FIXED AT | MAKE | SIZE | REMOVED FROM
SAME AS OTHER SIDE
CHIEF OF TESTING DEPT.....

FIG. 7.

should be sent to the chief engineer and the other half kept by the testing department. Their tabs should only bear a serial card number.

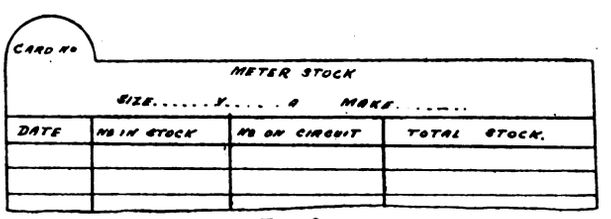


FIG. 8.

8. *Stock Cards.*—The stock cards (Fig. 8) differ only in ruling from the meters received cards, the numbering and filing being exactly the same.

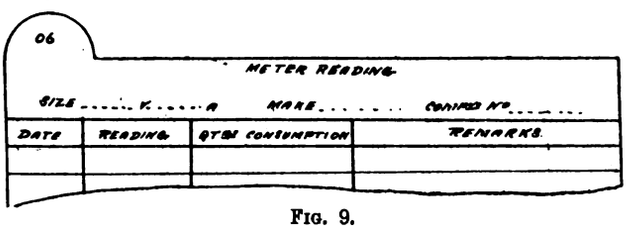


FIG. 9.

9. *Meter-Reading Cards.*—The meter reading is often done by the accountant's office, but if it is done by the meter department, as it should be, meter-reading cards as shown in Fig. 9 will be required, and they must be filed similarly to the test cards in order of the meter number. Books can be had to hold 100 cards especially for meter-reading purposes, and each meter reader can be given one or two streets to read and provided with the meter-reading cards for those streets.

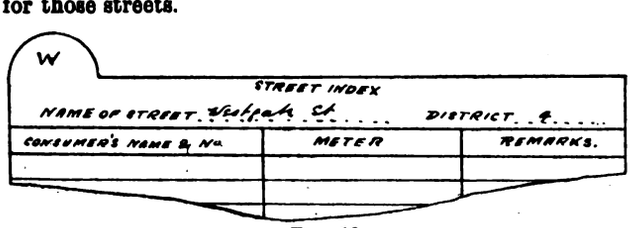


FIG. 10.

10. *Street Index Cards.*—It will be found convenient, especially for meter reading, to keep a street index (Fig. 10), each card dealing with one street and showing the consumers connected in that street. These should be filed alphabetically, the card number becoming the first letter of the street's name.

11. *Index Cards.*—These cards (Fig 11) are filed like the test cards in order of meter number, and contain references to all the other cards.

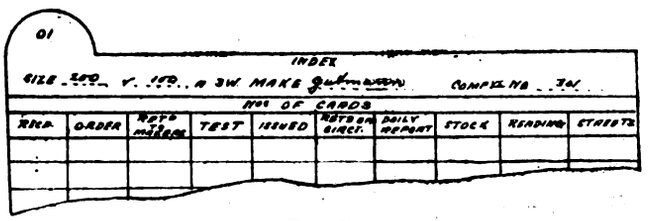
01
INDEX
SIZE..... V..... A 3W MAKE..... COMPY'S No.....
Nos OF CARDS
REC'D. | ORDER | RETD FROM METER | TEST | ISSUED | RETD ON CIRCT. | DAILY REPORT | STOCK | READING | STREETS

FIG. 11.

The rulings shown are necessarily only a rough guide, as every department will have special cases which have to be met with special rulings.—H. R. M.

*Answer to No.* 678 (*awarded* 5*s.*).—The books required by the meter department are few in number, but should be so arranged that it is possible to ascertain without any trouble or delay, first, the number, size, and type of meter on any consumer's premises; secondly, all particulars respecting the tests made on it before it was installed; thirdly, it should be easy to trace any meter. The best form of ruling the books will be found in an excellent article respecting the meter department generally, written by Mr. C. A. L. Prusmann, in the early numbers of 1899 in the *Electrical Engineer*. Most of the forms required are, I find, in the number dated Jan. 27, 1899. It would take too much space to reproduce them in the "Questions and Answers" column. The first book might be called the meters received, ruled to show owner's number, maker's number, maker, type, size in amperes and volts, date received, date passed as accurate, date installed, number or name of customer, where it was installed, and any remarks. The next book required is the tests record. This book is numbered for as many meters as are owned by the department, in plain block figures. For a foolscap size book allow, say, three numbers on each page. These numbers, of course, refer to owner's numbers, not maker's. Allowing three numbers to each page, you have 11 lines to make records for each meter. First give maker's number, amperes, volts, maker, testing constant, and if meter does not read in units state what the dials do record. Then after the meter has been adjusted, if necessary, and found to pass your standard tests, then record three tests taken at one-tenth, one-half, and full load, recording the volts, amperes, watts, number of revolutions, time in seconds, percentage of error. You have still plenty of room to record further tests should the meter be returned at a later date to the test-room.

A meters outwards and a meters inwards should also be kept, giving number of meter (owner's number), makers, size, reading, and by whom fixed or removed, cause of removal, and remarks. There should be a meter index, showing owner's number, maker's number, maker, amperes, volts, and the folios in the meters received, test record, the meters outwards and meters inwards books. There should also be a customer's index, giving name, address, number if used, and the folios in the meters outwards and meters inwards books.

But probably one of the most important books is that kept by the meter inspector. Now that high-voltage and Nernst lamps are common, the current used is comparatively small, and it is necessary to adopt a severe periodical inspection. A man with a number of lamps fixed in batten lampholders fastened inside a box of convenient size, a portable ampere and voltmeter, should test each meter on circuit. His book ruled to give: customer's name, address, owner's number, starting current, and three tests at, say, one-tenth, half, and full load, giving watts, number of revolutions, and time in seconds. These can be checked with the entries in the tests record, and should any meter be found defective, a label should be made out giving customer's name and address, number of meter, volts, amperes, and type. The meter fixer will take this label, taking a suitable meter with him, will take away the defective meter, attach the label, and instal the meter he has brought from the stores. Both meters are then booked in the meters outwards and inwards books, the meter index, and the customer's index.

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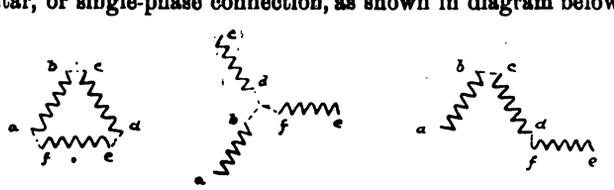
The above books will give a good record of all meters owned by the department, and, if carefully kept, stray meters and stray units will be reduced to a minimum. A card system is often more convenient, but there is always a risk of a card getting mislaid, so that books, although more trouble, are a little more reliable. The meter-reader's book really belongs to the office. It should be ruled to give name of street, name of customers booked in rotation with their street numbers, and the reading of the dials. One card is very convenient. When an application form reaches the office, the clerk opens a ledger account and enters the details of the application on a card, giving the name and address of the customer and the number of lights. The storekeeper gets this ticket and passes out a suitable meter, he stating on the card the size of meter and its number. The meter-fixer inserts the date he fixed the meter, and the jointer the date the service was laid on. The card is then returned to the office showing how the application has been attended to.—K.

*Question No.* 679.—With £100 to spend, and having access to a direct-current 230-volt supply, say what machinery and instruments you would buy in order to illustrate the principles of alternating currents.

*Answer to No.* 679 (*awarded* 7*s.* 6*d.*).—Presumably the plant is required for the electrical laboratory of a technical school, where it will be handled by students with varying degrees of care, and it is with this idea that the apparatus outlined below is suggested. The chief thing is to familiarise the students with the general behaviour of plant of various kinds, and the effect on efficiency, etc., of such variations of conditions as are likely to occur in ordinary work. High-class instruments and plant are unnecessary in view of the limited sum at one's disposal, as it is not suggested that the apparatus is to be used by advanced students for research work. The plant to be acquired and its approximate cost are as follows:

| | |
|---|---|
| A. Motor-generator (direct-current to alternating), 1 kw., 1,200 to 1,800 revolutions per minute | £45 |
| B. Induction motor, three-phase, ½ b.h.p. | 15 |
| C. Transformer, single-phase, ¾ kw. | 8 |
| D. Instruments — two single-phase wattmeters at £6, two ammeters at 50s., and two voltmeters at 50s. | 22 |
| E. Wires, casing, lamps, etc. (to be erected by students) | 5 |
| Contingencies | 5 |
| | £100 |

A. The motor-generator is to consist of a four-pole direct-current 230-volt motor of 1¾ b.h.p. capacity, with a field rheostat to give speeds from 1,200 to 1,800 revolutions. It is to be provided with four slip-rings, *a*, *b*, *c*, and *d*, so tapped off from the armature that three-phase currents can be obtained from the rings *a*, *b*, *c*, or single-phase currents from *a* and *d*. The slip-rings are, of course, to be provided with brushes, and the alternating voltage obtained from them will be about 165 volts single phase or 140 volts three phase independently of the speed, the periodicity varying from 40 to 60 ⁓ with the speed of the motor. The generator of this set is to be a 1-kw. three-phase alternator of the revolving-field type, and four-polar, so as to have the same frequency as the motor. The three phases of the armature winding are to be kept separate, each being brought out to two terminals so that they may be arranged in mesh, star, or single-phase connection, as shown in diagram below.




When the field is excited at 230 volts, each winding is to give 80 volts at 1,200 revolutions, or 120 volts at 1,800 revolutions. The alternator will, therefore, give the following voltages in its various connections at top and bottom speed and periodicity:

| Speed. | Periods. | Three-phase. Mesh. | Star. | Single-phase. |
|---|---|---|---|---|
| 1,200 | 40 ⁓ | 80 | 140 | 160 |
| 1,800 | 60 ⁓ | 120 | 210 | 240 |

These voltages may be reduced by 30 per cent. (at constant periodicity) by weakening the alternator field. The alternator is to be provided with a pulley to enable brake tests of efficiency to be made, and the set is to have four bearings, so that the motor may be run by itself as a rotary converter, or the alternator as a synchronous motor, when uncoupled.

B. The induction motor is to be of the three-phase type, ½ b.h.p. capacity, wound for a normal periodicity of 50 and voltage of 160. It is to have a wound rotor with slip-rings, and a three-pole starting resistance. A pulley is to be fitted to its spindle, so that brake tests can be made.

C. The transformer, of ¾-kw. single-phase type, is to be wound for a primary pressure of 50 cycles, 160 volts transforming to 200 volts.

D. The instruments should all be of the portable type The ammeters should read up to 15 amperes, the voltmeters to 250 volts. The wattmeters should be capable of carrying 15 amperes and 240 volts without overheating. All calibrations should be made at 50 periods, the instruments being of a type affected but little by variation of periodicity.

E. The wiring need not be elaborate, as the highest pressure will be 250 volts, and, in general, less. Three banks, each of four 32-c.p. lamps, will be required to provide a non-inductive variable load for the three-phase and single-phase tests. Lamps of several voltages must be kept, of course.

The chief experiments to be carried out with this apparatus are as follows: The direct-current motor (uncoupled from the alternator) may be run as a rotary converter, giving three-phase or single-phase current, efficiency tests being made upon the banks of lamps An inductive load may be obtained by small improvised choking coils in each leg of the leads to the lamps. Again, the rotary may be used to drive the induction motor, or the alternator as a synchronous motor; and in either case, by varying the speed of the rotary, we may observe the effect on the motor of change of periodicity at steady volts, and we may further experiment on the synchronous motor by varying its field; or, using the single-phase slip-rings, we may test the transformer, connecting its secondary to a bank of lamps. (It may be noted that the alternator when in "single-phase connection" is not reversible—*i.e.*, cannot be regarded as a single-phase motor.) Next, by coupling the motor and alternator together, we may test the efficiency of the set, loading the alternator on its three phases by the lamps. The efficiency of the alternator in single-phase connection may also be tested, but is naturally very low, and not truly representative of a single-phase machine. We may use this connection with advantage to supply a single-phase current of varying voltage and periodicity to the transformer. We may also supply current from the alternator to the slip-rings of the motor, either three-phase or single-phase (and in the latter case, if desired, with the interposition of a transformer), thus obtaining a kind of Hopkinson test, the direct-current motor supplying mechanical torque to the alternator, which returns a magnetic torque to the motor, the external power mains making up the deficiency. Then, again, we may drive the induction motor by means of the current supplied by the alternator, and as both periodicity and voltage are now variable (within limits), we can adequately test the effect of change in either of these upon the starting torque and general behaviour of the motor; and further, by "shorting" the lattter's slip-rings, we may also test the starting current and torque of the motor under conditions analogous to those of the squirrel-cage type of machine.

It has been assumed in the above that the laboratory is already provided with direct-current instruments to measure the power absorbed, and that speed counters, material for rigging up a "Prony" brake, and similar non-electrical sundries that may be required in the various tests, are available. This being so, it is believed that the sums set out above will suffice for the purchase of the suggested plant, this being of a serviceable and substantial type, though not, perhaps, of the very highest class of workmanship and finish.—C. E. C.

*Answer to No.* 679 (*awarded* 7*s.* 6*d.*).—The following is a suggested list of articles, with approximate prices, on which the amount specified might be advantageously expended,

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| | | | |
|---|---|---|---|
| Motor-dynamo (1 h.p.) | £63 | 0 | 0 |
| Alternating-current arc lamp | 5 | 10 | 0 |
| Choking coil for arc lamp | 1 | 0 | 0 |
| Direct-current arc lamp | 5 | 0 | 0 |
| Adjustable resistance for arc lamp | 1 | 5 | 0 |
| Hot-wire ammeter | 3 | 0 | 0 |
| Hot-wire voltmeter | 3 | 0 | 0 |
| Condensers | 3 | 10 | 0 |
| Reversing switch | 1 | 5 | 0 |
| Induction coil (Faraday's) | 1 | 10 | 0 |
| Delezene circle | 3 | 5 | 0 |
| Magnet with movable laminated iron core | 2 | 10 | 0 |
| Several sheets thin metal and several metal rings | 0 | 15 | 0 |
| Regulating transformer | 4 | 0 | 0 |
| Two or three incandescent lamps on board with terminals.. | 0 | 10 | 0 |
| Connecting wires, carbons, etc. | 1 | 0 | 0 |
| | £100 | 0 | 0 |

The motor-dynamo (Fig. 1) can be driven from the direct-current supply and will provide an alternating current for

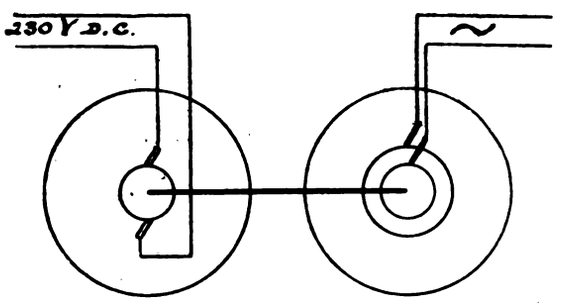


FIG. 1.

the experiments. The arc lamps may be on together, thus the peculiar phenomena of each can be studied and contrasted. It will be noticed (Fig. 2) that the direct-current arc distributes light mainly in one direction, from the crater on the positive carbon. The alternating arc has no decided crater, and the light rays are thrown both

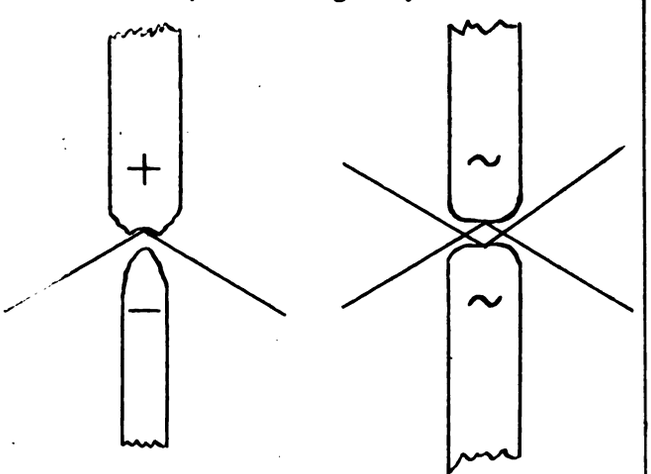


FIG. 2.

upwards and downwards. This leaves a dark horizontal zone, which is very noticeable. Opportunity is here afforded to point out that with the direct-current arc the positive carbon is burnt away about twice as fast as the negative carbon; hence the positive carbon is made larger in proportion. With an alternating-current arc the carbons are

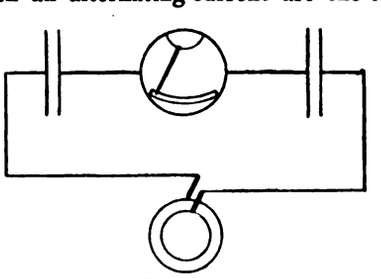

FIG. 3.

of equal diameter. With the exception of a rather greater consumption of the upper carbon, due to its position, the carbons burn at equal rates. By placing the choking coil in circuit with the direct-current lamp it can be shown that although it cuts down the volts in the alternating circuit, with a direct current it acts simply as an ohmic resistance. The hot-wire instruments will be useful for taking measurements, both alternating and direct. Every text-book contains descriptions of the phenomena that may be exhibited by means of Faraday's induction coil. With the Delezene circle it is readily shown how an alternating current can be obtained by moving a coil of wire in the earth's magnetic field. The condensers (Fig. 3) will enable the operator to show that alternating-current effects can be transmitted without a direct connection. Suspend a thin sheet of iron close to the poles of the laminated electromagnet, energise the magnet with a direct current, and reverse the current quickly several times by means of the reversing switch. A clicking sound will be heard, given off by the vibrations of the sheet of iron. If, now, the magnet windings are fed with an alternating current, the clicking sound will develop in a more or less musical note. The pitch of the note may be altered by varying the speed of the motor-dynamo. Energise the magnet with direct current and hold the metal rings close to the poles, the rings will remain cold; under like conditions, but with alternating-current excitation of the magnet, the rings will be found to become warm. Note effects when rings of different metals are used, also when placed in different positions. By suspending the rings in front of the poles many interesting phenomena may be observed. The regulating transformer will afford a means of raising or lowering the voltage as desired. Two small carbons should be cemented together (Jablochkoff's candle) and burnt; when the arc is at the top it will be seen that it takes the form of an arch, when at the bottom that it tends to creep up the candle. By passing the lead carrying the current several times below the arc at ends of candle (Jamin's arrangement), the arc can be kept in its proper position and burnt steadily. It is readily shown that these candles cannot be used with direct current. For want of space only a few experiments have been enumerated. The changes, however, that may be given with this set of apparatus are practically infinite.—M. M.

*Answer to No.* 679 (*awarded* 5*s.*).—To illustrate the principles of alternating currents, some primary or secondary source of such currents is absolutely necessary. Therefore, the first and greatest item of expenditure is in the form of some type of motor-generator arranged in regard to windings to work on the 230-volt circuit, which may take the form of motor-dynamo of the double-field type of Crocker-Wheeler system, say developing 1 h.p. at 62 per cent. efficiency, costing £55, including motor starter and field regulator. The next item is some form of alternating-current motor, which are now to be had to suit any voltage and from 40 to 125 cycles; one to suit such a motor-generator would cost £4. 15s. Another important item is an electromagnet having several windings and also movable cores, one of iron wire and one of solid iron or steel, or both if possible; also copper ring, plate, etc., for illustration E. Thompson's experiments—approximate cost, £2.

Some forms of arc lamp is also necessary, and, if possible, two of the same type, so as to illustrate series work, say two Angold lamps, 12 hour, 10 amperes, £5 each—£10. In regard to choking coils, the electromagnet should be so arranged as to be useful in this direction by means of its movable cores. Another essential piece of apparatus is a small transformer, say ½ h.p, costing £9. Further, some artificial load is also necessary, and for this purpose a bank of incandescent lamps is sufficient, say 20, with connecting arrangements, costing 55s. In reference to measuring instruments, an electro-dynamometer will be necessary, having a range of, say, 0 2 to 20 amperes, and costing £8. 8s. Finally, there will be £7. 2s. left for the purchase of, say, simple volt and ammeter. Therefore the total expenditure may be drawn up as follows:

| | | | |
|---|---|---|---|
| Motor-generator complete | £55 | 0 | 0 |
| Two Angold arc lamps | 10 | 0 | 0 |
| Transformer, ½ h.p. | 9 | 0 | 0 |
| Alternating motor | 4 | 15 | 0 |
| Artificial load | 2 | 15 | 0 |
| Electromagnet | 2 | 0 | 0 |
| Electro-dynamometer | 8 | 8 | 0 |
| Voltmeter and ammeter | 7 | 2 | 0 |
| —K. | £100 | 0 | 0 |

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THE

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## SUPPLY OF ELECTRICITY BILL.

The Government Bill which has been introduced by Lord Wolverton into the House of Lords will effect some radical and much needed amendments in the law relating to electric lighting if it comes on the statute books in its present form. As it is a Government measure, there is a good chance that it will become law, and that in consequence there will be considerable development in electric supply undertakings. It comes too late, however, to affect the question of electric supply in all but the smaller towns in the United Kingdom, but certain of its clauses may be made retrospective. In these towns the introduction of electric supply systems has been hampered from causes which are not operative in larger towns. In the first place, the cost of obtaining an electric lighting provisional order is practically the same irrespective of the size and wealth of the area to be supplied. This cost is comparatively a small matter in a large town, but in a country area the spending of three hundred pounds to six hundred pounds cannot be lightly undertaken either by the local authority or by a company. This expenditure, and the doubt that the undertaking may not be a remunerative one, tends to prevent the local authority from undertaking the work. The Electric Lighting Acts now in force tend to prevent a company from doing what the local body is loth to undertake. Under these Electric Lighting Acts the consent of the local authority has to be obtained, and this consent has often been withheld from obstructive reasons only. In other cases the price which the would-be undertakers have had to pay for the consent, in the form of arbitrary terms, has so hampered the undertaking as to make it an unremunerative one. Under this new Bill radical alterations are made in this respect. In the first place, the consent of the local authority to the grant of a provisional order may be dispensed with; any objections will, of course, be heard, but these need not prevent the issue of the order by the Board of Trade. Again, the new Bill varies the purchasing powers of local authorities, and in certain cases the purchasing clause will be omitted from provisional orders. This will be done when the Board of Trade consider it is inapplicable, either by reason of the undertaking being situate in a number of districts, or by reason of the objects of the undertaking not being such as can be properly carried out by local authorities, or by reason of any other special circumstances affecting the undertaking. In this case, also, the authorities interested will be heard before the clause is struck out. The above provisions are likely to raise considerable objection from local authorities, but the fact that the larger towns are not interested may tend to keep the opposition within reasonable limits. In other respects the clause (4) of the new Act favours local authorities, in that it gives them the right to purchase generating stations placed outside the municipal boundaries. It also, in Sub-Section 3, provides for the purchase of a company's undertaking extending over several municipal districts. This important section reads as follows: "Any local authority having power under the Electric Lighting Acts or any provisional order to purchase so much of the undertaking of a company as is within the district of that local authority may, with the consent of and upon such terms and conditions as may be approved by the Board of Trade, and with the consent of the company, transfer their rights of purchase to any other local authority having power to purchase so much of the same undertaking as is within the district of that last-mentioned local authority, and the deed of transfer may contain such consequential provisions as may be necessary for giving effect to the transfer." The other provisions in the Bill are equally favourable to

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local authorities and to companies. For instance, it will give the power to any undertaker authorised to supply electricity in any area to acquire compulsorily for the purpose of a generating station land situated either within or without their district. It also provides for the breaking up of streets outside the area of supply when for economical reasons the generating station has to be placed outside this area. These powers of breaking up the streets extend to the crossing of railways, tramways, etc., when required. The Bill also provides for a five-yearly revision of the maximum price instead of seven years as before, and it amplifies and amends the provision of the electric lighting clauses of the Act of 1899 as to the certification of meters. Under Clause 5 of this Bill arrangements are made for the electric supply undertaking for adjoining districts being controlled by a joint committee or board. This has been already done, an instance being the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, which Board has constructed works and is about to commence giving a supply of electrical energy. Last, but by no means least, the Act settles the question of stand-by supply. In Clause 10 it is provided "that a person shall not be entitled to demand a supply of electricity for any premises having a separate supply, unless he has agreed with the undertakers to pay them such minimum annual sum as will give them a reasonable return on the capital expenditure and will cover other standing charges incurred by them in order to meet the possible maximum demand for those premises." This is a fair and reasonable arrangement, and it has been already adopted in certain areas in spite of the provisions of the Electric Lighting Act. In conclusion, we would emphasise the fact that the Bill provides means for overcoming objections in detail in older legislation on the same subject. It will, if passed, do much to simplify procedure, and in consequence it will tend to extend the industry. It is to be hoped that it will be considered by local authorities in a reasonable light, as they may be sure that the interests of the inhabitants of any district will be properly protected by the Board of Trade veto.

## CORRESPONDENCE.

### SYNCHRONISING GEAR.

SIR,—Please allow me to correct a printer's error in my answer to Question No. 676 in the current issue of this journal (pp. 675 and 676). Figs. 1 and 5 should be interchanged, and the remarks in the first portion of the answer refer to the diagram *without* the "rotary synchroniser," while those at the end refer to the diagram of connections showing this instrument.—Yours, etc., MONOPHASE.

### AMERICAN PATENT LAW.

In these days, when our industrial legislation is so often reproached with lagging behind that of other countries, it is consoling to see that in some respects, at least, we are in advance of our Transatlantic rivals. In our issue of the 18th inst. we referred to the provisions of the Patent Law Amendment Act of 1902 in regard to the compulsory working of patents, and some comments in the *Electrical World and Engineer* of New York indicate the scope for a somewhat similar measure in the States. In almost every line there are large numbers of patents running back over a long term of years. Very few of these are fundamental in their bearing upon the art. The majority are interlinked with their predecessors in a more or less complicated fashion, and belong to the category of improvements. Of the whole mass of patents, primary and secondary, only a very small percentage have any record of practical usefulness. The vast majority is composed of patents unsuccessful and entirely unworked, or of patents taken out for purely defensive purposes, and never seriously intended to be worked, so that the inventor honestly striving to produce an article of industrial importance continually finds his way blocked by prior patents, often touching his invention only remotely, though sufficiently to hinder material improvements. By way of remedy, our contemporary is disposed to advocate a primary term of not more than seven years, followed by a reissue for a similar period on the presentation of evidence sufficient to show to the office that the invention is actually being manufactured and sold in the open market in good faith and in quantities sufficient to adequately meet current demands. At the expiration of this reissue term, a second similar reissue might be permitted after a somewhat more stringent enquiry. Although this would throw heavy responsibility on the officials in charge and open the way for some perhaps questionable decisions, our contemporary expresses confidence in their ability and probity. If the field is to be cleared for improvements, the Statute-book of the Union needs an addition in order to eliminate the huge accumulation of failures and obstructive patents without waiting 17 years for them to expire from senility.

### INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the list of Council nominations for election of Council and honorary officers for the session 1904-5, as announced at the ordinary meeting on April 28:

*President.*—Mr. Robert Kaye Gray.†

*Vice-Presidents.*—Dr. J. A. Fleming, Mr. J. E. Kingsbury, Mr. W. H. Patchell,* Mr. W. M. Mordey.*

*Members of Council.*—Sir J. Wolfe Barry, K.C.B., F.R.S., Mr. T. C. Callender, Mr. S. Dobson, Mr. B. Drake, Mr. S. Z. de Ferranti, Mr. J. Gavey, C.B.,* Mr. F. Gill, Dr. R. T. Glazebrook, F.R.S.,* Mr. F. E. Gripper, Mr. J. S. Highfield,* Mr. H. Hirst,* Mr. G. Marconi, Mr. C. H. Merz,* Mr. C. P. Sparks,* Mr. A. A. Campbell Swinton.

*Associate Members of Council.*—Mr. T. Mather, F.R.S.,* Mr. Sidney Morse, Mr. A. J. Walter.

*Honorary Auditors.*—Mr. F. C. Danvers, Mr. Sidney Sharp.

*Honorary Treasurer.*—Mr. Robert Hammond.

*Honorary Solicitors.*—Messrs. Wilson, Bristows, and Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with Article 45 of the articles of association. All the honorary officers being eligible, are nominated for re-election. † See note on the subject of presidency in another column.

At the ordinary general meeting on April 28 the following were the candidates balloted for:

*Associate Members.*—J. L. Andrews, King's Hill Villa, Wednesbury; A. R. Bacon, 45, West-side, Wandsworth Common, S.W.; C. E. Crocker, Electric Power and Light Corporation, Limited, Kalgoorlie, Western Australia; T. A. F. Cutler, Brookleare, Lynoombe-vale, Bath; M. T Evans, 12, Queen's-square, Bristol; J. T. Fahy, New Zealand Railway, Wellington, New Zealand; T. Humphreys, 46, Taylor-street, Rochdale, Lancs.; E. B. Mulliner, 17, Park-way, Liverpool; H. H. Nash, Durlston, Dorset-road, Bexhill; H. P. Onslow, Electric Light and Traction Company of Australia, Adelaide, South Australia; C. L. de W. Reader, Glen-da-Lough, The Avenue, Fareham; W. G. Stones, 10, Richmond-terrace, Blackburn, Lancs.

*Associates.*—A. W. Brown, Stirling Districts Asylum, Larbert, N.B.; J. Caldwell, Rockfield, Renfrew-road, Paisley; H. S. Davies, 150, Westbourne-terrace, Paddington, W.; S. Gillitt, Elm Grove House, Wellingborough, Northampton; A. S. Hughes, St. David's, Greystones, co. Wicklow; D. L. Mitchell, Electricity Works, Kirkcaldy, Fife; S. Roseveare, Colham, Basingstoke-road, Reading.

*Students.*—A. Adams, 94, Tiverton-street, Ardwick, Manchester; J. N. Aitkin, 22, Park-avenue, Levenshulme, Manchester; A. Ardern, Welbeck Lodge, Ashton-under-Lyne; C. F. N. Atterbury, 111, Cyprus-street, Stretford, Manchester; W. M. Berry, 6, Havelock-terrace, Preston; F. S. Bowen, Heathside, Knutsford; W. F. Boyd, Barton House, Didsbury, Manchester; A. W. Brydon, Bramhall Park, Cheadle Hulme, near Stockport; G. G. Bullmore, 67, Park-view, Queen's Park, Manchester; D. Burns, Stanley House, Motherwell, N.B.; H. Burroughes, 23, Livingstone-street, Chorlton-on-Medlock, Manchester; W. D. Busteed, 61, Bolton-road, Pendleton, Manchester; H. Butler, 49, Azalea-road, Blackburn; A. F. N. Chandler, 34, Bath-road, Bedford Park, W.; K. C. R. Chowdry, Owen's College, Manchester; W. G. Conner, Egerton House, Ashton, Preston; H. Coope, 47, Market-street, Farnworth, R.S.O.; A. L. Coward, 17, Bevidge-road, Blackburn; F. W. Crawford, 113, Donore-terrace, S.C.-road, Dublin; F. Crompton, 2, Holland-villa, Stretford, Manchester; C. E. Crowther, 43, Richmond-grove, Longsight, Manchester; J. G. Cunliffe, 421, Blackburn-road, Accrington; R. G. Cunliffe, 421, Blackburn-road, Accrington; W. G. Cunliffe, 13, Queen's-grove, Longsight, Manchester; C. J. Elliott, 9, Lancaster-road, Pendleton, Manchester; A. G. L. Evans, Park-road, The Common, Uxbridge.

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## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

*Scope of Paper.*—It is proposed in this paper to discuss some of the salient features of a station for power supply, in the design of which station all other considerations are made subservient to the commercial success of the undertaking as a whole. We do not suggest that the power station, as distinct from the outside system, is the more important section; on the contrary, it should not represent more than 50 per cent. of the total expenditure. It is, however, a simpler matter to compare the details of design and cost of this part of an undertaking with the corresponding part of another than is the case with the outside or distribution system. We shall omit particular reference to the generation of electrical energy either from waste products or by water power; the latter is not of great importance in this country, while the former is in itself of sufficient interest to demand a whole paper for its adequate treatment. The principles of power station design referred to hereafter are applicable to all electricity works, large or small, whether they be designed for power supply, traction, or lighting, though in small stations some of the considerations may naturally lose force for commercial or other reasons. Power stations are designed for numerous purposes, from the small station for a town lighting or traction system to the large station for dealing with all the requirements of an industrial neighbourhood; it may therefore be advisable, although the general principles of design are identical, to say at the outset that many of the remarks as to detail which we shall make apply more particularly to the power station (5,000 kw. or over) of a power supply undertaking—that is is to say, of an undertaking whose object is to supply all the requirements (power, traction, and lighting) of a district extending over a considerable area.

*Essential Conditions for Commercial Success in Electricity Supply.*—The commercial success of such an undertaking is absolutely dependent upon the cheapness and reliability of the supply. It may be urged that this is no new phase of the supply problem; but the argument, though possibly correct in principle, is so wide of the mark in degree that if a station for power supply were designed on similar lines to many existing power stations for traction and lighting purposes, commercial failure would almost certainly result. In the case of a tramway system the capital expenditure on the electrical equipment is not a very large proportion of the cost of the whole system; large sums, therefore, can be, and frequently are, expended on elaborate and ornamental buildings, on highly finished equipment, on the provision of an excessive amount of spare plant, and on unnecessary duplication of auxiliary machinery, without appreciably affecting the commercial success of the system. In the case of power supply, however, there is a limit in price below which a supply company must keep if it is to get consumers at all. This limit is low because many large individual consumers are very favourably situated from a power generating point of view, and a power company can therefore only attain success by giving due consideration to the factors governing economical production. Reliability of supply must, however, take precedence over everything else, even over economy of production. It is impossible to contemplate interruption of supply to a manufacturer, for if this happens a power company has failed in its purpose. To meet this condition involves careful and substantial engineering design and the use of only the best and most reliable apparatus obtainable. It further involves a reasonable allowance of spare plant and renders essential simplicity of design and standardisation of details.

*Relative Importance of Power Station to Distribution System.*—Before entering on the main object of this paper, it may be useful to analyse more closely the relative importance of the power station and the distribution system. Since the early days of the distribution of electrical energy an amount of attention has been directed to the power station as compared with the distribution system which is hardly warranted by its importance from either an engineering or a commercial standpoint. This is no doubt partly due to the fact that it is, so to speak, the mainspring of the whole system, and partly because the merits or demerits of its design are ever open to observation. The importance attached to the power station probably accounts for the lavish and unnecessary expenditure which has in many cases been bestowed upon it.† It may be worth while to carry the suggested comparison into detail, if only because the conclusions to be drawn materially affect the expenditure of the power station itself.

*The Distribution System.*—(1) The distribution system of a power scheme will usually consist of a three-phase supply at 40 or 50 cycles per second. We do not refer to the voltage, as this depends to a great extent upon the area covered, and in any case it can easily be transformed. The system of supply having once been decided upon and the cables laid, it is more or less permanently settled for better or worse, and cannot be changed without great expense. (2) The expenditure upon the distribution system will probably, in the majority of cases, amount to more than 50 per cent. of that on the whole scheme, especially if the consumer's installation be taken into account. This, whether supplied by the power company or not, is really part of the system, in that the company must bear the expense of any alteration necessary on account of change of system. (3) The manufacture of cables is well understood, and if they be properly designed and laid, they are subject to a very small repair account. A smaller depreciation account is therefore justifiable than in the case of the power station. (4) Large power schemes will probably eventually consist of a network of transmission cables, sub-stations, and distributing cables, supplying all the power requirements of a neighbourhood, and drawing a supply from more than one power station, the latter being located where electricity is to be obtained most cheaply from either coal or waste products. (5) The distribution system has a comparatively high efficiency—probably not less than 75 per cent. (6) On account of the high initial cost of installing the distribution system, in taking up ground, etc., and the difficulty of making small beginnings and economically adding to them hereafter, the distribution system should be, and generally is, put down with more margin for future requirements than is the power station. On the other hand—

*The Power Station.*—(1) A power station has a comparatively low efficiency—not more than 10 per cent. There is thus room for large improvement in the generation of power. For this reason the depreciation account must necessarily form a much higher percentage of the capital cost than in the case of the distribution system. (2) A power station is capable of easy extension without affecting in a very marked degree the ultimate cost. It can therefore be begun on a smaller scale. (3) It may pay in the future to change even the location of the power station, and to feed the system from some other site or sites where energy can be more cheaply generated.

*The Principles of Power Station Design.*—It is essential for the designer to keep before him the two main considerations—"reliability of supply" and "economy of production." The latter may be conveniently sub-divided into running charges and capital costs. Early engineers, whether civil, mechanical, or electrical, were justifiably content if the work for which they were responsible proved reliable, operating and capital costs being minor considerations. The necessity for low operating costs was next fully recognised, so much so that this consideration was allowed to overrule all others, even that of reliability—certainly a backward step. The fact that a project must work well and efficiently, and that it must do both these with a minimum of initial expenditure, is now realised as essential. No engineer can afford to disregard *low capital cost*, which is equivalent, commercially, to *low annual cost*. The importance of keeping the capital cost as low as possible, especially in the case of the power station, may be fully appreciated by a careful consideration of its characteristics as referred to above. We do not think it is wide of the mark to suggest that 10 per cent. per annum should be considered as sinking fund in deciding whether to spend more money than is absolutely necessary on any particular section of the plant in a power station in order to secure lower running costs. In stating this we have specially in mind the liability of change in the generation of power, both in method and in the location of the power station. The relative importance of capital cost and running cost may be seen at a glance for any particular values of either load factor, capital cost, or running cost, from the curves attached (see Fig. 1). From these curves it will be seen that a reduction of the capital outlay by £1 per kilowatt has a greater effect on the running costs than has a reduction of the coal bill by 6 per cent.* This applies with a load factor as high as 30 per cent.; it is therefore evident that for lower load factors the question of limiting capital expenditure becomes of overwhelming importance as compared with that of reducing running costs. There are one or two general principles which it may be worth while to discuss, each having special reference to reliability of supply and economy of production. They are: (1) simplicity of design; (2) sub-division of plant and apparatus; (3) labour-saving devices; (4) provision for extension.

1. *Simplicity of Design.*—Simplicity of design is desirable apart from (as well as on account of) the question of economical production, and, generally speaking, it may be accepted that no complications introduced to facilitate the repair of a breakdown are justified should the complications themselves increase materially the risk of breakdown. That all the earlier station engineers should consistently disregard this axiom was perfectly natural, as, in view of the comparatively unreliable apparatus at their disposal, they were more impressed by the necessity of speedy repair than by the importance of avoiding a breakdown

* Paper read before the Institution of Electrical Engineers.

† When we consider that a boiler only costs £2 or £3 a kilowatt, and a turbine or high-speed reciprocating set £10 at the outside, it is surprising to find power stations running out (as they still do in many cases) to a total cost of £40 or even more per kilowatt. In other words, the mere collecting and joining together of the principal apparatus may cost three or four times as much as the apparatus itself.

* On the basis of coal at 6s. per ton.

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altogether. In fact, they came to regard breakdowns as inevitable, devoting their attention to minimising their effect rather than to reducing the amount of apparatus in which a breakdown could occur. This line of procedure, while possibly justifiable in the earlier stages of the industry, has in many cases been pushed too far. In some stations the designers have apparently set themselves the task of rendering possible every conceivable combination of boiler and engine, engine and exciter, pump and boiler, etc. Ten years ago Mr. Ferranti actually practised this doctrine of simplification, more especially with regard to the electrical side of the station, and as an example of its systematic and logical application the general arrangement of a Ferranti single-phase board is unsurpassed. In the design and general arrangement of the mechanical portion of the station equipment the complication which formerly existed now appears to be diminishing. For instance, at one time a ring steam-main was considered necessary, but it was speedily realised that the inherent objections were very numerous, most engineers returning to the sub-divided straight main into which all boilers fed and from which all engines drew their supply of steam. Fortunately, cases of a burst steam-pipe in a station have been rare, but the failure of a pipe or valve at full load anywhere near the middle of a main would probably result in shutting down the whole station, whether a ring main be used or not.

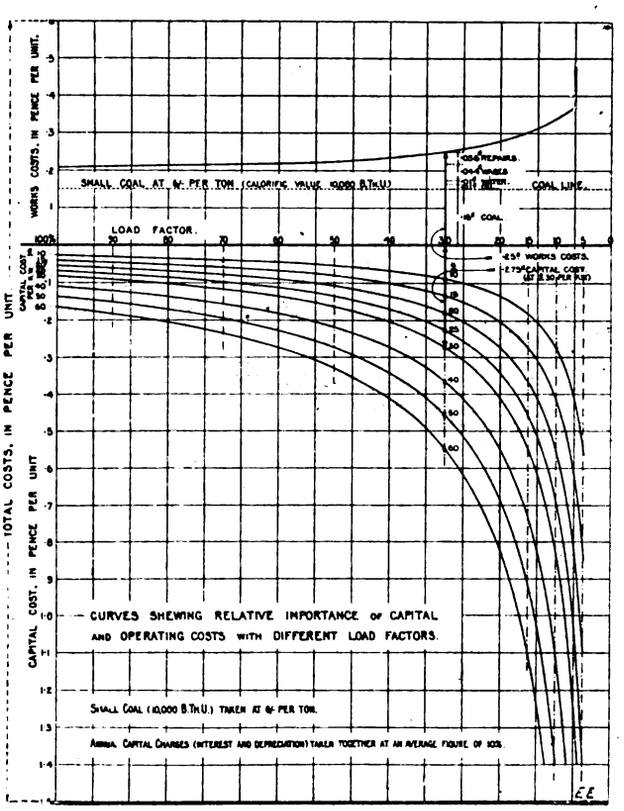
TOTAL COSTS, IN PENCE PER UNIT
CAPITAL COST, IN PENCE PER UNIT
WORKS COSTS, IN PENCE PER UNIT.
LOAD FACTOR.
COAL LINE.
CURVES SHEWING RELATIVE IMPORTANCE OF CAPITAL AND OPERATING COSTS WITH DIFFERENT LOAD FACTORS.
SMALL COAL (10,000 B.TH.U.) TAKEN AT 9/- PER TON.
ANNUAL CAPITAL CHARGES (INTEREST AND DEPRECIATION) TAKEN TOGETHER AT AN AVERAGE FIGURE OF 10%.

FIG. 1.

2. *Sub-Division of Plant and Apparatus.*—The only way to remove all risk of a complete shut-down due to the failure of a steam-pipe is to sub-divide the boiler-house plant into a series of groups, each group having no connection with its fellows.* In fact, it is now considered imperative in a large power station to sub-divide all parts of the apparatus from the boiler-house to the switchboard into a series of units, each complete in itself. This is certainly essential to reliability of supply, and it is in no way inconsistent with economy of production. From the point of view of reliability of supply, if trouble is to be had with anything, it will be obtained by crowding together all kinds of water and steam pipes in one trench. If trouble is to be had with auxiliary apparatus, it will be obtained by locating it with other apparatus, and not sub-dividing it properly. If trouble is to be had with switchgear, it will be obtained by fixing many cables or connections for different purposes either on one panel, or in one partition, or in one cable trench, as the case may be.

3. *Labour-Saving Devices.*—It is sometimes justifiable to disregard the question of economical production on account of the difficulty of obtaining labour, especially intelligent labour, at a reasonable price. To obtain suitable labour becomes more and more difficult every day, not (we hope) because the supply grows less, but because the demand increases faster than the supply. This matter is specially referred to, as the authors have found it difficult to justify the inclusion of a great proportion of labour-saving apparatus by any actual calculation of possible economies in capital or running costs. Take even the ordinary mechanical stoker; we doubt very much if, taking into account first cost and repairs and also efficiency, this is in practice justifiable except in order to meet the labour difficulty. Certainly in the case of most coal-handling plants it will be found that the cost of labour saved is more than counterbalanced by the charges for interest, depreciation, and repairs on the elevating and conveying apparatus. We have known a case in which the capital and repair charges exceeded by 200 or 300 per cent. the economy in wages—there obviously the expenditure was not justified. Before expending money in labour-saving devices the *pros* and *cons.* of the case should be systematically considered. On the one side should be put capital charges, taken at not less than 15 per cent. on the capital cost, and repairs—the latter to be estimated. On the other side should be put the saving in labour. The expenditure may be justified if the two sides balance, not otherwise, unless, of course, the case be qualified by the existence of special labour difficulties. Incidentally it may be remarked that the adoption of labour-saving apparatus may either increase or reduce reliability of supply. It will increase it, in so far as the human element can be safely replaced by automatic machinery. It will reduce it, due to the absence of anyone to look after it, or to take its place should it break down, if the apparatus installed be too complicated.

4. *Provision for Extension.*—Frequently in the design of a traction station engineers have considered it sufficient to merely provide for immediate requirements, or to so arrange the station that it is capable of extension to a certain definite number of additional units of specific size only. In stations essentially for the wholesale supply of power this does not seem sufficient. Not only are future requirements unknown, but it is difficult to foresee the type of plant which it may be advantageous to instal in the future. For instance, a station made for half a dozen reciprocating sets would provide accommodation for three times as many turbines, in which latter case a difficulty would be met with in providing boiler space with reasonable lengths of steam-piping. This is a difficult matter to deal with. Not only has one to consider the use of turbines if they are not installed in the first instance, but to make a choice of the different types of turbine—vertical and horizontal—and to consider the further possibility of adopting gas-engines later.

*Effect of Extension on Capital Cost.*—Power stations for wholesale supply, if the eventual capital expenditure per unit sold is to be kept down, must not be designed for to-day. There is nothing which increases the station capital account so rapidly, and prevents that gradual decrease of capital expenditure per unit sold, which should take place with the growth of a system, as alterations to existing work and rearrangements in order to meet increased output. It is possible in laying out a station to avoid placing chimneys, flues, offices, and elaborately-built brick ends so as to interfere with extensions to either boiler-house or engine-room, though it is to be feared that this is not always done. In deciding upon general arrangements, therefore, or the position of any particular piece of apparatus, or the size of any pipe or trench, it is essential to consider whether such decision is likely to affect (or to be affected by) future extensions.

Having referred to the main principles governing power station design, we shall proceed to discuss some of their effects on actual design, on the assumption that the power station under consideration is for the supply of energy as three-phase high-tension current at 5,000 volts or over. To illustrate discussion we make frequent reference to certain designs for which we, as engineers, are responsible, our justification for this course being that we are necessarily familiar in these cases with the reasons governing the detail design and the choice of apparatus.

### 1. TYPE OF GENERATING PLANT.

*Influence of Type of Plant on General Arrangement of Power Station.*—Although the general design of the main building should permit of any type of plant being used for extension, it is obviously necessary to settle on the type to be adopted in the first instance before proceeding with the detail design of any portion of the structural work. While, therefore, it would appear the natural sequence to deal with the buildings and general arrangement before discussing the generating plant, we propose in this paper to adopt the course which would be followed in actually designing a generating station, and to discuss first the relative merits of various types of prime movers. The most convenient way of doing this is to consider them in the order of their development—viz.: (1) slow-speed reciprocating engines; (2) high-speed reciprocating engines; (3) steam-turbines; (4) gas-engines.

*Reciprocating Engines.*—Comparisons have been so frequently instituted between the first two types and their relative merits so thoroughly discussed that it would serve no useful purpose to carry the discussion further. Before, however, proceeding to group together slow and high speed reciprocating engines to compare their merits with those of the turbine, we will briefly touch on their chief characteristics. High-speed apparatus

* When the initial capacity of a station is comparatively small and a cross connection is considered desirable, it should be made through a length of pipe having stop valves at each end.

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should obviously for the same power cost less than slow-speed. It will, moreover, take up less room. On the other hand, the advocates of slow-speed engines claim that the repair bill of a high-speed engine is higher and the economy not so good as in the case of a slow-speed set. It is only in this country that the question as between the two types has arisen at all—neither on the Continent nor in the United States has any progress been made with high-speed apparatus, and the perfection to which high-speed engines have been brought in this country is all the more creditable in view of relatively slow progress in some other branches of the industry.*

*Steam-Turbines.*—Every year steam-turbines claim increasing attention.† They have already been adopted for the largest new stations in this country, on the Continent, and in America. Opinion is, however, still divided with regard to their merits, and we are therefore, perhaps, justified in dealing with the question at some length. The present position of steam-turbines may be said to be almost entirely due to the indefatigable energy of the Hon. C. A. Parsons, who has laboured many years on their development. A Swedish engineer, De Laval, has also been engaged on the subject for nearly, if not quite, as long. His turbine, however, runs at so high a speed (of the order of 10,000 revolutions per minute) that it is impracticable except in comparatively small sizes. Of turbines‡ more recently placed on the market the best known is perhaps the "Curtis,"§ which has been developed by the General Electric Company of America. Other types are the "Rateau,"‖ manufactured by the Maschinenfabrik Oerlikon, Zurich, and the "Stumpf," developed by the Allgemeine Elektricitäts-Gesellschaft, Berlin. In addition to these there are various modifications of the Parsons turbine manufactured by different firms.

*Advantages of Steam-Turbines.*—Whether the final form of turbine will be of the Parsons type, or whether it will be modified by the use of expanding nozzles¶ or by other device, it is impossible to say at present. The turbine has, however, already reached such a high standard of efficiency compared with that obtainable within the temperature limits that unless these limits* are themselves largely varied it would seem to resolve itself almost solely into a question of first cost. Turbines of any type obviously possess certain inherent advantages over reciprocating engines—they are cheap, simple, take up little room, and have no vibration. If, therefore, they can be made to run with reasonable economy in steam consumption and repairs, they fulfil the essential requirements for power supply as enumerated in the introduction much more effectively than can the best reciprocating engine, whether high or low speed. "Reliability of supply" is met by their simplicity of construction, which also results in a small repair bill and a small labour bill for operation. "Economy of production" is met (*a*) by their low first cost (which is further helped by the small space occupied, a cheap foundation, and absence of vibration) and (*b*) by their economy in operation and saving in repairs, oil, and labour.

(*To be continued.*)

* See *Proceedings* of the Institution of Civil Engineers, vol. cli.: "High-Speed Electrical Generating Plant," by T. H. Minshall. According to figures recently published, high-speed engines have been built with a consumption of only 16lb. of water per kilowatt-hour (steam at 200lb. and 200deg. F. of superheat)—which figure will bear comparison with the very best slow-speed results.

† See paper before the Municipal Electrical Association: "Steam-Turbines," by S. E. Fedden, July, 1902. Also "Some Notes on Steam Turbo-Electric Generating Plants," by Geo. Wilkinson, before the Leeds Local Section, Institution of Electrical Engineers, October, 1903.

‡ The only turbines of large size which have been running any considerable time are those of the Parsons type made by C. A. Parsons and Co., though the Westinghouse Company and Messrs. Brown-Boveri (who manufacture the Parsons turbine under license) have also started up some large turbines within the last 18 months. The following table gives a few particulars of the various types of steam-turbines:

| Type. | Output, kw. | Speed, r.p.m. | Approximate peripheral speed in feet per second. | Expansion stages. | Total number of rows of blades. | General characteristics |
|---|---|---|---|---|---|---|
| Parsons.. | 1,500 | 1,200 | 100 to 220 | Continuous | 78 | Drum construction—fall of pressure equally divided between stationary and moving blades. |
| Rateau... | 1,500 | 1,200 | 160 to 250 | 25 | 25 | Disc construction—fall of pressure occurs only at nozzles in stationary discs. |
| Curtis ... | 1,500 | 750 | 400 | 4 | 8 | Disc construction—arranged vertically, two rows of revolving blades to each set of expanding nozzles. |
| Stumpf.. | 1,500 | 3,000 | 1,400 | 1 | 1 | Expanding nozzles, single disc, buckets similar to Pelton wheel. |
| De Laval | 200 | 10,600 | 1,400 | 1 | 1 | Expanding nozzles, single disc, drives dynamo through helical gearing. |

§ See *Proceedings* of the American Philosophical Society of Philadelphia, April, 1903. "The Curtis Steam-Turbine," by W. L. R. Emmet.

‖ See paper by Prof. Rateau before the Conference of the Institution of Civil Engineers, June, 1903. (*Engineering*, July 3, 1903, *seq.*)

¶ With the exception of those of the Parsons type, all turbines have some form of expanding stationary nozzle.

### Discussion.

**Mr. J. H. Barker** remarked that he had the honour to be connected with the installation of the first turbine at the Neptune station. He was surprised to find that after producing alternating current the distribution was effected on the direct-current system. Mr. Merz credited manufacturers with getting £10 per kilowatt for their engines and dynamos, but those halcyon days had passed; £6 was now a good price for engines of such small capacity as 500 kw. or 600 kw. In regard to cost per kilowatt of plant installed, town councillors lost sight of the actual cost per unit of interest and redemption. Nobody could tell what this would be at the end of, say, 15 or 20 years. The authors, he was pleased to see, had laid great stress on this point. He agreed with the authors in their partial condemnation of labour-saving devices. So long as the consumption of coal is not more than 1-1¼ tons per hour per man, more steam could be obtained by hand-firing than by any automatic stoker. He recently had occasion to compare reciprocating engines and turbines somewhat closely, and was now delighted to see that the engineer who represents what was the exemplary reciprocating engine had become a strenuous advocate of turbines. The turbine builders had scored at Newcastle. Referring to the figure given in the steam-consumption test, he was rather at a loss to know what "calculated steam" meant. He considered that the turbine in question had scarcely had justice done to it. This turbine, when designed, had a nominal capacity of 1,500 kw., which had since been raised to 2,000 kw., and a sister turbine for the same castings had been put in at Neptune Bank to do 2,500 kw., at which output the steam consumption would be 16lb. per kilowatt-hour. He would like the authors to give some figures in regard to the power needed for moving the immense quantity of circulating water from the river to Carville. Perhaps, too, as Mr. Merz had been to Chicago, he could say something as to the results obtained from the Curtis turbine, of which conflicting reports were to hand.

**Mr. J. H. Rosenthal** said that the paper was one of the most practical he had ever listened to, because it summed up the position in which the appliances for producing energy stood to-day. The paper might have been entitled "How to Do It." The Carville was the first installation to his knowledge in which an effort had been made to bring the cost of the installation down to the lowest possible limit consistent with good, durable appliances, and that was a matter of vital importance to the electrical industry. Mr. Merz's design had been made the subject of a great many imitations, the most important being the new 20,000-kw. station of the Paris Metropolitan Railway. The only difference in this case was that the economisers are arranged in a floor above, instead of in a line with the boiler-houses. The steam-pipe design at Carville was a very practical and satisfactory one, and he thought it would not be long before the importance of designing steam-piping plant with only a few parts which were alike, and hence interchangeable, was recognised.

**Major-General Webber** remarked that the paper gave little attention to the subject of distribution, but he would like to remind Mr. Merz that three or four years ago the latter gave evidence before a Parliamentary Committee that the stations then in course of erection at Newcastle would cost £20 per kilowatt installed. There did not appear to be any complete justification of that figure in the paper, and he would like the author, if he could, to give in his reply the total costs of the Carville works when completed. He thought the most interesting part of the paper was that relating to the cost and mode of distribution, which he hoped would be discussed. The authors' views upon automatic devices in the feeder circuits and in machine circuits were admirably expressed, and he trusted that engineers, and young engineers especially, would study the difficulties that had yet to be overcome in regard to these.

* The principal sources of loss in a turbine are leakage, eddy or fluid friction, and incomplete expansion. It is safe to assume that in no turbine will this be reduced to below 15 per cent. We may, therefore assume that the best attainable result is that the turbine should return as useful work 85 per cent. of the total energy contained in steam between specified boiler and condenser temperatures. Assuming the efficiency of the dynamo, including the losses in bearings, excitation slip-rings, oil-pumps, etc., to be 90 per cent., then one kilowatt-hour in the switchboard will, with steam at 200lb. pressure superheated 200deg. F., and with a condenser temperature of 100deg. F., require a consumption of 11·85lb. of steam (from Rankine's formula). Turbines have already been constructed consuming 14·5lb. of steam per kilowatt-hour at full load with a steam pressure of 190lb. superheated 200deg. and with 27·9in. of vacuum in the condenser, so that future developments must be looked for rather in higher efficiency at low load and in the adoption of higher pressure or greater superheat.

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**Mr. G. L. Addenbrooke** congratulated the authors upon the lines they had chosen in dealing with such an extensive subject. Everybody would agree with almost all that was said in the paper. He was glad to see that the authors had called attention at the outset to the fact that electric power supply was a commercial undertaking. It was a commercial undertaking in a wider sense than many other large systems—such as waterworks or electric lighting. In the latter prices could be adjusted in their relation to cost; but it was not so in the case of electric power supply, because this sought to supplant something already existing. It was not a question of sentiment. If the power could not be supplied at a price which gave advantages over local or other generation, the power station would not get business. Capital cost represented an even more important point than works' cost. One point the authors had not dealt with was the question of condensation and condensing water. On steamers water was always available, but it was astonishing what a serious matter it became when condensing water had to be provided for a large power station—thus, a 10,000-kw. plant required a million gallons per hour. Even when near a river a great amount of care and attention was requisite, especially in the case of tidal waters. Alluding to Mr. Merz's curve in Fig. 1. he considered that greater accuracy would have been secured if the line representing coal had been curved instead of straight. This difference might not be great with coal at 6s. per ton, but when more expensive the line would be a little higher at the low power factors. Applying this curve to actual costs, he remarked that Mr. Merz had not allowed for administration. This was a delicate matter, but it would be well to remember that this item amounted to an appreciable sum. He would like to ask Mr. Merz whether his table referred to units generated or units sold. Having had something to do with a power station in the South of England, where the higher price of coal rendered the value of gas-engines greater, he had had to go carefully into the question of the relative costs of generating power. He had come to the conclusion that the only saving with gas-engines was in the coal bill. The capital cost, as things stood at present, was rather greater. Assuming that gas-engines realised all that their advocates claim, the result would be a difference of something like 6 per cent. in the price at which energy could be supplied, or an increase of 1 per cent. in the dividend on the ordinary shares, if the same price was obtained for the energy. He inclined to the view that steam plant could be laid down without much fear of being superseded by gas, at any rate for some time.

**Mr. A. Lupton** would be very glad if the authors would fill up their balance-sheet in regard to the relative costs of gas-engines and turbines. The cost of fuel was shown by the diagram—·15d. per unit—and was not a very large item; but it would be of importance if it could be reduced to nil, as certain gas engineers claimed it could be. The fuel consumed in a gas-engine was one-half of the amount required in a steam plant, if there was no sale of by-products. If these were sold, they were worth as much as the first cost of the fuel, so that the latter disappeared from the balance-sheet. The authors had dismissed gas-engines as unworthy of entering into the competition. If they would not do the work, as the authors stated, the question was settled in regard to them; but he knew of large firms in the North who were prepared to state that gas-engines are capable of doing and actually do the work as well as any steam-engine. Referring to Mr. Addenbrooke's estimate of the respective results, he considered that the margin of 1 per cent. in the dividend a vital matter, as the question of whether a company paid 4 per cent. or 5 per cent. made all the difference to its success.

At this stage the discussion was adjourned until the next meeting.

## TRADE NOTICES AND NOVELTIES.

### Polyphase Induction Motors.

We have received from Messrs. Griffith and Biliotti, 8, John-street, Adelphi, Strand, W.C., a copy of their price-list of type W. R. polyphase induction motors for outputs ranging from 2 h.p. to 50 h.p. A notable feature in regard to these motors consists in that, contrary to usual practice, the slip-rings are inside the bearing, thus affording complete protection to all revolving parts, while the use of carbon brushes reduces the wear of the rings to a minimum.

### Electric Welding.

We note that the Electric Welding Company, Limited, 28, Basinghall-street, London, E.C., have adopted the picture-postcard method of advertising. Attention is called to their electric welder's great range of usefulness by a group of miscellaneous parts which have been operated upon.

### Electrical Recording Anemometer.

A list recently issued by Messrs. Negretti and Zambra, 38, Holborn-viaduct, London, E.C, illustrates and describes a recording anemometer designed to record the velocity of the wind electrically—that is to say, the recording apparatus may be placed indoors and connected electrically with the cups out of doors.

### Automatic Cut-Off Switch.

From the Electrical Company, Limited, 121-125, Charing Cross-road, W.C., we have received an illustrated description of their automatic cut-off switch for shop windows, lamp signs, etc. By fitting one of these switches in circuit with the lamps, windows can be kept illuminated for any length of time, at the expiration of which the automatic gear comes into action and switches off the lamps. The apparatus consists of an ordinary alarm clock in combination with an S.P. switch of the firm's Royal type. The clock will go for 24 hours with one winding, it being set during the day to switch out at any desired time the same evening. This article is at once simple and cheap; it should certainly prove useful to up-to-date shopkeepers.

### Accessories.

Mr. G. Braulik, 217 and 218, Upper Thames-street, London, E.C., has just issued a revised list supplementary to his electric light section "L" catalogue. This list deals with lampholders, ceiling roses, cut-outs, tumbler and main switches, pear switch and fuseboards, wall and floor plugs, wood blocks, counter-weights, etc.

### Air-Lift Pumping.

From Messrs. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester, we have an illustrated pamphlet describing their improved air-lift system. With this system it is possible to raise water from wells and boreholes by compressed air without the use of any valves or moving parts in the well. Its successful operation is not affected by the presence of sand or other solid matter in the water, and it may be arranged to operate one or more wells from one central air-compressor, regardless of distance or location.

### Metallic Packing.

We have recently received from the United States Metallic Packing Company, Limited, Soho Works, Bradford, a copy of the latest edition of the booklet dealing with their metallic packings. The increase in the volume of this publication from year to year is very marked, due to fresh additions to the collection of appreciative letters received by the firm from all parts of the country. In some cases their clients, we note, have had the packing in service for over 12 years, working day and night. Regarded as a whole, the letters in question furnish remarkable testimony to the value of the firm's speciality.

### Open Arc Lamps.

One of the latest pamphlets issued by the British Thomson-Houston Company, Limited, illustrates and describes the firm's open-type arc lamps. We are told that the company now manufacture at their Rugby works a high-grade open-arc, double-carbon, focussing lamp, which is specially designed for street-lighting. The standard lamp is for continuous current and takes 10 amperes. But lamps to burn in series on rectified circuits can also be supplied to order.

### Water-Gauges.

Several types of water-gauges for steam-boilers are dealt with in a list recently issued by Messrs. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester, who claim important advantages especially for their "Vivaxo" gauges. The list is well worthy the attention of engineers who may be troubled with defective fittings of the class in question.

### Fireproof Cable.

The St. Helens Cable Company, Limited, Warrington, announce that they are in a position to supply the electrical trade with a fireproof cable. The following are a few of the properties of this cable: (1) a flame, or even an arc, playing on a piece of this cable cannot set fire to it; (2) on withdrawing the flame, the cable is not only not alight, but not even glowing; (3) the fireproof properties of the cable are not affected by its immersion in water, as the fireproofing materials are insoluble. It is hardly necessary to say anything as to the special uses for this cable, as switchboard and cable subway fires are only too frequent. The firm's vulcanised-rubber and dialite insulated cables are made up in this manner at a very moderate increase in price.

## NEW COMPANIES REGISTERED.

**British Electric Separating Company, Limited.**—Capital, £30,000, in £1 shares. Object: to acquire the business of tin strippers now carried on at Swansea by the British Electric Separating Company, Limited, to adopt agreements with the old company and R. P. Pike (the liquidator thereof), and with H. A. Leaver, and to carry on the business. Registered office: New Cut-road, Swansea.

**Lodge Electric Light and Power Company, Limited.**—Capital, £3,000. Object: to acquire the business now carried on by H. Lodge at 4, Whitworth-chambers, 8A, Lord-street, Liverpool, as the Lodge Electric Lighting Company, and to carry on the business of an electric light and power company in all its branches. Registered office: Central buildings, 41, North John-street, Liverpool.

### Liens Registered.

**British Tramways and General Construction Company, Limited, London, E.C.**—Charge registered April 22, for an indefinite amount, the instrument being stamped to cover £120,000, to the Bank of Ireland. Secured on the uncalled capital, the undertaking, and all the property, present and future.

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## FORTHCOMING EVENTS

FRIDAY, MAY 6.

**Iron and Steel Institute.**—At 10.30 a.m., annual meeting (continued). At 7 p.m., annual dinner, Hotel Cecil.

**Physical Society.**—At 7.45 p.m., council meeting. At 8 p.m., "An Experiment with Lubricating Oil," by Mr. W. A. Price: "Some Instruments for the Measurement of Large and Small Alternating Currents," by Mr. W. Duddell; and an exhibition of Apparatus from the National Physical Laboratories (date changed from May 13)

**South-Western Polytechnic, Chelsea, S.W.**—Distribution of prizes by Lord Cadogan, K.G.

SATURDAY, MAY 7.

**South-Western Polytechnic.**—At 7.10 p.m., conversazione, lectures, and demonstrations.

**Association of Municipal Engineers.**—At Newcastle, general meeting.

MONDAY, MAY 9.

**Faraday Society.**—At 8 p.m., "Studies in Viscosity," by Mr. C. E. Fawsitt, D.Sc., Ph.D., and "The Electrolytic Oxidation of Anthracine," by Mr. Alberto Fontana and Mr. F. Mollwo Perkin.

**Institution of Mechanical Engineers.**—Graduates' Association: "A Method of Locomotive Valve-Setting," by Mr. G. C. Schultz.

TUESDAY, MAY 10.

**Royal Institution.**—At 5 p.m., "Meteorites," by Mr. L. Fletcher. (Lecture II.).

**Institution of Electrical Engineers.**—Glasgow Section: At 8 p.m., annual general meeting, "Corporation Telephones," by Mr. A. R. Bennett (adjourned discussion); "Electric Hauling Machinery for Collieries and Allied Purposes," by Mr. Maurice Georgi (reply to discussion).

WEDNESDAY, MAY 11.

**National Electrical Manufacturers' Association.**—At 7 p.m., annual dinner at the Hotel Cecil.

THURSDAY, MAY 12.

**Institution of Electrical Engineers.**—Ordinary general meeting at 8 p.m., at the Society of Arts. Paper on "The Steam-Turbine as Applied to Electrical Engineering," by Messrs. Parsons, Stoney, and Martin.

**Junior Institution of Engineers.**—At 6 p.m., visit to Great Northern, Piccadilly, and Brompton Railway Works, Brompton-road.

FRIDAY, APRIL 13.

**Institution of Electrical Engineers.**—Dublin Section: At 8 p.m., ordinary general meeting.

**Royal Institution.**—At 9 p.m., "The Queen Victoria Memorial," by Mr. M. H. Spielmann.

**Electrical Engineers (R.E.) Volunteer Corps.**—At 8 p.m., at Headquarters, Bohemian concert.

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**Association of Municipal Engineers.**—The following prospective arrangements for meetings have been fixed: Buxton, May 20 and 21.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

**Institution of Mechanical Engineers.**—Chicago Meeting, May 31 to June 3.

**British Association of Waterworks Engineers.**—Annual meeting, June 9 and 10. June 11-18, visit to Belgium.

## PERSONAL.

Mr. Harry A. Harding, draughtsman to the metropolitan borough of Bermondsey electricity and destructor department, who has been appointed as chief assistant electrical engineer to the Leatherhead Electricity Supply Company, was accorded a most hearty send-off by the staff of the above department, and was presented with a handsome case of pipes and a fountain pen as a token of their esteem and good wishes for his welfare. Mr. Harding previous to taking up his appointment in Bermondsey was with the Weston-super-Mare electricity department and the Brush Electrical Engineering Company. He also served with the Electrical Engineers in South Africa.

Colonel J. J. Mellor, the chairman of the Metropolitan Railway Company, has resigned owing to failing health, and is succeeded by Sir Charles M'Laren, Bart., M.P., formerly deputy-chairman. Sir Charles is also deputy-chairman of the Harrow and Uxbridge Railway, and a director of the Brecon and Merthyr Tydfil Junction Railway.

Mr. Cecil E. Lugard, who has for several years been chief of the electrical department of Messrs. Ashmore, Benson, Pease, and Co., Limited, Stockton-on-Tees, has now entered into practice as a consulting electrical engineer at Field's-buildings, Middlesbrough.

Mr. J. W. Hame, assistant electrical engineer to the Wigan Corporation, has resigned his position, having obtained the appointment of chief assistant electrical engineer to the city of York.

We are informed that Mr. J. A. Smeeton has resigned his position with Arthur Koppel, 27, Clement's-lane, E.C., and has joined the staff of Messrs. Richardsons, Westgarth, and Co., Limited, Hartlepool, Middlesbrough, and Sunderland, as manager of their London office. The latter firm are opening new offices at 9, Gracechurch-street, and will be fully represented for marine and electrical engineering, turbines, turbo-generators, gas-engines, etc.

## NEW COMMITTEES.

ABERDARE.—*Lighting*: Messrs. J. Bucknell, J. W. Evans, W. T. Morgan, W. Rees, D. Jackson Thomas, Rev. J. Morgan Jones, Messrs. D. Davies, T. Lewis, T. Walter Williams.

ALNWICK.—*Lighting, Hospital, Market, etc.*: Messrs. Scott, Moore Douglas, Hume, Hindmarsh.

AMBLE.—*Finance, Lighting, and Allotment*: Messrs. Earnshaw, Duncan, Leighton, Pratt, and Rutherford.

BROADSTAIRS AND ST. PETER'S.—*Lighting*: Councillors Ford, Posnett, Reed, Brown, and May.

BURNHAM.—*Lighting and Town Hall*: Messrs. Cox, Champion, Keats, Lawrence, and Jacques.

BUXTON.—*Electricity*: Councillors Salt, Banks, Smithurst, Lane, and Mill.

CHEADLE AND GATLEY.—*Tramways*: Messrs. J. B. Cairnie (chairman), G. Board, J. Robinson, W. H. Platt, W. H. Cross, and Dr. Wilson.

DRIGHLINGTON.—*Water and Lighting*: Councillors Smith (chairman), Varley, Fairburn, and Clayton.

ERITH.—*Electric Lighting and Tramways*: Messrs. Johnston, Masson, Stallwood, Everett, Grey, Vickery, and Wren.

FELIXSTOWE.—*Lighting*: Messrs. Clarke, Croydon, Fisk, Thurman, Warner, Woodmancy, and Wawman.

FINCHLEY.—*Electricity*: Councillors Stockton, Boggon, Ashby, and Royston; with the co-opted members, Messrs. Gough, Arundel, and Jenkins.

FRIERN BARNET.—*Lighting*: Councillors Hales, Sweetland, Elliott, and Whitten. *Light Railways*: Councillors Hales, Elliott, and Maxfield. *Electric Lighting*: Councillors Maxfield, Hales, Sweetland, Whitten, and Worrall.

HARPENDEN.—*Lighting*: Captain Lydekker, Messrs. R. N. Christie, A. T. H. Putterill, W. Sears, and W. King.

HOYLAKE AND WEST KIRBY.—*Electric Supply*: Messrs. Allen, Bird, Earl, Griffith, Latta, Smith, and Sutton.

HURST.—*Tramways*: the whole Council; Councillor Marsden (chairman). *Lighting and Finance*: the whole Council; Councillor Pleasants (chairman).

KINGSTEIGNTON.—*Lighting and Fountain*: Messrs. Yeoman, Sharp, Butland, Ward, Howe, and Knowles.

NORTHALLERTON.—*General and Lighting*: Messrs. Gardiner, Britton (chairman), Eaton, Guthrie, and Stockdale.

PENGE.—*Tramways*: Messrs. Culver, Grant, Grose, Greetham, Richardson, and Peskett.

RADSTOCK.—*Lighting, Fire Brigade, and Roads*: Chairman, vice-chairman, Messrs. Biggs, Coombe, Mattick, Orchard, and Aylesbury

RAMSBOTTOM.—*Lighting*: Messrs. Cunliffe (chairman), Elton, Wilkinson, and Foster. *Electricity and Trams*: Messrs. Ashworth, Garnett, Wilkinson, and Stockdale.

RAWMARSH.—*Tramways*: Councillors Bennett, White, Hall, Spick, Bamforth, and Rose.

SCALBY.—*Sanitary and Lighting*: Councillors Hurd, Rudgard, Bielby, Brown, and Boddy.

SHEPLEY.—*Lighting*: Councillors King, Bray, Armitage, and Matthews.

SHILDON.—*Electric Lighting*: As before, with the addition of Mr. Tulley.

SLAITHWAITE.—*Highways and Lighting*: Councillors Garside (chairman), Dean, Beaumont, Varley, Cotton, Coates, and Freeman.

SLOUGH.—*Lighting and General Purposes*: Mr. Godfrey (chairman), Messrs. Rendell, Berry, Bowyer, Goodchild, Jackaman.

TIPTON.—*Tramways and Electric*: Councillors Powell (chairman), Robbins, Stanton, Hawkins, Earp, Mansell, Richards, Salter, and Doughty.

WATFORD.—*Electric Light*: Messrs. Benskin (chairman), Buck, Feilden, George, Southam, Staples, and Trewin.

## APPOINTMENTS VACANT.

**Foreman,** India, Government telegraph workshops, Alipore, Calcutta. Age not to exceed 30 years. Engagement for three years, with option of extension, if approved by Government. Salary, Rs.300 per mensem, rising by annual increments of Rs.25 to Rs.450 per mensem. A second-class passage provided from and to England at the expiration of three years. Applicant should be a man thoroughly conversant with light machine shop and tool-making work (the class of manufacture being electrical instruments), able to design and supervise the making of tools for special purposes, and set up automatic machines for screw-cutting, etc. A good knowledge of milling machines is also essential. Form of application and further particulars can be obtained by applying, in writing, to the Director-General of Stores, India Office, London, S.W., by May 10.

**Telephone Sales Manager** for large manufacturing firm. Sound technical knowledge essential. Apply to G 27, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, E.C.

**Foreman,** mechanical section, Ipswich tramways. Salary £140 per annum. Applications by 23rd inst. See advertisement.

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# LEGAL INTELLIGENCE.

## KERSHAW v. LAWSON.

In the King's Bench Division on Saturday, Mr. Justice Kennedy heard an action brought by Mr. W. J. Kershaw against Mr. H. J. Lawson to recover £200 on a bill accepted by the defendant, which was dishonoured on presentation.

**Mr. Norman Craig** stated that in 1901 the plaintiff and two other gentlemen obtained a provisional order from the Board of Trade for the construction of a light railway in Warwick and Worcester, and formed a limited company. In March, 1902, the promoters agreed to sell their interest in the order to the Electric Tramways and Maintenance Company, Limited, which was controlled by the defendant, who used it for the purpose of bringing out different ventures. The purchase price was £4,125, payable by instalments. In the event of the failure of the assignees to perform their obligations all money paid was to be forfeited; so that the assignment was conditional. Three hundred and fifty pounds and £650 was paid, and then definite default was made. In June, 1903, judgment was obtained for £2,249, notice of forfeiture of the money paid was given, and a petition to wind up the Construction Company was filed. This was adjourned from time to time to enable a scheme for the resale of the provisional order by the defendant's company to be carried out. The negotiations failed, and then the defendant suggested a compromise. It was eventually agreed, on Oct. 27, that the promoters should abandon the winding-up petition, that they should retain the order, and that Mr. Lawson should pay them £50 cash, and give them two bills for £200 each, at three and six months.

**Mr. Ashton Cross** said the defence was a denial of the allegation that Mr. Lawson agreed that the promoters should retain the order, and the whole question for his lordship to decide was whether the property in the order was in the promoters or in Mr. Lawson.

After hearing evidence, **His Lordship** upheld the plaintiff's case, and judgment was accordingly entered for the amount claimed, with interest and costs.

# COMPANIES' MEETINGS AND REPORTS

## BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT.

A general meeting of the 4½ per cent. debenture stockholders was held at Winchester House last Friday to consider a resolution sanctioning certain modifications of the rights of the stockholders or trustees, proposed by the Company and recommended by the trustees, and authorising the latter, with a view to effecting such modifications, to concur with the Company in executing a supplemental trust deed, providing, amongst other things, for an increase in the nominal amount of debenture stock. Mr. Henry R. Belton, one of the trustees for the debenture holders, presided.

**Mr. H. St John Winkworth**, one of the directors, explained the altered position of the Company which had caused the Board to make the proposal to the debenture stockholders. He said that when the debenture issue was made, the capital issued and paid up was 101,200 ordinary shares of £1 each, and the authorised amount of the debenture issue was limited to £120,000. There had since been issued £50,000 of 7 per cent. cumulative preference shares. The Company had since acquired the undertaking of the Lewisham Company and the provisional orders for Lewisham and Penge, and an agreement had been entered into, conditional on the approval of the Board of Trade, for the purchase of the undertaking of the Crystal Palace District Company, which would more than double the original area of supply. The Company's Act of Parliament obtained last year also authorised the supply of electricity in bulk to authorised undertakers for use outside the area of supply. In these circumstances, the financial arrangements made for the smaller area were unsuited for the extended area. The directors consulted the brokers, who had expressed the opinion that the following terms would be both equitable to the Company and likely to induce the debenture holders to convert—namely, to give to the debenture holders the right to convert their debenture stock immediately into 7 per cent. preference shares at par, or, in the alternative, to take for £100 of their present debenture stock £125 of a new 4½ per cent. first mortgage debenture stock, the amount of which to be limited to the amount of share capital for the time being subscribed. The directors, therefore, made the proposal which was recommended by the trustees.

The **Chairman** said that the trustees had induced the directors to insert in the trust deed a provision for depreciation, which, by maintaining the assets of the Company, was equivalent to a sinking fund. They had no hesitation in recommending the debenture stockholders to consent, under those conditions, to such an enlargement of the mortgage as was proposed, and which was limited to the paid-up capital of the Company.

The number of debenture stockholders present being insufficient to constitute a quorum, the resolution could not be voted upon, and the matter was adjourned for a week. The meeting informally signified its approval of the proposed modifications.

## BROMLEY ELECTRIC LIGHT.

The annual general meeting of the Bromley Electric Light and Power Company was held on Monday evening, Mr. F. E. Gripper (chairman) presiding.

The directors' report stated that the progress made by the Company during the year had been very satisfactory, the lamp connections having increased from 35,743 to 47,030. The sale of current had increased from £7,938 to £9,843. 3s. 8d. The works had been maintained in good order and repair, and during the year large additions had been made to the generating plant to meet the increased demand both for light and power. The result of the year's trading, including the balance of £147. 10s. 1d. brought forward from last year, and after allowing for bad and doubtful debts, showed a profit of £7,143. 18s. 6d., and after payment of debenture and loan interest, etc., amounting to £2,845. 0s. 8d, the amount available for dividend was £4,298. 17s. 10d. An interim dividend at the rate of 4 per cent. per annum was paid for the half-year in October, and the directors recommended the payment of a further dividend for the last half-year at the rate of 6 per cent. per annum, making a total dividend of 5 per cent. for that year, that £1,500 be placed to a reserve fund for the renewal of plant, and that the expenses in connection with new issue of capital, amounting to £173. 6s., be written off, leaving a balance of £335. 3s. 6d. to be carried forward to the next account. During the year 4,000 new shares had been issued and subscribed for.

The report of the Chislehurst Electric Supply Company, Limited, stated that the number of lamps connected up to Dec. 31, 1903, had increased from 8,329 to 10,819, and the gross revenue from £2,365 to £2,892. Including £19. 4s. 5d. brought forward, the net revenue account showed a profit of £1,072. 15s. 6d., which after paying interest on debentures and loans left a balance of £735. 14s. The directors recommended the payment of a dividend at the rate of 3 per cent. free of income tax, that £250 be placed to reserve fund for renewal of plant, and that the balance, £38. 9s. 3d., be carried forward.

The **Chairman** remarked that the increase of lamps was the largest the Company had had, and as building was going on in all directions, there was a tendency to connect more lamps every year, so that the Company must continue to grow. According to the report, the lamp connections numbered 47,030, but this had now been increased to over 50,000, which number was reached within the last fortnight. They had had put down a very large engine and dynamo—one twice as large as they had ever had before. Large new boilers had also been put in. The actual amount of expenditure showed an increase of about 20 per cent., but at the same time their lamp connections had increased to the extent of 33⅓ per cent. The year's trading showed a profit of £7,143, as against £6,600 last year, and after paying their debenture and loan charges, the amount available for dividend was £4,298, compared with £3,400 last year. The prospects for the coming year encouraged the directors in the belief that they would be able to go up a step in their dividend next year, especially as the estimated profit for the first three months of the year was nearly £500 more than for the first three months of last year. The working costs had already been reduced to such a low figure that he did not think they had much prospect of reducing them much more. Last year the units were generated at just a shade over 2d., and this year the cost worked out at 1 9d., showing a reduction of 5 per cent. A special meeting of the directors would have to be called within the next two or three weeks to pass a formal resolution allowing the amount of debentures to be increased. In conclusion, he moved the adoption of the report and accounts, and the payment of a dividend at the rate of 6 per cent. for the half-year, making a total dividend of 5 per cent. for the year.

**Mr. Gristed** seconded the motion, which was carried unanimously.

The two retiring directors, Messrs. Gristed and Taylor, and the auditor, Mr. E. E. Price, were re-elected, and the remuneration of directors and auditor fixed.

## NEW GENERAL TRACTION.

An extraordinary general meeting of the members of the New General Traction Company, Limited, was held at the offices of the Company on the 28th ult.

The **Chairman** explained that, in connection with the issue of £80,000 prior lien bonds, it had been deemed best to substitute the word "issued" for "subscribed" in the articles of association, so that there might be no question of illegality in connection with these bonds, as the articles provided that the borrowing powers of the Board should not exceed the "subscribed" capital. The funds were required for traction work. The Chairman moved a confirmatory resolution, which was seconded by the Hon. A. G. Brand, and carried unanimously. It was also resolved that the seal of the Company be affixed to a contract with the Coventry Electric Tramways Company for the construction of new tramways and the reconstruction of part of the Coventry Company's existing tramways.

## ANGUS ELECTRIC LIGHT AND POWER.

The second annual meeting of the shareholders of the Angus Electric Light and Power Company, Limited, was held at Montrose, Dr. Stone, chairman of the directors, presiding. Particulars of the report appeared in our issue of the 22nd ult.

The **Chairman** said that the Company had during the past year added about 100 h.p. of motors. With the increase of motor power there was a corresponding decrease in their working expenses, and they were in a position to supply about three times the power that was at present used.

**Ex-Provost Scott** seconded the report, which was adopted.

## BRUSH ELECTRICAL ENGINEERING.

The directors in their report for the year ended Dec. 31, 1903, state that the profit and loss account shows a gross profit of £72,663. 8s. 3d. General charges, maintenance, interest on debenture stock, and £6,500 carried to depreciation reserve fund, absorb £44,605. 16s. 10d., leaving a balance of net profit of £28,057. 11s. 5d., which the directors recommend be appropriated as follows: to dividend at the rate of 6 per cent. per annum on preference shares for the year ended Dec. 31, 1903, £18,000; to general reserve fund, £7,000; to balance carried forward,

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£3,057. 11s. 5d. If the shareholders adopt this recommendation, the general reserve fund will then stand at £20,500. and the depreciation reserve fund at £38,606. 18s. 1d. Outlay on new plant and buildings has been made only to the extent necessary to ensure economy and efficiency in production. Notwithstanding the keen competition with home and foreign manufacturers, the Company has secured a fair share of the orders placed during the year, and the car and truck departments especially have been kept well occupied. The competition, however, has had the effect of reducing prices, and has retarded to some extent the benefit accruing from the extension of the Company's business. The increase in the volume of orders received by the Company has involved additions to stock, which must be carried out in order to avoid delays in manufacture and delivery.

## CALCUTTA ELECTRIC SUPPLY.

The report of the directors for the year ended Dec. 31, 1903, states that the number of units of electrical energy sold during the year was 2,014,681, compared with 1,552,775 for the preceding year. The gross revenue from all sources amounted to £47,139, compared with £35,124. The working costs were £25,552, compared with £21,990 The net result of the year's operations, after making provision for future maintenance and repairs, is a profit of £21,587, compared with £13,133 in the preceding year. Exchange is calculated at 1s. 4d. per rupee. The directors congratulate the shareholders upon the steady progress and prosperity of the Company. The capital expenditure during the year has been again large, the total outlay being £87,116, the principal items of which are £4,730 on freehold land and buildings, £13,308 on machinery and tools, £55,850 on mains, £5 554 on meters, and £6,611 on electrical instruments, switchboards, etc. The total capital expenditure to Dec. 31 last amounted to £382,770. The directors have set aside a sum of £8,500 for the renewals fund account (an increase of £1,500 over the sum set aside for last year). Of the sum so provided £2,574. 4s. 10d. has been expended, leaving a balance of £5,925. 15s. 2d. to be added to the £9,352. 7s. 4d. brought forward from last year, making a total balance of £15,278. 2s. 6d. carried forward to the current year. The reserve fund account remains at £35 000. To the net profit of £21,587. 5s. 5d. there has to be added the sum of £1,077. 16s. 3d. brought forward from the preceding year, making an available balance, after deducting the interim dividend paid in November, 1903, interest on loans and income tax, of £13,932. 15s. 10d. The directors recommend a final dividend for the half-year at the rate of 8 per cent. per annum on the paid-up share capital, making, with the interim dividend, 7 per cent for the year, and that the balance, £2,482. 15s. 10d., be carried forward. It will be observed that in order to meet the capital expenditure the directors had to resort to a temporary loan from their bankers, which at Dec. 31 last stood at £40,500. This loan has been already greatly reduced, and will be paid off out of the issue of 20,000 additional shares made in January last. The supply of electricity has been satisfactory during the year, and the whole of the machinery and mains have been maintained in efficient repair. Orders have been placed for the equipment of the new station in the northern part of the town at Ultadanga, and for a generating station at Howrah.

## TELEPHONE COMPANY OF EGYPT.

The report of the directors for the year ended Dec. 31, 1903, states that, after paying debenture interest, the revenue account shows a balance to credit of £9,516. 2s. 10d., which has been transferred to profit and loss. Including £2,634. 17s. 11d. brought forward from 1902, the balance for disposal is £12,151. 0s. 9d. The directors recommend this amount to be dealt with as follows: to pay a dividend at the rate of 7½ per cent. per annum on the preferred shares issued, less income tax, which will absorb £5,799. 8s. 11d., to transfer £4,000 to reserve, and carry forward £2,352. 11s. 10d. At an extraordinary meeting of the Company held in August last, the nominal capital of the Company was increased to £200,000 by the creation of 20,000 preferred shares of £5 each, for issue from time to time as funds are required. During the year 133 additional provincial lines were completed on behalf of the Government, and further installations of 393 have been contracted for, which are now in course of construction. The demand for exchange telephone lines in Cairo and Alexandria continues satisfactory, the net increase for the year being 260 lines. A considerable number of private lines have also been erected. In order to provide capital for further extensions and the installations of provincial lines, the directors have issued during the past year 5,000 preferred shares of £5 each and £5,000 of 5 per cent. debentures. The working of two trunk line circuits between Cairo and Alexandria, which commenced on May 1 last, has, so far, resulted in a small profit to the Company, after paying all expenditure in connection therewith.

## AUCKLAND ELECTRIC TRAMWAYS.

The directors in their report for the year ended Dec. 31, 1903, state that there has been expended during the year on capital account an amount of £82,663. 17s. 3d., making a total expenditure in connection with the electrical construction to Dec. 31 last £506,835. 3s. 5d. The total revenue for the year amounted to £82,939. 13s. and the expenditure to £62,106. 14s., which sum includes debenture and other interest, the rental and percentage of profits payable to the Auckland City Council, cost of repairs and maintenance, and all other expenditure chargeable against revenue, and, in addition, an amount of £4 000 which the directors have placed to a contingency provision account, leaving a profit of £20,822. 19s., which the Board recommend should be applied as follows: amount to be reserved to meet depreciation, £5,000; dividend at the rate of 4½ per cent. on the share capital, £13,500; balance to be carried forward, £2,322. 19s. At the date of the last report only about nine miles were in operation. Since that date various extensions have been opened and there is now in operation 17·2 miles. A further 1·4 miles is in course of construction, which it is anticipated will be opened before the summer season. By a poll of the citizens power has been given to the Company to operate on Sundays within the city of Auckland, and a service of cars has been maintained on Sundays over the entire system since Oct. 4, 1903. An issue of £200,000 5 per cent. first mortgage debenture stock at par was made in July last and was fully subscribed.

## ELECTRICITY SUPPLY COMPANY FOR SPAIN.

In their report for the year 1903 the directors state that the revenue has produced £32,122. 8s. 7d., to which has to be added interest on deposits and transfer fees, making a total of £32,617. 13s. 6d. After deducting debenture interest, interest on loans and all charges, amounting to £16,764. 12s., and after providing £1,943 for redemption of debentures, there remains a surplus of £13,911. 1s. 6d., which, with the amount brought forward from last year, leaves a balance of £14,411. 19s. 4d. The directors propose to write off the whole of the debenture expenses account, amounting to £9,368. 19s. 6d., and to carry forward the balance of £5,042. 19s. 10d. In consequence of the expressed intention of the shareholders to devote the greater part of the revenue during the past and the current year to the redemption of the existing debentures, the directors do not recommend any dividend on the share capital of the Company, although the full dividend on the preference shares might have been declared. £1,900 consolidated debentures were paid off on Jan. 1. 1904, the money being provided in the accounts. During 1904 the following amounts of debentures will be drawn and redeemed: on July 30, 1904, first debentures, £7,100, and "B" debentures, £3,900; on Jan. 1, 1905, consolidated debentures, £2,100.

## ROTHESAY TRAMWAYS.

The report and statement of accounts of the Rothesay Tramways Company for the year ended Dec. 31, 1903, state that the total outlay to Dec. 31, 1903, including reconstruction cost, amounts to £112,622. 13s. 5d. There is due to the British Electric Traction Company, Limited, £44,337. 12s. 6d. for advances, etc. The profit and loss account shows that the total revenue for the year amounts to £8,653. 17s. 1d. and the expenditure to £8,804. 14s. 1d. The latter amount includes interest on loans and debentures (£2,634. 7s. 10d.), cost of repairs and maintenance, and other expenditure chargeable to revenue. There remains a debit balance of £150. 17s., which, deducted from the amount of £760. 18s. 5d. brought forward from the previous account, leaves a credit balance of £610. 1s. 5d.

## TRACTION AND POWER SECURITIES.

The report for 1903, to be presented at the meeting on the 17th inst., states that the directors have postponed the issue of the £1,000,000 of preference shares created at the last annual meeting, and have written off the Government stamp duty and expenses thereof, amounting to £2,645. The balance of revenue for the year is £4,833, which it is proposed to carry forward. This, with £7,538 brought forward from the previous year, makes a total carry forward of £12 371. The costs of joining in the promotion of the unsuccessful City and North-Eastern Suburban Electric Railway Bill and other undertakings (amounting to £2,524) have been charged to revenue. Investments remain in the books at cost. Until, in due course, their outcome is ascertained, the directors will make no revaluation, and the reserve account will continue to stand at £10,000.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tender for rails and other material.

**Utrecht (Holland).**—The Municipality require tenders for supply and laying of electric cables by 31st inst.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Birkenhead.**—The Corporation invite tenders for extension of feeder and distributing mains. Specification, etc., may be obtained from the Borough Electrical Engineer. Tenders by May 14.

**Neath.**—The Corporation invite tenders for electric light mains, feed pillars, and switchboards in their area. Specifications may be obtained from the Borough Engineer, Gwyn Hall, Neath. Tenders by May 16.

**Mexborough.**—The Urban District Council invite tenders for two 100-kw. steam dynamos. Specifications, etc., may be obtained on application to the Engineer, Electricity Works. Tenders by 31st inst. See advertisement.

**Whitby.**—The Urban District Council invite tenders for supply and erection of one surface condenser, with air-pump and piping. Specifications, etc., may be obtained from the Electrical Engineer. Tenders by 10 a.m. on 12th inst.

**Rugby.**—The Urban District Council invite tenders for paper-insulated, lead-covered, armoured service cables. Specification, etc., may be obtained from Mr. T. M. Wratislaw, clerk. Tenders by 20th inst. See advertisement.

**Glasgow.**—The Corporation invite tenders for four sets of 800-kw. dynamo panels. Specifications, etc., may be obtained from Mr. W. A. Chamen, 75, Waterloo-street, Glasgow. Tenders by May 9. See advertisement in former issue.

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**Bristol.**—The Electrical Committee invite tenders for one 750 to 1,000-kw. single-phase turbo-alternator. Specifications can be obtained from the City Electrical Engineer. Tenders by noon on May 16. See advertisement in last issue.

**Walthamstow.**—The Urban District Council invite tenders for the supply of tramcars. Specifications, etc, may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on May 20. See advertisement in last issue.

**Canterbury.**—The Lighting Committee invite tenders for the supply of about 1,800 yards of cable. Specification to be obtained from the Engineer, Electricity Works. Tenders by 10 a.m. on May 14. See advertisement in last issue.

**Stretford.**—The Electricity Committee invite tenders for a 400-kw. steam-driven generator. Specifications, etc., may be obtained from Mr. T. L. Miller, M.I.C.E., 19, Brazennose-street, Manchester. Tenders by 18th inst. See advertisement.

**Hackney.**—The Council invite tenders for electricity supply mains (feeders and distributors). Specifications, etc., may be obtained from Mr. R. Hammond, M.I.C.E, 64, Victoria-street, S.W. Tenders by May 26. See advertisement in former issue.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant: excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc. Tenders by May 17. See advertisement in former issue.

**Salford.**—The Tramways Committee invite tenders for the supply of 20 cars and also two rail-cleaning and watering cars. Particulars may be obtained on application to Mr. Ernest Hatton, Tramway Offices, 32, Blackfriars-street, Salford. Tenders by 16th inst.

**Brighouse.**—The Corporation invite tenders for laying cables in their borough. Specification, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's gate, Westminster, on and after 7th inst. Tenders by the 19th inst. See advertisement.

**Pietermaritzburg.**—The Corporation invite tenders for the supply of six completely-equipped electric tramcars, double-deck and single-truck type. Specifications, etc., may be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W. Tenders by 16th inst.

**Egremont (Cheshire).**—The Wallasey Urban District Council invite tenders for 12 months' supply of various stores required for their steamer and ferries, including electric globes and carbons. Particulars from the Manager's Office, Egremont Ferry, Cheshire. Tenders by May 9.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for a number of four-ton electric wharf cranes for Clydebank Dock. Specifications may be obtained at 16, Robertson-street, Glasgow, from Mr. Geo. H. Baxter, mechanical engineer. Tenders by noon on May 23.

**Stoke-upon-Trent.**—The Corporation invite tenders for (Section A) electricity meters, (B) demand indicators, and (C) cut-outs. Specifications, etc., can be obtained from Mr. P. J. S. Tiddeman, Field-place, Stoke-upon-Trent. Tenders by 5 p.m. on May 13. See advertisement in last issue.

**Abergavenny.**—The Building Committee of Visitors of the Monmouthshire Asylum invite electrical lighting schemes for the asylum and tenders for carrying out the same. Particulars can be obtained from Dr. James Glendinning, medical superintendent. Tenders by 10 a.m. on May 24.

**Acton.**—The Urban District Council invite tenders for wiring their new isolation hospital, and for the laying of underground mains in connection therewith. Specifications, etc., may be obtained from Mr. W. H. Trentham, 39, Victoria-street, Westminster, S.W. Tenders by 3 p.m. on 16th inst.

**Southampton.**—The Corporation invite tenders for the supply of stores, fittings, etc., required in the electric tramway department during 12 months. Specifications, etc., may be obtained from the Traffic Manager, Tramway Offices, Above Bar-street, Southampton. Tenders by 12th inst.

**Foots Cray.**—The Urban District Council invite offers for purchase or working of Council's provisional order for electricity for public and private purposes within the urban district of Foots Cray and a portion of Chislehurst. Particulars from Mr. A. E. Leonard, clerk to the Council, Sidcup, Kent.

**Poplar.**—The Council invite tenders for supply of cables and supply and erection of battery. Specifications, etc., may be obtained from the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders before 9 a.m. on May 7. See advertisement in former issue.

**Barnsley and Monk Bretton.**—The District Electric Traction Company invite tenders for the repair and maintenance of the tramway tracks in Barnsley and Monk Bretton. Particulars may be obtained from the Secretary of the Company, Donington House, Norfolk-street, Strand, London.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for 12 months from May 31. Specifications, etc., may be obtained from Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by 25th inst. See advertisement in last issue.

**Aberdeen.**—The Electric Lighting Committee invite tenders for the supply and erection of mild-steel coal bunkers, together with coal and ash conveyor of the endless chain bucket type, with accessories. Specifications can be had from the City Electrical Engineer. Tenders by May 14. See advertisement in last issue.

**Hammersmith.**—The Borough Council invite tenders for the supply of two 1,500-kw. steam turbines or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters, capable of evaporating a total of 40,000lb. of steam per hour. Tenders by May 18. See advertisement in former issue.

**Greenwich.**—The London County Council invite tenders for the supply of 10 water-tube boilers, with superheaters, and for the erection of the same at the electricity generating station at Greenwich, for the electrical working of portions of tramways. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 17th inst.

**Wallasey.**—The Urban District Council invite tenders for one independent counter-current jet condensing apparatus, with air and water lifting pumps, to treat 40,000lb. of steam per hour, and to give a vacuum of not less than 27in. Specifications, etc., may be obtained from the Engineer's Office, Seaview-road, Liscard, Cheshire. Tenders by May 7.

**Mexico.**—Tenders are invited by the Municipality of Sans Luis Potosi, Mexico, for the electric lighting of that city by not less than 150 arc lights. The system is to be established by the end of this year, the contract to be concluded for 15 years. The selected contractor will be required to deposit 5,000dol. Mexican as caution money. Tenders will be received up to May 15.

**Argentina.**—Tenders are invited for the construction of a system of electric overhead trolley tramways between the Plaza de Mayo, Buenos Ayres, and the townships of Ortuzar, Devoto, and General Urquiza. Particulars may be obtained at the office of the Section of Public Works, Secretariat of the Municipality of Buenos Ayres. Tenders by 2 p.m. on 30th inst.

**San Luis Potosi (Mexico).**—Tenders are invited by the Municipality of San Luis Potosi for the electric lighting of that city by not less than 150 arc lights. The system is to be established by the end of this year; the contract to be concluded for 15 years. The selected contractor will be required to deposit 5 000dol. (Mexican) as caution money. Tenders will be received up to May 15.

**Ayr (Scotland).**—The District Lunacy Board invite tenders for the following plant: (Section 1) boiler, pump, feed-water heater, piping, etc.; (2) building, chimney, flues, foundations, and iron roofing; (3) engines, dynamos, and main switchboard; (4) electric wiring and mains, etc. Specifications, etc., may be obtained from Mr. W. Maxwell Stewart, 55, West Regent-street, Glasgow. Tenders by May 20.

**Canterbury.**—The Lighting Committee invite tenders for the following: One Lancashire or dry-back marine boiler, superheater, steam-pipes, a 300-kw. steam dynamo, switchboard and connections and extensions to economiser Specifications, etc., may be obtained from Mr. Hammond 64, Victoria-street, Westminster, S.W., after May 4. Tenders before 10.30 a.m. on June 1. See advertisement.

**Hornsey.**—The Town Council invite tenders for the following: (Section D) condensing plant; (E) water-cooling apparatus; (F) pipework and valves; (G) water softener and purifier; (H) switchboards and connections. Specifications, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W., on and after 10th inst. Tenders by 30th inst. See advertisement.

**Burslem.**—The Corporation invite tenders for water-tube boilers, steam-piping, pumps, water-softener, etc., engines, dynamos, balancer, and boosters, switchboard, cables (including laying), arc lamps, accumulators, and refuse destructor plant. Specifications, etc., may be obtained from Mr. A. Bremner, A.M.I.E.E., Market-buildings, Burslem, after 25th inst. Tenders by 12 noon on May 14. See advertisement in former issue.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant in connection with electric lighting and tramways for the burgh: (Specification No. 11) overhead equipment, trolley wires, poles, and brackets, etc.; (12) rolling-stock; (13) wiring of generating station and car-shed. Specifications, etc., can be obtained on and after 10th inst. from the Town Clerk. Tenders by 12 noon on the 28th inst. See advertisement.

**Manchester.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection on the southerly side of Dock No. 9, 20 movable electric cranes (with spare gear therefor) for cargo working purposes. Specifications, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders before 10 a.m. on May 25.

**Antwerp.**—With reference to the notification issued by the Board of Trade on the 23rd ult. respecting calls for tenders by the Municipality for (1) the installation of additional heating apparatus in the Flemish Theatre and (2) the installation of heating apparatus in the gymnasium of the State secondary school, a dispatch has now been received from H.M. Consul-General at Antwerp reporting that the adjudication of the tenders has been deferred from the 3rd to the 17th inst.

**Dublin.**—The Lighting Committee invite tenders for the supply and erection of a steam generating three-phase extra-high-pressure set of plant, consisting of Bellis engine and condensing plant, combined with alternators of the make of either Dick-Kerr, Electric Construction, Oerlikon, or Westinghouse, size 1,000 kw., 1,250 kw., or 1,500 kw., whichever can be delivered most quickly, steam and exhaust piping, and extension to switchboard. Tenders by May 9. See advertisement in former issue.

**London County Council Tramways.**—The London County Council invite tenders for the following switchgear—namely: (*a*) one extra-high-tension three-phase board, with operating table and instrument board; (*b*) one low-tension combined direct-current and three-phase board; (*c*) one combined extra high-tension and low-tension sub-station board; and (*d*) one extra high-tension and low-tension transformer board; and for the erection and connecting-up of the same at the Council's electricity generating station, Greenwich. Tenders by May 17. See advertisement in former issue.

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**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Natal.**—The Government of Natal are prepared to receive tenders for the supply, erection, and completion (including maintenance for three months) of the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, outline specification, conditions, and form of tender may be obtained on payment of £5. 5s. from the Agent-General for Natal, 26, Victoria-street, S.W., or from the Harbour Engineer, Natal. Tenders, in sealed covers, endorsed "Tender for Electrical Equipment of Railway Customs Bonded Warehouse, Port Natal," are to be furnished in duplicate, addressed to the Agent-General, as above, or to the Chairman, Tender Board, Pietermaritzburg, Natal. Tenders close both in London and Natal on May 9.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

## RESULTS OF TENDERS.

**Croydon.**—The tender of W. Cory and Son has been accepted for he supply of small coal.

**Reading.**—The Corporation have placed an order with Dick, Kerr, and Co. for five double-deck bogie cars and one watering car.

**Keighley**—The tender of J. W. Laycock, Keighley, for supplying tiebars, bolts, nuts, and washers, at £648. 18s. 6d., has been recommended for acceptance.

**Partick.**—The Electrical Committee have accepted the tenders of Bruce Peebles and Co. for a 500-kw. traction generating set and for two 37½-kw. balancing dynamos.

**Dundee.**—The Town Council have accepted the tender of R. L. Ireland and Co., Dundee, for supplies of small coal, to be delivered at Dudhope electric power station, Dudhope crescent-road, Dundee.

**Croydon.**—The Town Council have accepted the tender of Goddard, Massey, and Warner for the furnaces, boiler, engine, generator, and forced draught at the refuse destructor at Brimstone-barn, at £5,886. 14s.

**Battersea.**—The tender of the Walsall Electrical Company for the provision of an additional panel to the main switchboard at the central electric generating station, at £179. 5s., has been recommended for acceptance.

**Bury.**—The British Westinghouse Electric and Manufacturing Company, Limited, have received an order from the Corporation for Westinghouse magnetic brakes to be fitted to 25 cars, 12 single-truck and 13 bogie cars, mounted on Maguire trucks.

**Greenwich.**—The tender of H. Lovatt, Limited, London and Wolverhampton, at £52,970, for the erection of the superstructure of the first portion of the Greenwich electricity station, has been recommended by the Highways Committee of the London County Council for acceptance.

**Portsmouth Dockyard.**—The Admiralty have placed an order with Messrs. Dick, Kerr, and Co. for five 600-kw. steam-generator direct-current sets, one 300-kw. steam-generator direct-current set, six motor-generator sets, and two balancer sets, main switchboard, switchgear, and auxiliary plant.

**Metropolitan Asylums Board.**—The Works Committee have instructed Messrs. A. and C. Harston to place an order with Julius Sax and Co. for the extension of the fire-alarm, electric bell, and telephone systems at the Tooting Bec Asylum to the adjoining receiving home for children, at a cost of £113. 13s. 6d.

**London, N.W.**—The St. Pancras Borough Council have received the following tenders for supplying two 1,000-kw. steam-turbines connected to two continuous-current dynamos, switchboards, condensers, etc., complete at the King's road power station:

| | |
|---|---|
| C. A. Parsons and Co. | £12,495 |
| Ditto (alternative, Scheme B) (accepted) | 14,000 |
| British Thomson-Houston Company | 12,580 |
| Willans and Robinson | 13,706 |
| Richardsons, Westgarth, and Co. | 15,012 |

**London.**—The Metropolitan Asylums Board have received the following tenders for wiring the Eastern Hospital and Ambulance Station for electric lighting purposes:

| | |
|---|---|
| Bergtheil and Young, 12, Camomile-street, E.C. (accepted) | £3,378 15 6 |
| Eastlake's, Limited, 1, Carteret-street, S.W. | 3,645 0 0 |
| Edmundson's Electricity Corporation, Limited, Broad-sanctuary-chambers, Westminster, S.W. | 4,450 0 0 |
| Buchanan and Curwen, 64, Victoria-street, Westminster, S.W. | 5,038 0 0 |
| Wenham and Waters, Limited, Paragon Works, Croydon | 5,172 0 0 |
| A. V. Gifkins and Co., 68, Victoria-street, Westminster, S.W. | 5,273 0 0 |

Engineer's revised estimate, £3,500.

**Hanley (Staffs).**—The Corporation have received the following tenders for the supply of an alternator generator, etc.:

| | |
|---|---|
| British Westinghouse Electric Company, Trafford Park, Manchester (accepted) | £3,162 |
| Mather and Platt, Salford Ironworks, Manchester | 3,193 |
| Reavell and Co., Ipswich | 3,773 |
| Browett and Lindley, Patricroft, Manchester | 3,200 |
| British Thomson-Houston Company, Rugby | 3,344 |
| Witting and Eborall, Temple Bar House, E.C. | 3,020 |
| Crompton and Co., Salisbury House, London-wall, E. | 3 252 |
| Electric Construction Company, 9, New Broad-street, E.C. | 3,358 |
| Dick, Kerr, and Co., Abchurch-yard, Cannon-street, S.W. | 3,706 |
| Electrical Company, Victoria-street, S.W. | 3,526 |
| A. Kramer, Parliament-mansions, Victoria-street | 3,201 |
| Skelding and Co., 189, Wolverhampton street, Dudley | 3,721 |
| Siemens Bros., York-mansions, York-street, S.W. | 3,625 |
| Johnson and Phillips, Old Charlton, Kent | 3,137 |
| International Electric Company, Clun House, Surrey-street, W.C. | 2,799 |
| Brush Electrical Engineering Company, Loughborough | 2,840 |
| General Electric Company, Queen Victoria-street | 3,566 |
| Bruce Peebles and Co., Edinburgh | 2,914 |

Turbo-alternators.

| | |
|---|---|
| Richardson, Westgarth, and Co., Hartlepool | 3,650 |
| C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne | 3,324 |
| Bruce Peebles and Co. | 3,234 |
| Brush Electrical Engineering Company | 2,840 |

Condensing plant.

| | |
|---|---|
| Bertrams, Limited, St. Katherine's Works, Sciennes, Edinburgh, one jet condenser (accepted) | 495 |

Thirty tenders received.

Superheaters.

| | |
|---|---|
| A. Bolton and Co., Deansgate, Manchester, three downtake superheaters (accepted) | 388 |

Sixteen tenders received.

# BUSINESS NOTES.

## TRACTION.

**Bradford.**—The new through cars to Shipley are being well patronised.

**Belfast.**—The Corporation's Tramway Bill has been reported to the House of Lords for third reading.

**Shipley.**—The Shipley tramways were formally taken over on Saturday by the Bradford Corporation.

**Preston-Blackburn Tramway Bill.**—The House of Commons Standing Orders have been complied with.

**Ilford.**—The Board of Trade has sanctioned the expenditure of £20,500 in connection with the Council's tramways.

**Warrington.**—There was a loss on the tramways for the year ending March 31, including interest and sinking fund, of £640.

**Nottingham.**—The Board of Trade have intimated their willingness to increase the speed limit for the Corporation trams to 12 miles an hour.

**King's Norton.**—A proposal that the tramways should be extended from Selly Oak to Northfield has been referred to the Tramway Committee.

**Bury.**—The Princess-street and King-street route of the Rochdale road section of the Corporation tramways was used for the first time last Friday.

**Dudley.**—At the last meeting of the Town Council it was stated that negotiations for the purchase of the tramways were being proceeded with as speedily as possible.

**Newcastle.**—The joint committee recommend that the Corporation authorise them to consider any proposal from the company with a view to a settlement of the running question.

**Lancaster.**—The Town Council have accepted a tender, amounting to over £10,000, for doubling the electric tramways in South-road and laying a new route to Castle Station and West-road.

**Edinburgh.**—The Town Council have given their consent to the National Electric Construction Company for the construction of an electric tramway between Portobello and Musselburgh.

**Hanley.**—The Town Council have decided to strongly urge the Potteries Electric Traction Company to issue quarterly, half-yearly, and yearly contract tickets, and to request them to adopt ½d. fares.

**Derby.**—The receipts of the Corporation tramways during the four weeks ended April 23, 1904, were £1,364. 1s. 6d., being an increase of £4. 3s. 11d., as compared with the corresponding period last year.

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**Chesterfield.**—The Corporation's Bill for tramways and improvements has been certified as complying with the House of Commons Standing Orders, and will be reported for second reading in the ordinary course.

**Sunderland.**—There is some likelihood that the Corporation will make another attempt to carry out their Roker improvement scheme. If successful, the Corporation will revive their scheme for additional lines in the centre of the town.

**Keighley.**—A motion will be brought forward at the Town Council's next meeting that in the construction of the electric tramway to the railway station the Tramways and Electricity Committees be empowered to lay double lines forward to Stockbridge.

**Gloucester.**—The electric tram system has been formally opened. Three sections have been completed, the longest and most important being a stretch of line from the Bristol-road district to Hucclecote. A party of Corporation officials performed a satisfactory trial trip.

**Glasgow.**—The Caledonian Railway Company has decided to introduce the zone system over its Greenock line between Port Glasgow and Gourock with the object of combating the expansion of the Corporation electric tramways. The charge for travelling is to be 1s. per week.

**Baker-street and Waterloo Railway Bill.**—This Bill has been read a third time in the House of Commons, Mr. Causton, M.P., stating that an arrangement had been come to with Mr. Yerkes in regard to the subway at the Elephant and Castle, by which the company will contribute £6,000 towards the cost.

**Salford.**—The Eccles Corporation offer no objection to the request of the Salford Tramways Committee for permission to defer the construction of the tramway in Worsley-road, Winton, between Parrin-lane and the Worsley boundary, pending the completion of the tramway of the South Lancashire Tramways Company.

**Belfast-Holywood.**—A private Bill for the construction of a tramway between these places has been sent by the Select Committee to the House of Lords for third reading. The committee has decided that the Belfast Corporation might supply electricity to the company within the city boundary, and allowed inter-running powers.

**Folkestone.**—As the Corporation are committed by an agreement with Lord Radnor to the conduit or surface-contact system, a deputation has been appointed to wait upon his lordship with a view to inducing him to waive compliance with the provision. An application is also to be made to the Board of Trade for extension of time for the commencement of the tramways.

**Stretford.**—The District Council have decided to offer no objection to the Manchester Corporation proceeding as contractors on behalf of the Council with the construction of the length of tramway from the Cock Hotel to the Sale boundary, but the Corporation will be asked for an assurance that they will proceed concurrently with the construction of the tramway within the Cheshire district.

**Leeds-Guiseley.**—At the last meeting of the Yeadon District Council a letter was read from the Leeds Corporation on the subject of the proposed tramway extension, in which it was asked whether the District Councils had decided anything as to their contributions towards maintenance. It was resolved that a joint meeting of the Yeadon, Rawdon, and Guiseley Councils be held to consider the matter.

**Lincoln.**—The City Council have resolved that the "G.B." system be adopted for the electrification of the tramline in High-street. The contractors are to indemnify the Council against loss through the adoption of the system, one of the terms being that the Council shall withhold all payments on the part of electrical equipment until 15 months after running the system, and a three months' probationary period.

**Small Heath** —Negotiations are in progress between the municipal authorities and the City of Birmingham Tramways Company in relation to a proposal for the conversion of the Small Heath tramway route into an overhead electric line, upon similar conditions to those which have been arrived at on the Bristol-road and Dudley-road lines. The existing lease has about 2½ years to run. A sub-committee of the Tramways Committee has the matter in hand, and will report in due course.

**Southport.**—The loss on the year's working of the Corporation tramways turns out to be considerably less than that of last year, the figures for the two periods being £341 and £1,182. 12s. 10d. respectively. There is a good prospect of next year's accounts showing a small profit. The income from passengers for the year now ended is £17,646, against £16,387 last year, an increase of £1,259. 12s. 9d. During the same period the working expenses have been £10,906. 4s. 8d., as against £11,231. 13s. 6d., a decrease of £225. 8s. 10d.

**Brighton.**—At the last meeting of the Council a recommendation of the Works Committee that the margins of the tramways tracks in Queen's and North roads should be paved with tar macadam was not accepted, and the Council passed a resolution that wood paving should be utilised where practicable. At yesterday's meeting of the Council the Works Committee presented a report showing the additional cost of paving the tracks with wood, which is estimated at £3,320. 19s. 6d. The total cost is given as £4,146. 19s. 5d., and the committee ask for further instructions.

**London United Tramways Bill.**—The preamble of this Bill, the principal proposal of which is the construction of a line of tramways from Baber Bridge to Staines, has been proved before the committee of the House of Commons, subject to compliance with the requirements of the Middlesex County Council as to the width of the road, surface drainage, kerbing, wood paving, and the lighting of cross and lateral roads, these works to be carried out to the satisfaction of the county surveyor. They also decided that the purchase period should be fixed at 25 years. Extension of time was granted for the completion of certain authorised lines.

**Falkirk.**—A committee of the Town Council have this week had a communication from an Edinburgh company which has been formed to acquire the provisional order for tramways, granted to a local syndicate three years ago. It is stated that the new company has a six months' option of purchase, and their communication contained an offer in regard to the payment for wayleave due to the Council, and requested sanction to Sunday running. The committee are willing to recommend the sanction to Sunday running, but not to modify the claim for payment of the wayleave in full.

**Aston.**—The Public Works Committee report that satisfactory progress is being made in connection with the Witton-lane tram depôt. The contractor has commenced the work of widening the carriageway in Witton-lane. The committee have instructed the consulting engineer to at once give notice to the contractor to commence the work of widening the carriageway in Victoria-road. The committee report that the company have approved the formal appointment of Mr. Green as arbitrator in relation to the purchase of the City of Birmingham Tramways, and he will at once commence the reference. The contractor has finished the temporary track—which is working very satisfactorily—between Aston Cross and the city boundary, and he has now commenced the construction of the permanent track between these two points.

**Rotherham.**—At the last meeting of the Town Council it was stated that the tramway receipts for the year amounted to £20,968, representing 9d. per car mile run The net result was a slight deficit, amounting to £21. 16s. 5d., but this was after allowing the sum of £2,693. 6s. 6d. for renewals. In addition to that £974. 2s. 3d. had been spent out of revenue for repairs to the permanent way and overhead electrical equipment. If the whole of the lines had been running from the commencement of the year, it was considered that the Council would have had an addition to the receipts of something like £4,200, which would have given them a substantial profit. The operating charges per car mile worked out at 5·67d. The average number of passengers carried per week was 95,025. The average fare paid per passenger worked out at 1·02d. The cost per unit per car mile was 1·50d. The Corporation did not intend to drop the Moorgate scheme, but in the immediate future would adopt the procedure of applying to the Board of Trade for a provisional order.

**Walsall-Wolverhampton.**—Now that the various tramway schemes in the Black Country interlacing the various towns together are practically completed, the competition caused thereby is being felt by the London and North-Western Railway Company. The railway authorities have now under consideration the reduction of fares between Walsall and Wolverhampton and intermediate stations. At present passengers can ride by tram between the two towns for the sum of 5½d., and there is a probability that this sum will be reduced by 1d., as a requisition has been sent to the British Electric Traction Company to make their fares from Dean's-road to the point where they meet the Walsall Corporation trams one-half the present rate; and it is possible that the Wolverhampton Corporation will run their cars all the way from the borough terminus to Dean's-road for 1d. If these alterations come about, it will mean that the fare for the through journey from Wolverhampton to Walsall will be 4d., or 2½d. less than is now charged for the journey on the Midland and North-Western Railways.

**South Shields.**—An important report has been issued by the Corporation officials to the members of the Tramway Committee regarding the proposed new South Shields electrical tramway service, which the South Shields Tramway and Carriage Company and a Manchester firm (Messrs. Rowcliffe) are tendering for leasing. The Shields firm are prepared to provide a stock of cars and to guarantee a five minutes' service. The company base their tender on a 28 years' lease. They offer to pay 5¾ per cent. per annum, and a sum of £20,000 for huge street and other improvements to permit the working of tramways in narrow thoroughfares. A further proposal is that the Corporation should repave the tramway area and the company pay £100 per mile and £75 for the repairing of the cables. Messrs. Rowcliffe and Co. intimate that they are prepared to construct the works themselves with the exception of feeder cables. The latter firm's offer for electrical energy is better than that proposed by the local firm, but they ask for a 42 years' lease. The exhaustive reports of the Corporation officials will be considered at a special meeting shortly, when it will be finally settled whether the Corporation will municipalise or not.

**West Riding Tramways Bill.**—A Select Committee of the House of Lords this week considered the West Riding Tramways Bill. The only opponents were the Yorkshire Electric Supply Company. Counsel for the promoters stated that there were a number of tramways in the neighbourhood of Wakefield and Leeds, which were in process of construction by the promoters, some of which would be opened in the present year. There was also a number of lines which were partly constructed, but which, owing to an oversight, had not been constructed within the time allowed under the Act authorising these lines. Hence the present Bill, which was really one to revive powers already granted. Beyond that it was proposed to construct a number of additional lines, the chief of which were one connecting Wakefield through Stanley and Altofts with Normanton, and one from Castleford to Methley joining with an existing light railway at Oulton. Clause 72 proposed that the promoters should have power to make arrangements for the supply of electrical energy for the working of the lines of both. The Yorkshire Supply Company objected to this clause on the ground of competition. The committee found the preamble proved, and the remaining clauses having been adjusted, the Bill was ordered to be reported to the House.

**East Ham.**—The following particulars of the report for the year ending March 31 of the District Council's tramways show substantial increases in traffic returns, car miles run, and passengers carried. Only one alteration was made during the year in the permanent way—duplicating the lines at High-street North and Station-road. In this

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connection the tramways manager refers to the necessity for more substantial paving. Weekly inspections of the overhead system obviated any serious breakdown. It may be mentioned that the Council's tramways again carried considerably more passengers per car mile than any other municipal service, while the receipts per passenger, owing to cheap fares and short routes, continued to be the lowest on record. The following figures relate to the 12 months 1903-4 and 1902-3 respectively: length of route, 6 miles 6 furlongs (6 miles 6 furlongs); total length of single track, 10·77 miles (10·75 miles); average number of cars in use, 21 to 32 (16 to 26); car miles run, 807,032 (650,224); electrical energy used, 920,696 (656,125); total passengers carried, 12,950,269 (9,971,337); traffic receipts, £34,312. 1s. 9½d. (£25,341. 8s. 3d.); per car mile, 10·20d. (9·35d.); per passenger, ·63d. (·61d.); number of passengers carried per car mile, 16·04 (15·3); units used per car mile, 1·14 (1·009); average number of passengers carried per day, 35,480 (27,319); average traffic receipts per day, £94. 0s. 1d. (£69. 8s. 7d.); average number of miles run per day, 2,211 (1,781); average number of units used per day, 2,522 (1,797); cost of power per car mile, 2·28d. (2·27d.); passengers carried per single mile of track, 1,202,439 (927,566); number of times population carried, 124 (96); percentage of ½d. passengers carried, 78·515 per cent. (82·2 per cent.); 1d. ditto, 17·247 per cent. (14·9 per cent.); 1½d. ditto, 3·005 per cent. (2·5 per cent.); 2d. ditto, 1·031 per cent. (·4 per cent.); 2½d. ditto, ·202 per cent. (·002 per cent.)

**London County Council.**—The House of Commons Committee have sanctioned the Tottenham Court-road tramway, the double line to extend as far as Francis-street, with a single line on to Percy-street. On Saturday a new route for Westminster cars was opened by way of St. George's-road. London-road will thus be relieved of an immense amount of traffic. At the last meeting of the Council, it was stated that the best financial result earned by the tramways was in the year 1899-1900. In that year £71,000 was contributed in relief of rates, after making full provision for interest and sinking fund on the tramway debt. Of this sum about £40,000 was derived from the northern system and the remainder from the southern system. From that time, however, the surplus remaining after payment of principal and interest of debt had declined. On the northern lines it had fallen from £40,000 to £25,000, in consequence of the sale by the northern company of lines outside the county, while the general dislocation of traffic caused by the work of electrification added to improvements of the service only left the southern system in equilibrium after payment of principal and interest. The work of electrification had proved more expensive than was anticipated, owing largely to the temporary arrangements for the supply of power. Taking the result of the tramway undertaking as a whole, even under the severe strain to which it was now subjected, equilibrium would, according to the estimate, be maintained after paying the full charge of interest and sinking fund. During the current year the electrification of the greater part of the southern system would be completed, and it might be hoped that in 1905-6 traffic dislocation on this part will be at an end. The Highways Committee recommend the acceptance of Messrs. Lovatt and Co.'s tender of £52,970 for the erection of the superstructure of the first portion of the Greenwich generating station. The committee also recommend restrictions to prevent trafficking in return halves of workmen's tickets.

## LIGHTING AND GENERAL.

**Walsall.**—It has been decided to provide electric lifts at the new town hall.

**Grimsby.**—The Town Council have decided to borrow £28,500 for the electricity undertaking.

**Ilford.**—An enquiry is to be held into the Council's application to borrow £43,500 for electricity purposes.

**Cannock.**—The District Council have decided to borrow a sum not exceeding £8,000 for the electric lighting.

**Malton.**—The Northern Counties Electricity Supply Company have laid about six miles of cable up to the present.

**St. Helens.**—The Corporation have obtained sanction to the borrowing of £4,650 for electric lighting purposes.

**Northampton.**—The Town Council have decided to offer the local electric light company £100,000 for its undertaking.

**Mansfield.**—The equivalent of 8 c.p. lamps connected during the last quarter was 7,854; the units sold numbered 45,954.

**Manchester.**—An enquiry is to be held shortly into the Corporation's application for a loan of £135,000 for electricity purposes.

**Stoke-on-Trent.**—The Town Council have ordered 3,855 yards additional electric lighting mains at an estimated cost of £2,523.

**Oulton.**—The Urban District Council are considering a proposal to apply for a provisional order to provide electric lighting in the urban district.

**Crediton.**—The electric light provisional order which the Board of Trade propose to issue is being considered by the Urban District Council.

**Sunbury.**—The Urban District Council are corresponding with the National Telephone Company with regard to an exchange line for local telephone service.

**Sale of Plant.**—Particulars of an offer by the Urban District Council of Mexborough to sell two 50-kw. steam dynamos, with spare armatures, appear in another column.

**Spain.**—Application has been made by Don Manuel Crusat for a concession for certain electric tramways—viz., from Cornellá to Molins del Rey and from Esplugas to Cornellá.

**Brynmawr.**—The Bill containing the provisional order authorising the Urban District Council to supply electricity within the area of their district has passed the examiners of the House of Lords.

**Birkdale.**—The Urban District Council are communicating with the Birkdale District Electric Supply Company re a flat rate and the supply of electric energy to the public buildings.

**Fulham.**—The Council are raising £25,000, part of the £31,874 sanctioned by the London County Council on July 21, 1903, for the purpose of this Council's electric lighting undertaking.

**Islington.**—The Lighting Committee are about to proceed with the lighting of Grosvenor and Wallace roads, in the latter case subject also to the sanction to the loan of £240 being obtained.

**Wednesbury.**—An office, test-room, and stores, adjoining the existing electric lighting station in Camp-street is to be constructed. Tenders are to be obtained for the work, and also a loan applied for.

**Mains in the City.**—The City of London Electric Lighting Company have obtained permission to lay mains along certain streets in the City on condition that the work be carried on by night as well as by day.

**Battersea.**—The Council have accepted an offer from Bellis and Morcom, Limited, to purchase for the sum of £170 the remaining engine and dynamo removed from the town hall electric lighting station.

**Electrical Trades Union.**—The Lambeth branch of the above union held their annual dinner on Saturday last at the Old Queen's Head, London-road, S.E., the general secretary, Mr. A. Ewer, presiding.

**Lancaster.**—The Electricity Committee have decided to advertise for pupils, but applications will only be considered from those who have studied electricity and wish to put their theoretical knowledge into practice.

**Melksham.**—It is rumoured that the Board of Trade have determined not to sanction the provisional order which proposed to authorise the supply of electricity for public and private purposes within the district.

**Howrah Station, E.I.R.**—We hear that a scheme will shortly be submitted by the locomotive superintendent to the agent for sanction to light the new joint passenger station and goods yard with electricity at a cost of Rs.1,30,000.

**Maidenhead.**—The Public Street Lighting Committee have called for a joint report from the borough surveyor and the resident electrical engineer as to the streets which the Council may consider that it is desirable to light electrically.

**Globe Telegraph and Trust Co.**—The directors recommend a balance dividend of 5s. per share, making a total distribution of 5½ per cent. for the year ended April 30, leaving a balance of about £3,000 to be carried forward.

**Kilmarnock.**—Messrs. Alton and Co., Western Works, Willesden Junction, have received the order for the whole of the pipework, including feed pumps, economiser, condenser, and other auxiliary plant, for the Kilmarnock electricity works.

**Hampstead.**—Two of the large engines at the electric lighting station are to be altered from tandem-compound to triple-expansion at a cost of £596. It is estimated that the alteration will effect a saving of 15 per cent. in the coal bill.

**Southport.**—The total profits of the electricity department last year amounted to £3,615. It is proposed to devote £2,250 in aid of the rates. A considerable part of the profits will be used for paying off previous years' arrears of profits, etc.

**Tunbridge Wells.**—We hear that much satisfaction is expressed at Tunbridge Wells at the unanimous decision of the Lighting Committee of the Corporation to recommend the Council to decline to sell the municipal electric light undertaking.

**Stock Exchange.**—The Stock Exchange Committee have ordered the Metropolitan Electric Supply Company, Limited, further issue of 5,015 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 71,107 to 76,121 to be quoted in the official list.

**Bangor.**—During the last year 508 electric lamps were added, making a total of 773. The deficit for the year was £510, but this sum, however, includes close on £200 capital expenditure. The Council are prepared to supply current for power at a cheap rate.

**London Gazette.**—The first meeting of creditors in the estate of the Automatic Telephone Company (1903), Limited, 72 and 74, London-street, Greenwich, will be held on May 17, at 11 a.m., at Bankruptcy-buildings, Carey-street, Lincoln's-inn, London, W.C.

**Dudley.**—During the year ending March last the receipts in connection with the electrical undertaking amounted to £10,600. The working expenses amounted to £5,608, leaving a gross profit of £4,924. The number of units of electricity generated was 470,000.

**Keighley.**—The current sold during March amounted to 18 036 units, an increase of 5,153 units upon the amount sold on March, 1903. It is proposed that 800 yards of cable be laid at an estimated cost of £320. The electric lighting of Cavendish-street has been agreed to.

**Lisburn.**—Mr. R. C. Douglas, of the National Electric Construction Company, has induced a number of residents to form a committee, who will ask the Urban District Council to call a public meeting of the inhabitants to consider the subject of lighting the town with electricity.

**Long Eaton.**—The balance-sheet of the Electric Lighting Committee for the 15 months ending March 31 last shows a profit to the Council of £884 for the period named. It has been decided to use £280 for extension, and to invest the £600 as should be hereafter decided upon.

**Newark.**—The Derbyshire and Nottinghamshire Electric Power Company, have informed the Urban District Council that the necessary steps are being taken for the company to proceed with their undertaking at Newark, and no doubt the works would be commenced shortly.

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**Japan.**—The returns for 1903 relating to exports for electrical plant from Germany show that during the 12 months 178 tons were shipped to Japan, an increase of 46 tons as compared with 1902, in which year the shipments of this description of plant totalled 132 tons.—*Anglo-Japanese Gazette*

**Cullercoats.**—The installation of the electric light in Cullercoats parish church is being carried out under the superintendence of Mr. T. Hanning, of the firm of Robson and Coleman, Newcastle. A proposal for introducing the electric light into Whitley parish church is at present under discussion.

**Poplar.**—In connection with the proposal to extend high-tension feeder mains to Blackwall at a cost of £2,214, we learn that the Electric Lighting Committee have decided to adopt, under license, the patent system of Messrs. Berry, Skinner, and Co. for the large amount of concrete conduit required.

**Watford (Herts).**—In his report Major Cardew states: "The existing chimney is only suitable with natural draught for boilers having a total capacity of 30,000lb. to 35,000lb. of steam per hour, and it is most desirable that you should make arrangements for the chimney to be given up entirely to the use of the electric light department."

**West Bromwich.**—The annual report and statement of accounts in connection with the electricity department for the year ended March 31 last shows that the total income for the year amounted to £9,318, whilst the total expenditure, including interest, sinking fund, and bank charges (amounting to £2,895), was £7,773, leaving a net profit on the working of £1,545.

**King's Lynn.**—The Council's application for sanction to borrow £11,500 for electric lighting purposes has been granted in respect of the whole of the proposed expenditure on new works, which aroused the opposition of the dock company, and also for the greater portion of the past expenditure. With reference to the balance, the Local Government Board are asking for more detailed information.

**Gloucester.**—The Council's electricity undertaking has just finished its third financial year. The gross receipts have increased by £1,300, or 28 per cent, and the gross works costs by £370, or only 15 per cent. During the year just ended the Council had to repay in interest and capital £3,729, of which £1,500 was repayment of principal alone. In spite of that, they are only £400 odd short of balancing their accounts.

**Colchester.**—The last report of the Electric Light and Power Committee shows that in the fifth year of working the total revenue had been £7,542, as compared with £5,821 in the fourth year, and that the gross profit on the fifth year's working was £3,963, less £2,683 "interest and redemption on loan," leaving a net surplus of £1,280. The average price obtained for the private supply of current was 4·75d., and for public lamps 2·36d.

**Clyde Valley Electrical Power Bill.**—This Bill has passed before Lord Balfour's Committee on Unopposed Bills of the House of Lords. Mr. Robert Robertson, C.E, Glasgow, the engineer of the Clyde Valley Electrical Power Company, was examined by Mr. A. Beveridge, of Messrs A. and W. Beveridge, parliamentary agents, Westminster, and proved the preamble. The Bill was ordered to be reported to the House without amendment.

**Diesel Engines.**—We are informed that the first Diesel engines were installed in 1898, and that now more than 900 of these engines are in actual use, exclusive of the United States of America, with an aggregate power of 45,000 b.h.p., including 54 engines in the United Kingdom, with an aggregate power of 3,812 b.h.p.; 138 engines in Germany, with an aggregate power of 6,510 b.h.p.; and 288 engines in Russia, with an aggregate power of 20,072 b.h.p.

**Electricity Supply Company for Spain.**—The first drawing of the 6 per cent. first mortgage debentures and 7 per cent. "B" mortgage debentures for redemption at par on June 30, 1904, will take place at the registered office of the company, College-hill-chambers, College-hill, London, E.C., on Tuesday, May 17, 1904, at 2.30 p.m. The registered holders of these debentures, or their legal personal representatives, are entitled to attend at this drawing.

**Paignton.**—A letter is before the Lighting Committee in connection with the application of the Council for sanction to borrow £15,910 for the carrying out of an electric lighting scheme, in which the Local Government Board state that they had no power to authorise the proposed use of a portion of Queen's Park as a site for the generating station, and suggested that it would be necessary for the Council to reconsider their proposals as regarded the site of the station.

**St. Austell.**—The Urban District Council having passed a resolution at their last meeting informing the National Provincial Electricity Corporation, Limited, that they would withdraw their objection to the existing provisional order for electric lighting purposes in St. Austell provided the company would give a guarantee to supply electricity within six months, a letter was received from the company stating that an adequate deposit had been made to carry into effect such guarantee.

**Exeter.**—On Sunday evening the presentation of the installation of the electric light to the Exeter Cathedral by Mr. H. A. Willey was officially recognised by a service of dedication. There was a large congregation, which included a great number of those associated with the firm of Messrs. Willey and Co., Limited, who had been invited to attend, and for whom seats had been reserved. The new electricity station, erected and equipped at a cost of £48,000, was opened by the Mayor on Tuesday.

**Ealing.**—The Town Council have obtained sanction to a loan of £225,000 for electrical purposes £19,576 to be borrowed for a period of 23 years, and the remaining £5,424 for 30 years. Further application is to be made for sanction to a loan of £20,000 for the purposes of the electrical undertaking, about £10,000 being required for the new steam alternator and condensing plant, and the remaining £10,000 being required for general extensions necessitated by the continued growth of the business of the undertaking.

**Wolverhampton.**—The lighting works are being thrown open to visits from the ratepayers. On Monday night some 40 members of the Blakenhall Conservative Club were conducted through the premises. Mr. Shawfield, borough electrical engineer, in a short address, said that in saying the undertaking was self-supporting one meant that it was paying a dividend of 6 per cent. on its capital. Last year the Lighting Committee had managed to put by a sum approaching £3 000 to form the nucleus of a reserve fund.

**Portsmouth.**—Mr. E. Manville, in his report on the plant at the generating station, future extensions, etc., urges that any additions contemplated should be made with the least possible delay, and says that the weak points of the station are insufficient supply of condensing water and the want of a duplicate steam supply to the two newer turbine units. He recommends that this should be remedied at a cost of about £5,000. The station was not seriously defective, but had not been kept up-to-date as the concern had grown.

**Torquay.**—The Town Council on Tuesday adopted a report which recommended the adoption of an intermediary site between the original site and the one subsequently agreed to for the erection of an electric light and power station, the provision of the chimney for the refuse destructor and electricity station, 260ft. in height, and a modified building, with walls reduced by 7ft., and the substitution of a wood for an iron roof. The scheme of the electrical engineer, showing an estimated outlay of £25,508 for machinery, was adopted, subject to the Bill now before Parliament being obtained by the Dolter Tramway Company.

**Edison and Swan United Electric Light Co.**—An extraordinary meeting will be held at Winchester House, E.C., on 12th inst. to pass a resolution that the capital of the company be reduced from £1,000,000 to £941,090 in 150,000 "A" shares of £5 each, 26,436 "B" shares of £5 each, and 23,564 "B" shares of £2. 10s. each, by cancelling paid-up capital which has been lost, or is unrepresented by available assets, to the extent of £2. 10s. per share on each of the 23,564 "B" shares which have been issued and are now outstanding, and by reducing the nominal amount of each of such 23,564 "B" shares to £2. 10s.

**St. Marylebone.**—The Borough Council yesterday week decided to reject the terms proposed by the Metropolitan Electric Supply Company in regard to supplying current in bulk from Willesden after their St. Marylebone property had passed into the hands of the Council; or, alternatively, leasing the undertaking for the period of the unexpired order—27 years. Further, the Council resolved that it would be more advantageous to the borough to carry on the undertaking themselves, providing at a cost of £400,000—exclusive of site value—a generating station admitting of a direct supply and self-contained system.

**Dover.**—The purchase of the Dover Electric Supply Company's undertaking is now practically completed. The £150,000 which it was necessary to find in connection with the purchase was obtained from the Admiralty, it being part of the money invested for Greenwich Hospital purposes, and the mortgage securing the loan has been sealed. The total cost of the transfer of the undertaking is £157,000, out of which sum the Dover Electricity Supply Company get £142,000, and the remainder comprises the capital expenditure incurred since the agreement to purchase was sealed, and the expenses of the transfer, stamp duties, and commission.

**Swansea.**—We learn that the net profit of the municipal electricity works amounts to £1,000, against about £400 last year. The Corporation telephone department are fitting up a telephone exchange at the Bath and West of England Show at Swansea for a month, starting two weeks prior to the opening, at an inclusive service charge of £1. The facilities gained by subscribers will be sufficiently obvious to all, but, amongst others, the ability of dictating telegrams direct to the head post office, Swansea, for transmission to any part of the United Kingdom without extra charge, and to dictate messages to be forwarded as letters, will commend itself to exhibitors.

**Croydon.**—It has been decided that the town clerk be instructed to include in the Bill to be promoted by the Council in the next session of Parliament the following provisions: (*a*) further powers in connection with electric supply, wiring, fittings, motors, etc.; (*b*) power to supply electricity in bulk or otherwise to any person or local authority outside the borough boundary. Extensions of the direct-current mains are to be carried out in the centre of the town at a total estimated cost of £321; also the conversion of incandescent lighting to Nernst lighting in Beech House and Chatsworth roads. Brackets of the swan-neck pattern will be substituted for the existing brackets in Factory-lane.

**Aston.**—The Town Council have applied for sanction to the borrowing of two several sums of £30,000 and £20,000. It is proposed that the prices for the supply of current for power purposes be 1½d. for 22 hours per day, and 3d. per hour for the remaining two hours, on the peak; and that the consumer whose load factor is less than 10 per cent. be charged the usual lighting rates. A flat rate of 1½d. per unit is being charged for current already supplied to motors. The price of current for lighting has been fixed at a flat rate of 2½d. per unit for the six months ended March 31, 1904. The committee have resolved to discontinue the supply of fittings on the "free wiring" system, and have given instructions that the Corporation's "free wiring" be carried to the "patera" only.

**Ashford (Kent).**—The Board of Trade have issued to the Ashford and District Electric Supply Company, Limited, whose registered office is at 17, Bank-street, Ashford, an order authorising the supply of electrical energy for public and private purposes in the urban district of Ashford, and which repeals the former Ashford Electric Lighting Order of 1899. It contains a special clause which authorises the local authority to purchase the undertaking upon giving to the undertakers 12 months' notice of their intention so to do, upon the following terms: if notice to purchase be given at the expiration of 21, 28, or 35 years from the commencement of the order, the price to be paid for

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the undertaking shall be fair market value thereof as a going concern, such value to be ascertained, in default of agreement, by arbitration.

**Durham.**—The following notice appears on the agenda for this week's meeting of the County Council: "That the Board of Trade, having decided to grant a provisional order to a company in the East of Durham for electric lighting over a large area and for a term of 42 years against the express wish of the local authorities, this Council resolve (1) to write to the Board of Trade protesting against the confirmation of the order; (2) to request Alderman Wilson, M.P., and Councillor J. Johnson, M.P., to use their utmost efforts in Parliament to resist the confirmation of the order, and to represent to the Board of Trade and Parliament that the County Council have under their consideration the development of a public scheme of electric service for the county, which such orders as those under notice will seriously retard."

**Wrexham.**—The following figures are to hand with regard to the working of the electricity undertaking in March: Units generated, 37,520, as against 20,469 in March, 1903; used for tramways, 11,053; light and other purposes, 26,467. No new consumers were connected during the month, but additions equal to 136 lamps of 8 c.p. were made. The number of consumers to that date was 133 as compared with 124 at the end of March, 1903. The total number of 8 c.p. lamps equivalent connected for private supply was 11,457, as against 8,750 in March, 1903. The town water has been entirely cut off from the electricity department, and no water from that source was used for it during the March quarter. A bitumen boiler is to be procured at a cost not exceeding £20. If it should be found necessary to go beyond that amount, the matter will be again brought before the committee before any order is issued.

**Eastbourne.**—The accounts for the financial year ended March 31 show a total income for the year on revenue account of £21,421 and a total expenditure of £8,413, leaving a gross profit of £13,008. After defraying the interest and contribution for redemption of debt out of the profit, there is a net surplus amounting to £3,852. This has been added to the profit of previous years, and the amount to the credit of the account is now £11,750—viz., £8,700 to the credit of the revenue account and £3,000 to the credit of the depreciation fund account. The Town Council propose to place £750 out of the profit to the aid of the general district rate, and to reduce the charge for the public arc lamps from £25 to £22 per annum and the private supply by ½d. per unit—the maximum demand rate from 7½d. for the first hour and 4d. per unit afterwards to 7½d. and 3d. per unit. The £3,000 which has been carried to the depreciation account will be invested.

**Rotherham.**—The gross profit of the electricity department for the year just ended was £6,067. 19s. 2d., and after deducting £2,388. 6s. 9d. for loan charges, sinking fund, and interest and instalment, there was a net profit of £1,278. 8s. 11d. At the end of the last financial year there was a deficit of £733. 14s. 7d.; there was thus a surplus balance for the year of £544. 14s. 4d. The particulars for the last year and the present year were: generation of electricity (including coal, fuel, oil, waste, water, wages, etc.), 1·237d. (·444d.); distribution of electricity (including wages of linesmen and repairs to mains, meters, etc.), ·011d. (·008d.); rent, rates, and taxes, ·231d. (·048d.); management expenses (including salaries of engineer, general staff, stationery, advertising, and established charges), ·511d. (·131d.); special charges, present year, ·034d.; the works costs (including management), 2·02d. (·665d.); loan charges, 2·437d. (·702d.); depreciation, present year, ·418d; total per unit, 1·785d., as compared with a total last year, 4·45d.

**Sanitary Institute.**—One of the special features of the Health Exhibition of the Sanitary Institute at Glasgow in July next will be a municipal exhibit arranged by the different departments of the Glasgow Corporation. The cleansing department propose to arrange for, amongst other things, exhibits of a model up-to-date destructor, and the Globe fertiliser, the gas and electric departments the latest developments in illumination, and the sewage departments what they can produce from what were formerly waste products. The other departments of the Corporation will also be well represented with their different interests, and we feel sure that the representatives of the municipalities who regularly attend the congresses of the institute will welcome this opportunity of witnessing the progress that is made in municipal enterprises by the Glasgow Corporation. The social and holiday aspect of the congress has not been overlooked, and excursions have been arranged to the following amongst other interesting places: Loch Lomond, the Trossachs, and the Falls of Clyde.

**Hull Telephones.**—Some correspondence has recently been taking place between the Hull Corporation, the National Telephone Company, and the Postmaster-General with respect to conditions of the company's license. The company consent to certain conditions being made, but they claim that that has been nullified by the decision of Mr. Justice Buckley in the action which they brought against the Corporation. The Postmaster-General expresses the opinion that the decision of Mr. Justice Buckley does not nullify the acceptance, although it may have prevented the attainment of its purpose, and in his letter he refers to two rates offered by the company for the Hull area, and which do not seem to be within the limits of the charge laid down for that area. These rates, which, he says, the company will no doubt take steps to withdraw, are: (1) the unlimited service rate for a four-party line, and (2) the minimum of 25s for 600 messages over an omnibus line. The latter rate is not in harmony with the provision that in no case shall the total annual amount payable by an exchange subscriber be less than £2.

**Football.**—The Arc Works Football Club have this year been successful in obtaining the Essex junior cup. The replayed match between the Arc Works and Tilbury took place on the King's Head ground, Chelmsford, on April 30, when the Arc Works won a well-contested game by one goal to nil. Sir Carne Rasch, M.P., president of the Essex Football Association, presented the cup and the medals to the competing teams. The two Manchester workshop competitions under the Rugby code came to an end on Saturday last, and of the 150 or so clubs that entered both competitions two electrical firms came out on top—*i.e.*, Glover's Cable Works won the Swinton cup and medals, and the General Electric Works the Broughton trophy. Last year also two electrical clubs won these competitions, the Chloride Works obtaining the Swinton cup and Glover's the Broughton. This is somewhat singular, considering the fact that so very few electrical clubs were entered for the above competitions. It may be remembered that Glover's and the Chloride teams played later on in the year for the district championship, which the Cablemakers won.

**Bury.**—An enquiry has been held into an application by the Town Council for sanction to borrow £45,000 for purposes of electric lighting. The town clerk, Mr. J. Haslam, said the amount was divided into many items, and included various sums which had been borrowed under the Tramway Act of 1901 for land, engine-house, boiler-house, and boilers, which were to be transferred to the Electric Lighting Committee. Under the Tramway Act the money was borrowed for 30 years, but under the powers now being sought it was desired to repay it in 25 years, so as to make a uniform period for all these sums. The next items were £7,500 for stores and offices on the frontage, plans of which had been supplied to the Local Government Board, and £16,000, which was comprised of a variety of items, mainly for extension of the works to meet the requirements of the tramways. Probably one-half had already been expended to enable the tramways to commence running. In addition there was a sum of £6,000 for mains (also mainly for tramway purposes), £3,750 for service to customers and meters, and £5,000 for motors.

**Worthing.**—The Town Council have adopted the following report upon the amount paid for street-lighting to the electricity undertaking: "This committee having carefully considered the matter, and, being of opinion that the charges made for current supplied for public lighting should be put on a more satisfactory basis, recommended: (*a*) that the payments to be made in the future should be based on the actual cost price per unit generated, to include generating, distributing, and management expenses, and all capital charges, such cost to be ascertained, and the payments adjusted on March 31 in each year; (*b*) that in order to accurately ascertain the consumption of current in each year the Electricity Committee be authorised to provide and fix a meter to each arc lamp circuit (15 in number) at the estimated cost of £50; and (*c*) that for the current half-year, and pending the fixing of such meters, the charge shall be calculated at the rate of 4½d. per unit, the number of units consumed to be estimated for the purposes of the calculation, in the same way as is now adopted for the purpose of furnishing returns to the Board of Trade.

**Indo-European Telegraph Co.**—An extraordinary general meeting of this company will be held at the offices, 18, Old Broad-street, E.C., on May 16 at 12.30 p.m., when the following resolution, which was duly passed at an extraordinary general meeting of the company held on April 27, 1904, will be submitted for confirmation as a special resolution: "That the articles of association of the company be altered by adding thereto the following regulation—namely: '153*a* The directors may, with the sanction of a general meeting, and either before or after recommending or declaring any dividend or bonus, form and maintain out of the net profits or reserve fund of the company, or from both of these sources, a retirement fund, for the benefit of officers and employés of the company, by carrying over or paying moneys to the credit of a trust, in such form and with such provisions as the directors shall determine.'" Holders of shares to bearer desirous of attending the meeting must deposit their shares with name and address, at the office of the company, before 12 30 p.m. on Saturday, May 14, 1904, against an order of admission. The share warrants deposited will be returned after the meeting.

**Carnarvon.**—A special meeting of the Carnarvon Harbour Trust was held on Friday to consider the North Wales Electric Power Company's Scheme Bill, which is referred to in another column. The Chairman (Mr. J. Menzies) said that it was proposed under the Bill to bring electrical power into the quarry districts of the county, and as one interested in slate quarrying he thought this would be a great advantage. It would, in his opinion, be the means of developing the slate industry. Railways and tramways might be electrified, and the town of Carnarvon would eventually benefit. Looking, however, at the matter from the trustees' point of view, he thought the Board ought to give the Bill their hearty support. After discussion of such details as were known, it was resolved that, having regard to the benefits and advantages that will accrue to the industries and trades of the neighbourhood by the introduction of electricity for power purposes by cheapening the cost of production and increasing the output, the trust, without in any way committing itself to the details of the Bill promoted by the North Wales Power Company, gives its hearty support to the principle of the Bill provided that proper safeguards as to monopoly and charges are inserted for the protection of other public bodies and the general public.

**Hull.**—The engineer has been instructed to proceed with the laying of the telephone lines to Hessle, Cottingham, and Beverley. A deputation from the Chamber of Trades and the Coltman and Albert Wards Ratepayers' Association will ask the Corporation Electric Lighting Committee to reduce the electric light charges. The North-Eastern Railway Company have under consideration the question of lighting the whole of their premises in Hull by electricity, and they anticipate for this a consumption of 1,225 000 units per annum. They also intend to gradually convert most of their cranes, hoists, etc., to electrical driving. With this end in view they will either build their own power station and transmit energy at extra high pressure over the whole of their system, or they will take in bulk from the Corporation a supply if a suitable price can be agreed upon. The Electric Lighting Committee have had the matter under their consideration, and they have received a report by their engineer, who points out that the company estimate for this supply a load factor of 27 per cent., or an equivalent

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of 6½ hours' use of the current per working day. The committee has decided to offer to supply the company with not less than one million units per annum at 1½d. per unit for a 27 per cent. load factor, with an increase of ¼d. per unit for each 3 per cent. increase or decrease in load factor, subject to the company entering into an agreement to take the supply for three years.

**Nottingham.**—An enquiry has been held into the application of the Corporation for sanction to borrow £100,000 for the purposes of electric lighting extensions. Sir Samuel Johnson explained that this was the seventh application made by the Council for loans for the purpose of carrying on their electric light undertaking. The undertaking was established in 1895, and the first year's gross profits only amounted to £529. 6s. 6d. It slowly progressed from that time until last year, when the gross profits were £31,695. 14s. 7d., while this year they had reached £34,768. 10s. 4d. Last year Mr. Talbot, the electrical engineer, laid five miles of fresh mains, and a year before that seven miles of fresh mains were laid, so it was not surprising that they were obliged to obtain additional capital. The demand upon them just now was such that the Corporation must proceed rapidly with the works, or they would not be able to supply their customers with electricity during the next winter season. It was a singular thing that although the Corporation also owned the gasworks, the demand and output was increasing there, and he submitted that it was some indication of the prosperity of the town and district that the demand for both gas and electric light was progressing in the way it did. Mr. Talbot, who was appointed electrical engineer when the works commenced, said there had been a steadily increasing demand for electricity, which they had been able to supply at a profit. All the capital borrowed previously had all been expended, and he thought the extension would be good enough for about three years. Sir John Turney supported the application as chairman of the Electricity Committee, a position which he has held since its formation.

**Loughborough (Leicestershire).**—An enquiry has been held into the Town Council's application for sanction to borrow £5,000 for electric lighting. The Town Clerk said the Corporation were entitled to borrow £225,000. An estimate was prepared by Mr. Gadsby in 1898, when the Corporation were going before Parliament. The actual estimate was for £20,540, the balance being for the provision of a working capital, and for extensions. Since that time several towns of a similar size to Loughborough had started electricity undertakings, and, judging by the experience of these towns, Mr. Gadsby came to the conclusion that his original scheme was inadequate and too small for the requirements of the town. There had been started in Loughborough the large electrical machinery works of Messrs. Morris and Bastert, who had intimated that unless the Town Council were ready to supply them with electricity they would start an installation for themselves, both for power and lighting purposes. Messrs. Cotton's Patent Hosiery Machine Construction Works had also stated that it was their intention to put down electric lighting plant, and would supply themselves unless supplied by the Corporation. The present scheme of Mr. Gadsby provided for a capacity of 500 kw., with a building wherein another 100-kw. site might be had at any time and at very small cost. The estimated cost of this scheme was £28,480, or £3,480 more than the Town Council were entitled to borrow at the present time. They were, therefore, asking for sanction to borrow £30,000 in all, instead of £25,000. Mr. Gadsby, engineer to the scheme, said that in only six towns in the United Kingdom of a similar size to Loughborough were there no electric installations, and these towns had the matter in hand. Contracts have been entered with 42 consumers, including the first of the larger firms above named.

**North Wales Electric Power Bill.**—A Select Committee of the House of Lords, Lord Clifford of Chudleigh presiding, has under consideration this Bill, the principal object of which is to authorise the use of the waters of Lyn Llydaw, on the eastern slopes of Snowdon, for generating electricity. The area of supply is the counties of Carnarvon, Merioneth, and Anglesey, and parts of Flintshire and Denbighshire. Among the petitioners against the Bill are the Conway Corporation, Carnarvon Corporation, Flintshire County Council, Carnarvonshire County Council, the Urban District Councils of Penmaenmawr, Llandudno, and Conway, and the Colwyn Bay Joint Water Supply Board. Mr. Baggallay, for the promoters, explained that it was proposed to construct a dam which would raise the waters of Llyn Llydaw some 20ft., thus giving a fall of 1,150ft. within a distance of a quarter of a mile of a generating station, and a line of pipes connecting it with the dam. All round the generating station were possible customers in the quarries and mines, and there was already evidence of a large demand for the power which the promoters would supply. It was proposed to transfer to the company the electricity powers of the Portmadoc Railway Company, and the two undertakings would be equal to about 12,000 h.p. About 1,000 h.p. of this would be utilised to electrify the railway authorised in the Act of 1901, and 11,000 h.p. would be available for quarries and other purposes. The promoters hoped to be able to supply energy at 1½d. per unit. The estimated cost of the works at Snowdon was £86,500, and this would be provided out of the proposed capital of £170,000, the balance being available for the construction of railways. The company would own all the shares in the Portmadoc Railway and the Narrow-Gauge Railway, and it was proposed to extend these lines to Carnarvon on the one side and Bettws-y-coed on the other. The promoters would supply electricity for these railways, and they would be worked by the Portmadoc Company. The cost of the acquisition of the undertaking in the Conway Valley would be £40,000.

**East Ham District Council.**—A progress report on the working of the Council's tramways and electric lighting undertakings for the year ended March 31, 1904, has just been issued by the engineer and manager, Mr. W. C. Ullmann, M.I.E.E., M.I.Mech.E. In the preface Mr. Ullmann refers to the statements showing the comparative figures for the years ending March 31, 1903 and 1904, and says: "In connection with the electricity supply it will be seen that a considerable increase in the units generated and sold has been made. The following gives the actual percentage of increase over that of last year's output: increase of units generated, 40·8 per cent.; units sold to private consumers, 59·7 per cent.; units sold to public lighting, 22·9 per cent.; units sold to tramways, 40·3 per cent. It will be noticed that the private supply has very considerably increased. This is accounted for partly by the large demand for arc lights by the tradesmen, and partly owing to the reduction in price, which came into operation on Jan. 1 of the present year, and also to the increased area of supply. The increase in consumers represents 85·8 per cent., or equal to an addition of 9,523 8-c.p. lamps. In order to meet this increasing demand, and that which is anticipated during the coming winter, preparations are now being made to instal the 750-kw. 1,200-h.p engine and generator, which is on order and expected to be working in time for next winter's load. In connection with the public lighting, a small increase is noted, the arc lamps having been increased by three and the incandescent lamps by five. At the present time extensions for the lighting of Katherine-road by arc lamps is in hand. The demand for tramway power has largely increased; this is accounted for by the extra number of car miles run and the quicker service now given. During the year the whole of the generating plant has worked very satisfactorily indeed, the cost of repairs being remarkably low. Considerable extensions to the distributor cables have also been made; the total length at the end of last year being 18·75 miles, to which has been added 6¼ miles, thus making the total length now laid 25 miles. A table is appended giving the following details of the electricity supply for the 12 months, 1903-4 and 1902-3 respectively: total units generated, 1,988,553 (1,411,924); sold, 1,774,163 (1,264,666); sold to private consumers, 457,210 (286,238); sold to public lighting, 396,257 (322,303); sold to tramways, 920,696 (656,125); used on works, 69,717 (54,239); units sold per 8-c.p. lamp (connections during year averaged), 30 (33·5); number of 8-c.p. lamps connected to mains (public arcs, incandescent lamps, private consumers, generating station, and car-sheds), 33,847 (22,957); total number of consumers, 656 (353); number of public arc lamps, 171 (168); incandescent lamps, 139 (134); capacity of plant installed, 1,275 kw. (1,275 kw.); total horse-power of same, 2,000 (2,000); actual maximum supply demand, 880 kw. (690 kw.); estimated receipts from electricity supply, as per meter returns—quarter ending June, £4,024. 7s. 4d. (£2,423. 13s. 7d.); September, £4,306. 12s. 6d. (£2,795. 0s. 11d.); December, £5,569. 3s. 11d. (£3,932. 0s. 10d.); March, £5,313. 0s. 2d. (£4,183. 14s. 4d.)—total, £19,213. 3s. 11d. (£13,334. 9s. 8d.; price charged per unit for lighting (maximum demand), 6d. and 2d. (7d. and 2d.); for fixed rate, 4½d. (5½d.); for motor power, 2½d. (2½d.); for public lighting (arcs), £18 per annum (£18 per annum); for incandescent lamps, £4. 6s. 3d. per annum (£4. 6s. 3d. per annum); for traction, 2d. (2d.); average price obtained—public lighting, 2·13d. per unit (2·11d. per unit); tramways, 2d. per unit (2d. per unit); private supply, 4·03d. per unit (4·12d. per unit).

## COLONIAL NOTES.

**Rand Central Electric Works.**—The result of the working for April has been telegraphed as follows: "Kilowatt-hours generated 882,915, yielding a gross revenue of £7,800." For the corresponding period of last year the result was: kilowatt-hours generated 630,205, yielding a gross revenue of £5,544.

**Cape Colony.**—The Municipality of Kalk Bay intend to introduce into the Cape Parliament a Bill authorising the Council to supply electricity for lighting, heating, and power purposes for general, industrial, and domestic purposes. The Allgemeine Elektricitäts-Gesellschaft, of Berlin, have secured the contract for the supply of electrical plant for power and lighting to the East London Harbour Board, South Africa.

**Christchurch (New Zealand).**—The City Council have adopted a minimum charge of 4s. a month for power for small motors. Tenders have been accepted for the third unit at the electrical plant. The following profits have been made since October: October, £25; November, £34; December, £55; January, £85; February, £103. This last-named figure covered interest, sinking fund, depreciation, and all standing charges. The two units already installed give 200 kw., the connections at present are represented by 185 kw., and the maximum Saturday night output was 95 kw. More than 200 premises are being wired, and when that work is completed the connections will be about 110 kw.

**Transvaal.**—The Johannesburg correspondent of the *Glasgow Herald* says: "Some time ago I gave particulars of the proposed electric power station at Johannesburg, and I now learn that the contract has been placed with Messrs. William Beardmore and Co., Limited, of Glasgow, and that the Oechelhauser gas-engine, now manufactured in this country solely by Messrs. Beardmore, will be adopted. There will be several of these engines of 1,000 h.p. and 2,000 h.p. driving electric generators, which are to be made by Messrs. Siemens Bros. and Co., Limited, London. The engines will be supplied with gas from coal producers, and will thus give a high economy. The Oechelhauser engine is primarily, although not exclusively, designed for using the waste gas from blast furnaces, and for this purpose is being extensively applied on the Continent up to 5,000 h.p. It has great advantages over some other types, for, although having only one cylinder, it is arranged with two pistons, giving more uniform turning. The engine is horizontal, and the pistons work in opposite directions, so that while one of them is connected direct to the crankshaft, the other works a sliding cross-head at the end of the cylinder farthest from the shaft, and from this cross-head rods extend back to the shaft, so as to contribute the rotating power to two side cranks. These latter are set at 180deg. from the centre crank, so that with one cylinder there is obtained the balancing advantage of three cranks. There are three ports in the cylinder, one for the admission of gas, a second for its egress or exhaust, and a third for air

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to clean out the cylinder after each of the explosions of the gas which gives the impulse or power to the engine. When the pistons are farthest apart and the remaining gas has been exhausted, a separate pump forces air into the cylinder to clean it, by the rebound or return stroke the pistons come together and drive the air out. Coal gas is then admitted when the cylinders are together, and this gas, on being exploded by an electric spark, drives them separate again, and so the pistons move towards and from each other, working the three cranks and the electric generator mounted on the shaft. This type of gas-engine excels in having no mechanically-operated distribution valves at all. It gives much higher efficiency than the steam-engine, the coal consumption being little more than one-half that for the best for steam-engines, while the rate of consumption is about ½lb. per unit of power per hour. There is consequently a great future for the type, the construction of which has only been recently introduced into this country."

**New Zealand.—Municipal Legislation for Electric Installation.**—The *New Zealand Mining, Engineering, and Building Journal* says: "New Zealand came late into the field in the matter of electric traction and lighting, but they are certainly making up for lost time. As a test of what is being done, it is only necessary to note the amount of capital which has been authorised by Parliament for such purposes. In 1891 Wellington, Christchurch, and Auckland were authorised by an Act to fetch in electric power under arrangement with the New Zealand Electrical Syndicate, Limited, and in the same year Dunedin took authority to raise £200,000 to acquire the tramways and electrify them. The next to apply for parliamentary sanction was the borough of Gore in 1893, but without authority to borrow, as they bought their power from the Gore Electric and Power Syndicate, Limited. In 1894 Reefton took power to levy a rate of ½d. in the £ on the town district and ¼d. in the £ on the suburban district for city purposes, which included lighting by electricity, and the town is now lit from that source, the generating power being water. In 1897 Hawera took power to bring in electricity, but without power for a loan. Next year the Petone Corporation took the same power and without borrowing powers. In 1898 Stratford took similar powers, followed next year by Ohinemuri. In 1900 the Auckland Electric Lighting Act was passed authorising the Council to contract with any firm or company to supply electricity for light or power purposes, and in the same year Dunedin was authorised to purchase the city tramways with power to borrow £200,000 at not more than 5 per cent., and with special rating powers, which was to include a sinking fund of ½ per cent. per annum. In the same year Greytown was authorised to raise £4,000 at 5 per cent., and Queenstown was authorised to make an agreement with any person or company for supply of electricity. In 1902 Christchurch was granted power to borrow £200,000 to purchase and electrify their tramways, at up to 5 per cent., with power to borrow an additional £100,000. In the same year they also took power to borrow £5,000 to investigate and take expert opinion upon schemes for supplying electric power, with further power to borrow £250,000, with interest at not more than 5 per cent. They also took power to borrow £50,000 to improve and extend the system. In 1902 the Hawera County took power to purchase power from the Hawera County Electric Power Company, Limited. The same Act also authorised the Hawera Borough Council, the Hawera County Council, the Normanby Town Board, and the Manaia Town Board at any time after 25 years to purchase the undertakings of the company by arbitration. In 1903 the borough of Dannevirke was authorised to construct works for electric purposes, and for that purpose to borrow £30,000 at 5 per cent., secured by a special rate, and they also had power to raise a further £10,000 by way of special loan. Gore also took power to contract with a private company for the supply and use of electricity for the borough. In 1903 Christchurch City got authority to borrow a further sum of £55,000 at 5 per cent., with special rating powers. Dunedin also got power to acquire water rights and bring in power to the city. In the same year the Otago Dock Trust got authority to supply electric power to light the wharves. Lastly, Wanganui, in 1903, got power to bring in electricity for light or power purposes, but without any special grant of borrowing powers. In this list it will therefore be seen that these local bodies have been authorised since 1891 to borrow no less a sum than £904,000, at an average rate of 5 per cent. per annum."

## PROVISIONAL PATENTS, 1904.

APRIL 25.

**9397. Improvements in and relating to "clusters" for incandescence electric lamps.** John Henry Dale, 51, Deansgate-arcade, Manchester. (Complete specification.)

**9442. Improvements in relation to resonators for use with currents of high-frequency wireless telegraphy and other like purposes.** Clarence Alfred Wright, 496, High-road, Leytonstone, Essex.

**9443. Improvements in relation to vacuum electrodes for the production of X-rays with currents of high frequency.** Clarence Alfred Wright, 496, High-road, Leytonstone, Essex.

**9453. Improvements in electric shoes.** John Wilson Gibbs, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, July 16, 1903, being date of application in United States.) (Complete specification.)

**9468. Improvements in or relating to a method of and apparatus for heating the charge of electric furnaces.** Albert Neuburger, 111, Hatton-garden, London. (Complete specification.)

**9427. An automatic electromagnetic sanding-gear for use on electric railways and tramways, operated instantaneously with the electric emergency brake from the controller handle.** Charles Wilson Crosbie and Arthur Ward, 135, Great Clowes-street, Broughton, Manchester.

APRIL 26.

**9517. Improvements in insulators.** Abraham Richardson, Joseph Heap, Henry Heap, James Bailey, Thomas Brierley, and Robert Billington, 6, Bank-street, Manchester.

**9518. Improvements in hangers for ears for overhead trolley wires.** Abraham Richardson, Joseph Heap, Henry Heap, James Bailey, Thomas Brierley, and Robert Billington, 6, Bank-street, Manchester.

**9523. Improvements in battery cells.** William Obid Duntley, 65, Chancery-lane, London. (Complete specification.)

**9530, Improvements in the electrical ignition used in connection with internal-combustion motors and the like.** Charles Ridley and John Ridley, 18, Hertford-street, Coventry.

**9542. Sparking plugs for use in connection with the electric ignition systems of internal-combustion engines.** Walter Williams, Harberton House, Pains-road, Southsea.

**9547. Improvements in electrodes.** Howard Coppuck Levis, 83, Cannon-street, London. (The General Electric Company, United States).

**9565. Improvements in electric tramway or railway vehicles.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

**9581. Improvements in electric motors.** Ralph McNeill, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 27.

**9647. Improvements in electromagnetic igniters for explosion motors.** Philippe Pichard and Emile Meunier, 18, Buckingham-street, Strand, London. (Complete specification.)

**9649. Improvements in connection with gas and electric light brackets and fittings for the same.** Arthur Rudd, 18, Southampton-buildings, Chancery-lane, London.

**9658. Improvements in machines for making incandescent electric lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9659. Improvements in governors for internal-combustion engines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9660. Improvements in starting devices for electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9669. Improvements in electric telegraph apparatus.** Siemens Bros. and Co., Limited, George Sylvester Grimston, and Frederick Turner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

APRIL 28.

**9711. Improvements in apparatus for starting and controlling electromotors and in circuit breakers adapted for use therein.** Ben Nelson Dadge and Samuel Lord, 34, Castle-street, Liverpool.

**9718. Improvements in or relating to electric lamps, especially applicable to electric lamps of the character known as "vapour arc lamps" or "luminous vapour electric lamps."** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**9744. Improvements in watertight covers for electric tumbler switches.** The General Contracts Company, Limited, and Walter Herbert Flood, 149, Strand, London.

APRIL 29.

**9796. An electrolytic resistance for electro-therapeutic use.** John Garwood Everett, 7, High-street, Windsor.

**9802. An improved electric ignition plug for internal-combustion or explosion engines.** Albert Howson, Bread-lane, Nantwich.

**9814. An electric or other lighted device for displaying in an illuminated form the word "exit" or other announcement on theatres or other public buildings.** Frederick Henry Trussell and Herbert Hawkins, The London Hippodrome, London.

**9815. Method of charging storage batteries without the aid of auxiliary or special apparatus.** Charles Kraft, 81, High Holborn, London. (Complete specification.)

**9831. Improved means for the regulation of electric circuits for the production of constant current and/or constant potential.** Reginald William James, 1, Queen Victoria street, London. (The Northern Electric Company, United States.) (Complete specification.)

**9840. Improvements in and relating to electric alarm appliances.** Lucien Laufer, 7, Southampton-buildings, Chancery-lane, London.

**9841. Improvements in commutators for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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**9842. Improvements in resistance units and methods of making same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9843. Improvements in incandescent lamps.** The British Thomson-Houston Company, Limited, 83 Cannon street, London. (The General Electric Company, United States.)

**9844. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9859. Apparatus for obtaining magnetic fields having a rectilinear reciprocating motion.** Paul Centner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**9874. Improvements in electric switches.** Gano Sillick Dunn, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 25 1903, being date of application in United States.) (Complete specification.)

APRIL 30.

**9884. A controller for electric motors.** Arthur Burgess Soar and Henry Frank Joel, Phipp-street, London.

**9914. Magneto-electric igniting device.** Carl Hauptmann, 10, Friedrichstrasse, Berlin, Germany. (Complete specification.)

**9950. Improvements in or relating to the collector rings of alternating-current generators and motors.** Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

**9951. Improvements in driving mechanism for electrically propelled vehicles.** Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

**9954. Safety device for electric lifts.** William Sprowson, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**9959. Improvements in electrically-driven steering gear.** William Horatio Harfield and William Rutledge, 4, South-street, Finsbury, London.

**9964. Electrical percussive drill.** Paul Centner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**9981. Shade-carrier for electric glow lamps and the like.** Karl Walther, 40, Chancery-lane, London. (Complete specification.)

**9984. Improvements in or relating to electric cable conductors.** William Ernest Hitch, 14, Abbey-road, Oxford.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 19, 1904.*

1903.

**6631. Apparatus for the production and application of high-frequency currents.** Sharman.

**9408. Apparatus for the transmission of electrical energy.** Artom.

**9551. Electric governors for elastic fluid turbines.** Boult. (Continental Turbine Company.)

**9552. Apparatus for controlling the lighting and extinguishing of gas, the flow of fluids, or the supply of electric energy at predetermined times.** Harris.

**9990. Electric motors and generators.** Fynn.

**10207. Electric switches.** Bray, Markham, Reiss, and Bray, Markham, and Reiss, Limited.

**10584. Electric light switches operated by the opening of doors, windows, and such like.** Oppenheimer. (Actiengesellschaft Mix und Genest.)

**13931. Secondary batteries.** Fiedler and Gerard.

**14166. Gas or vapour electric apparatus such as mercury vapour lamps for lighting or other purposes.** Le Tall. (Cooper-Hewitt Electric Company.)

**14223. Electro-pneumatic action for organs.** Burton.

**14375. Switches for use in connection with selective electric signalling apparatus.** Jacobs and Nicholson.

**15746. Electrical arc lamps.** Guest, Keen, and Nettlefold's, Limited, and Symons.

**17232. Terminal holders for electric wires, leads, or cables.** Stevens.

**20926. Electric-current transformers.** Müller.

**22388. Apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line wire.** Howorth. (Turchi and Brunè.)

**23548. Gas and electric lamp pendants.** Jones and Smith.

**25567. Process and apparatus for producing a shifting of phase of 90deg. in alternating-current meters.** Morck.

**28709. Electric telegraphy.** Rugh.

1904.

**1258. Electric clocks.** Tiffany and Van Inwagan.

**3385. Automatic telegraph transmitter.** Murray.

**4075. Supports for conductor rails of electric railways.** Doulton and Morris.

**4590. Telephone annunciator or indicator switchboard.** Eckstein and Bell.

**4413. Electric switches.** Spalding.

**5227. Supports and guards for conductor rails of electric railways.** Doulton and Morris.

**7209. Multi-voltage electric generators.** Gibson. (Date applied for under International Convention, April 4, 1903.)

**7236. Electric insulators.** Lorrain. (Soc. Ceramica Richard Ginori.

**7327. Process for the preparation of dynamo brushes.** British Galvanic Metal Packing Company, Limited. (Galvanischen Metall Papier-Fabrik Akt.-Ges.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜ ⅝ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5¼-5⅜ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 101-106 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manu., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3⅜-4¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 90-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ⅛-⅜ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | 1-1⅛ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 98-99 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 72-77 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | – | 5¼-5⅜ |
| Crompton and Co. ..... | 5 | – | 1⅜-2⅛ |
| —— 5 per cent. Debentures..... | 100 | – | 96-99 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 5 | – | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | – | ⅛-1⅛ |
| —— 5 per cent. Debentures..... | 100 | – | 74-79 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1⅛-1⅜ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2⅛-3 |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9⅛-9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference ..... | 5 | – | 5-5¼ |
| —— 4½ per cent. Debentures ..... | 100 | – | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 18¼-18½ |
| —— 4 per cent. Debentures..... | 100 | – | 98-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 14½-15½ |
| Telegraph Construction and Maintenance..... | 12 | – | 34-37 |
| —— 5 per cent. Bonds ..... | 100 | – | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | – | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | – | 115-120 |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 11¼-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9¾-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | .. | 102-105 d |
| Brompton and Kensington, Ordinary..... | 5 | – | 10⅜-11¼ |
| —— 7 per cent. Preference ..... | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | – | 6⅜-7¼ |
| —— Nos. 20,001-30,000 ..... | 5 | – | 6⅜-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 106-109 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5-5¼ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 102-104 |
| Chelsea Electricity Supply ..... | 5 | .. | 6¼-6⅜ |
| —— 4½ per cent. Debentures ..... | 100 | – | 106-109 |
| City of London, Ordinary..... | 10 | – | 10¼-10⅜ |
| —— 6 per cent. Cumulative Pref..... | 10 | – | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | – | 7-8 |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 5⅜-5⅞ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 104-107 xd |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 92-97 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | – | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | .. | 7⅛-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11¼-12¼ |
| —— per cent. Debenture Stock Red ..... | 100 | – | 102-105 |
| Kensington and Knightsbridge and Notting Hill ..... | 100 | – | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary ..... | 5 | – | 1-1½ |
| —— 6 per cent. Pref..... | 6 | .. | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | .. | 95-98 |
| Metropolitan Ordinary ..... | 10 | – | 19 20 |
| ——4½ per cent. First Mortgage Debenture Stock .... | 100 | .. | 109-113 |
| ——3½ per cent. Mortgage Debenture, Red. ..... | 100 | .. | 95 98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | .. | 98-101 |
| —— Preference ..... | 4 | – | 100-103 |
| Notting Hill Electric Lighting ..... | 10 | – | 12¼-13½ |
| —— 4 per cent. First Mort. Debs ,Nos. 1-500 (Reg.) .. | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 1,-14,310..... | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock ..... | 100 | .. | 96-99 |
| Royal Electrical Company of Montrea. 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 98-101 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000.. | 5 | – | 3-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 85-90 |
| South London, Ordinary ..... | | – | 3¼-4 |
| St. James's and Pall Mall, Ordinary, 101-30,080..... | 5 | – | 14-15 |
| —— 7 per cent. Pref. ..... | 5 | – | 8-9 |
| —— 3½ per cent. Deb. ..... | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 4⅜-4⅞ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4¾-5 |
| Westminster, Ordinary ..... | 5 | – | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251..... | 5 | – | 6¼-6⅜ |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Electric Railways.—** | £ | | £ |
| Central London, Ordinary | 100 | – | 92-95 |
| —— 4 per cent. Pref. | 100 | – | 98-101 |
| —— ,, ,, deferred | 100 | – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 | – | 110-113 |
| City and South London, Consolidated Ordinary | 100 | – | 49-52 |
| —— 4 per cent. Debenture Stock | 100 | – | 106-109 xd |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 122-125 |
| —— ,, ,, ,, '96 | 100 | – | 120-123 |
| —— ,, ,, ,, '01 | 100 | – | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 4¼-4½ |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Waterloo and City, Ordinary | 100 | – | 90-93 |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 1-260,007 | 5 | .. | 4¼ 5¼ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 | – | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-2⅛ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¼-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 97-102 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 98-101 |
| —— Ord Pref. | 100 | .. | 99-102 |
| —— Non-Cum. 5 per cent. Pref. | 10 | .. | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 102-104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 | . | 98-101 |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 | – | 8¼-9 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 9¼-10¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 114-117 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-2⅞ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5¼-5⅝ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 | .. | 104-107 |
| —— Prov. Cert., all paid | 100 | .. | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | .. | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | .. | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | .. | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 99-102 xd |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 100-101 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 6 per cent. Cum. Pref. | all | – | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8¼-8⅜ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11¼-11⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | .. | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | .. | ¾-1 |
| New General Traction, Ordinary | 5 | .. | ¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 12-12¼ |
| —— 5 per cent. Cum. Pref. | 10 | – | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | .. | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,132 6 per cent. Preference | 1 | – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | – | 103-105 |
| —— Deferred Stock | 100 | – | 88-91 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 10-12 |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 10-12 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5-5¼ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 97-99 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 101-103 |
| Oriental Telephone and Electric Company | 1 | . | 15/16-1 1/16 xd |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April30 | 1,187 | 907 | + 280 | +11,824h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 23 | 262 | 260 | + 2 | + 120 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 30 | 36 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | May 1 | 1,009 | 999 | + 10 | – 74 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | April23 | 268 | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 29 | 8·9 | 785 | + 84 | + 201 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·42 |
| Blackpool Corporation | ,, 28 | 507 | 405 | + 101 | + 173 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 30 | 320 | 305 | + 14 | – 312 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | May 1 | 1,787 | 1,663 | + 124 | – 128 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·16 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 27 | 1,018 | 975 | + 43 | + 321 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | April23 | 3,925 | 3,297 | + 682 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | May 1 | 814 | 788 | + 26 | + 32h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | April29 | 4,797 | 4,538 | + 259 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 30 | 997 | 727 | + 270 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | May 1 | 312 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | April30 | 1,879 | 1,719 | + 160 | + 240 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 30 | 178 | 186 | – 8 | + 264 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 30 | 6,850 | 6,806 | + 44 | – 1,028h | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | May 1 | 2,681 | 3,001 | – 320 | – 1,684h | 6⅜ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | April28 | 434 | 467 | – 33 | – 218 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 29 | 272 | 228 | – 6 | – 112 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 30 | 182 | 211 | – 29 | – 169 | 4⅔ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | May 1 | 104 | 101 | + 3 | + 84h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 2,359 | 7·68 |
| Dublin U. T., electric cars | April29 | 4,177 | 3,731 | + 446 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 29 | 1,023 | 747 | + 281 | | | | | | | | | | | |
| Dundee City Tramways | ,, 27 | 794 | 783 | + 11 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 30 | 728 | 577 | + 151 | + 370 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 30 | 13,916 | 13,180 | + 736 | +59,974h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Halifax Corporation | ,, 20 | 2,554 | 2,994 | – 440 | – 39 | 31⅔ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 9 | 1,546 | 1,186 | + 360 | + 8,914 | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 30 | 2,033 | 1,798 | + 235 | + 732 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 30 | 446 | 317 | + 129 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 28 | 139 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 27 | 202 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 23 | 5,532 | 4,887 | + 645 | + 1,821 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 23 | 10,191 | 9,556 | + 635 | + 3,752 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | May 1 | 1,553 | 1,623 | – 70 | + 72h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | April23 | 10,922 | 8,489 | +2,433 | + 7,550 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 16 | 143 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 30 | 11,918 | 11,687 | + 231 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 30 | 114 | 57 | + 57 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 30 | 3,518 | 3,078 | + 440 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 30 | 453 | 294 | + 159 | + 508 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 30 | 1,656 | 1,406 | + 250 | + 814 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | May 2 | 116 | 115 | + 1 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 5 | 3,967 | 3,116 | + 851 | + 2,029 | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 1 | 4,450 | 4,164 | + 286 | + 130 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | April28 | 900 | 896 | + 4 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 27 | 264 | 223 | + 41 | + 111 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 29 | 505 | 295 | + 210 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | May 1 | 1,135 | 1,005 | + 130 | + 14 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | April30 | 655 | 634 | + 21 | + 34 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 28 | 716 | — | — | — | 1⅔ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 27 | 550 | 392 | + 157 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**Canadian Electrical Association.**—At a meeting of the executive committee of the Canadian Electrical Association on the 21st ult. it was decided to hold the annual convention in the city of Hamilton on Wednesday, Thursday, and Friday, June 15, 16, and 17.

**The Institution Library.**—Mr. R. K. Gray, the president, has purchased the late Mr. McMillan's collection of books, and presented it to the Institution library. Mr. Gray humorously proposed a vote of thanks to the donor, which was accorded with mingled enthusiasm and amusement.

**Books Received.**—Messrs. Harper and Bros. are publishing a translation of "Starters and Regulators for Electric Generators and Motors," by Rudolf Krause, price 4s. 6d. net; "Dynamo Attendants and their Dynamos," by F. Broadbent (London: S. Rentell and Co. 1s. 6d.). This is the fourth edition of this little volume, which has been re-written and brought up to date. A section has been added dealing with the various types of motors, and the publication provides a useful handbook.

**The Metric System.**—The Select Committee of the House of Lords which is considering the Weights and Measures (Metric) Bill commenced its sittings last week. On behalf of the Home Office, Mr. H. Cuningham, assistant under-secretary, submitted that Clause 6, which tended to make all contracts not conforming with the metric system void, was too drastic. He considered it would be sufficient if the provisions were framed so that such contracts would be rendered illegal, and would incur a small penalty. The other evidence tendered was partly favourable, partly adverse, the reasons given for the latter being that the change would facilitate foreign competition and involve heavy expense for new apparatus. In regard to the first of these objections, it does not impress us as very convincing, seeing that the mathematical qualifications of our Continental rivals have generally enabled them to cope with our present system.

**Electrical Traction in Peru.**—The *Railway and Engineering Review* of Chicago states that, according to consular dispatches, a commencement has been made with electric traction in Peru. An electric car line, of the street railway type, has been built from Lima to Chorrillas, eight miles in length, touching the seashore at Barranco, which is one of the popular resorts. It is anticipated that the service will facilitate advancement in certain directions, such as in the erection of a better class of buildings and in the improvement of the streets. Another electric car line is under construction between Lima and Callao. This road will be 10 miles long, and will be laid with a double track. It will come into competition with two steam railroads in operation between the two cities, and it is expected to effect some reduction in passenger rates, which the public claim are unreasonably high. The cars and plant are of American manufacture.

**Action of Radium on Metals.**—Mr. N. Orloff, as stated in a recent communication to the Russian Physico-Chemical Society, covered in April, 1903, an ebonite capsule containing 0·03 grm. of radium bromide with an aluminium plate 0·01mm. in thickness instead of the mica generally used. In the course of July the author, having opened the capsule, noted on the surface of the aluminium turned towards the radium some protuberances of the same aspect as the surrounding surface of the aluminium and resembling small drops of melted metal. These protuberances proved to be radioactive, producing a photographic image on acting for some minutes through black paper, and even after six months they were found to emit invisible radiations without any appreciable weakening. The author thinks that a stable alloy is formed by the accumulation of material particles given off from the atomic systems of radium around small aluminium nuclei.

**Protection from High-Tension Wires.** — In referring to the accidents to men and plant that have resulted from crosses occurring while stringing wires, the *Western Electrician* of Chicago mentions that one method of protection is to make a net of very stout cord and about 14in. mesh, the size of the whole being about 30ft. long and 10ft. wide. Ropes, each three spans in length, are rove through the sides of this net so that they may be suspended from one pole to the next and kept spaced by a stretcher, consisting of a piece of wood about 1ft. longer than the cross-arms. The ropes are run from the poles, between which the net is suspended, and fastened to the bases of poles adjoining each end of the span. The position of the net can be varied according to the position of greatest hazard of contact with high-tension wires. This simple arrangement, in addition to furnishing conditions of safety, also permits the work to be done at a more rapid rate because unusual precautions are rendered unnecessary.

**The South-Western Polytechnic.** — The eighth annual distribution of prizes and certificates took place on Friday night, Mr. R C. Antrobus in the chair. The occasion was utilised for the formal opening of the new buildings, which include extensions to the electrical and mechanical laboratories. The principal (Mr. Tomlinson), in a brief report, said that the institution was never in a more flourishing condition. The amount of fees received and grants earned had increased in the last eight years from less than £1,000 to over £8,000. Lord Cadogan distributed the prizes and certificates, and also formally declared the new buildings open. At the conclusion of the proceedings an address and testimonial were presented to the principal on his retirement from that position. The following evening a conversazione was held, the programme being a very extensive one. Lectures on radium and X-ray photography, with experiments, were given by Mr. S. Skinner and Mr. F. T. Addyman, and Mr. J. B. Coleman discoursed upon "Illuminants—Old and New." Opportunities were given for the inspection of the admirable electrical, mechanical, and other laboratories, and with two concerts and a series of gymnastic displays visitors were provided with ample entertainment.

**Reduction Phenomena Produced by the Action of Alternating Currents.**—This subject is treated by Messrs. F. Pearce and C. Couchet in the *Comptes Rendus*. The authors state that when certain saline solutions are subjected to the action of an alternating current, either the electrodes are dissolved as observed by Le Blanc and Schick, or the dissolved salts are more or less completely reduced; the latter phenomenon is dependent on the nature of the electrodes, those formed of readily oxidisable metals being the most effective, and also on the density and frequency of the current; with a current of low density, the electrodes only are oxidised, whilst with a high-density current the dissolved salt is also reduced. Solutions of ferric alum are only slightly reduced in the presence of platinum electrodes, much more reduced when electrodes of aluminium, lead, or cadmium are employed, whilst with iron electrodes the reduction is almost complete. Solutions of alkali nitrates are reduced quantitatively to nitrites with electrodes of cadmium or zinc, whilst with iron, copper, or carbon electrodes there is practically no reduction. Under similar suitable conditions, cupric salts are reduced to the cuprous state, mercuric to mercurous salts, or chromates to chromium salts, and nitrobenzene to a salt of aniline.

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**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on the 9th inst., the Duke of Northumberland, K.G., president, in the chair. The chairman announced that he had nominated the following vice-presidents for the ensuing year: Sir William Abney, K.C.B, Mr. Shelford Bidwell, Right Hon. Lord Kelvin, Dr. Ludwig Mond, Sir Thomas H. Sanderson, G.C.B., Sir Felix Semon, Sir James Crichton-Browne (treasurer), and Sir William Crookes (hon. secretary). The following were elected honorary members: Prof. E. H. Amagat, Prof. N. Croft, Prof. L. P. Cailletet, Prof. and Madame Curie, Prof. H. L. Le Chatelier, Prof. G. Lippmann, Prof. J. W. Bruhl, Prof. G. H. Quincke, Prof. E. Fischer, Prof. F. W. G. Kohlrausch, Prof. H. Landolt, Prof. L. Boltzmann, Dr. H. Kamerlingh Onnes, Prof. H. A. Lorentz, Prof. E. W. Morley, Prof. E. C. Pickering, Dr. G. Lunge, Prof. P. T. Cleve, and Prof. P. Zeeman. The special thanks of the members were returned to Mrs. Frank Lawson and to Sir Thomas Sanderson, G.C.B., for their donations to the fund for the promotion of experimental research at low temperatures. The following were elected members: Mr. P. M. Brophy, Mr. W. J Canter, Mr. Eyre Crowe, Mr. H. T. Ellis, Miss E. Morgan, Mr. Berkeley Portman, and Mr. Burnett Tabrum, J.P.

**Galvanising by the Electrolytic Process.**—The last few years have witnessed a considerable extension in this process. It is now used for heavy pieces of machinery, such as parts of centrifugals for sugar factories, which cannot be galvanised by immersion in melted zinc without becoming distorted; and even heavier objects, such as girders, sheet iron, and boiler tubes, are now galvanised electrolytically. It has been found, moreover, that the electrolytic deposit of zinc adheres better to a clean metallic surface than on one coated by dipping, and articles galvanised by electrolysis can be punched, riveted, and otherwise worked without the zinc peeling off. Press-rolls also are now treated by this process. The old method had several disadvantages, of which the worst, perhaps, were the unequal thickness of the zinc coating and the lumps formed by the dripping of the melted zinc, both of which necessitated the roller being turned in the lathe in order to obtain a proper surface. The electrolytic deposit of zinc, on the contrary, is perfectly uniform, and no turning is required, so that the roll can be used just as it comes from the zinc bath; besides which the rolls do not warp, as was frequently the case with the old process, as the electrolytic precipitation of the zinc is carried out cold. The electrolytic process has been found of great value for practically all parts of machinery subject to the action of rust.

**St. Marylebone.**—It will be remembered that when the company's suit against the Borough Council was before Mr. Justice Buckley some 2½ months back, his lordship made an order by consent extending the time for completion of the purchase until April 30, the Council to pay £15,000 before March 31 in respect of capital expenditure. The case was again formally mentioned in court last week, when Mr. Fletcher Moulton, K.C, applied for the matter to stand over until June 30, stating that the Bill authorising the loan was expected to be passed shortly, and that the Council were prepared to pay another £5,000 within a fortnight, and a further £5,000 before June 30. Counsel for the plaintiffs replied that the company desired to act amicably, and his lordship granted the defendants' application. In a letter to the *Times*, Mr. E. C. Owen, the secretary, referring to abortive negotiations for a lease of the undertaking, announces that as soon as the period and conditions attaching to the sinking fund had been settled by the House of Commons, the company offered to take a 27 years' lease of the undertaking on terms which would have relieved the borough of the annual charges for interest and sinking fund during that period, the only stipulation being that in the improbable event of Parliament sanctioning a competitive supply the company should have the option of determining the lease at two years' notice. It may be recalled that when the preamble of the Bill was passed, the House of Commons Committee refused the Council, according to precedent, power to lease the undertaking to a new company, so it will now have to be worked municipally.

**Radium and Disruptive Discharges in Air.**—The conclusions drawn by Dr. Sokolzeff in a paper presented to the Russian Physico-Chemical Society are as follows: Of the two electric emissions occurring in the disruptive discharge in the air, and at normal pressure, the positive emission plays the essential part. This conclusion is borne out by the following facts: In the case of the point being positive, the spark passes at a much higher distance than from a negative point. In the case of both electrodes being identical, the junction of the anode with the earth will always weaken the spark, whereas by connecting the cathode to the ground the intensity of the spark is always augmented. The electric emission from the anode is stronger than that given off from the cathode, producing the spark more easily. On investigating the transformation of the slow discharge into a spark, the discharge is found to pass from the anode to the cathode. Several facts recorded in literature show the predominant part played by the anode in the formation of the spark—namely, the action of magnetic fields, the pressure and the fall of potential in the spark, the incandescence of the cathode, and the analogy with the discharges taking place in Geissler tubes. The positive emission is paralysed under the action of radium, while no appreciable action is noted in the case of the negative emission. The influence of radium becomes less as the shape of the electrode is more pointed. If in the spark circuit there are no appreciable strong oscillations the radium will extinguish a rather long spark, the more easily as the surface of the anode is greater. The action exerted on oscillating sparks is of quite a special order. With positive points and negative discs radium is found to extinguish a spark in the neighbourhood and to light a spark at a distance. In the case of the spark length being upwards of a certain limit, any other oscillating sparks are easily started up by radium.

**Standard Tramway Poles.**—We are informed that a conference of tramway pole manufacturers will take place at the Institution of Civil Engineers on Thursday, June 2, at 2.30 p m. The recent electrical conference convened by the Sub-Committee on Generators, Motors, and Transformers to discuss certain points which have arisen with reference to the proposed standards for motor speeds and frequencies, and to which we referred in our issue of Jan. 22 last, led to such satisfactory results and proved of such great assistance to the work of that sub-committee that the Electrical Tramway Sub-Committee propose to adopt the same course. The Sub-Committee on Electric Tramways, which is presided over by Mr. A. P. Trotter, electrical adviser to the Board of Trade, was formed at a meeting of the Electrical Plant Committee in May last year, and consists of the following gentlemen: A. P. Trotter, Esq. (chairman), Philip Dawson, Esq., F. Forbes Higginson, Esq., E. R. Hill, Esq, J. H. Rider, Esq., W. Rutherford, Esq, H. M Sayers, Esq., R. H. Scotter, Esq., A. M. Sillar, Esq., J. J. Steinitz, Esq., A. H. Walton, Esq., Leslie S. Robertson, M.I.C.E. (secretary), C. Le Maistre, A M.I.E E. (electrical assistant secretary). Several sittings have been held, and a large

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amount of information, relating to both sectional and taper poles, has been gathered through the medium of circular letters addressed to users and manufacturers. The replies which were received to these circulars were very carefully considered by the sub-committee, after which they proceeded to draft a proposed standard specification for three-section tramway poles. This conference has been convened to discuss some of the more important questions which have arisen as the result of the committee's enquiries. We are requested to state that the committee will welcome any gentlemen desirous of attending to give evidence on the subject of tramway poles. Particulars of the conference may be obtained on application to the secretary, Mr. Leslie S. Robertson, 28, Victoria-street, Westminster.

**A 100-Ton Alternating-Current Crane.**—We notice in the *Electrical World* of New York a description of a 100-ton crane equipped with induction motors, which has been recently erected for the Southern Pacific Company at Los Angeles, California, for their railroad repair shop. The induction motor was chosen because the public supply is on the alternating-current system, and also to save the wear on the commutators which there would have been with direct-current motors. It is also claimed that in this instance there is a distinct increase in efficiency, owing to the fact that no transformers, rotary converters, or motor-generators are needed to change the alternating-current supply into direct current for the crane. There is, of course, also a considerable saving in first cost. The crane span is 37ft. 5in., and there are two hoists, each capable of lifting 50 tons. Each main hoist is driven by a 50-h.p. (nominal) alternating-current crane type motor, and is fitted with electric brakes. The main hoists are moved on the bridge by a 10-h.p. (nominal) motor. A motor of the same rating is also used on the auxiliary hoist. The bridge is driven by a 50-h.p. motor. The operating speeds are: for the main hoist, full load 10ft. per minute, 20ft. per minute light load; trolley, full load 80ft. per minute, 100ft. per minute light load; bridge, full load 175ft. per minute, 225ft. per minute light load. The motors are three-phase, 440-volt, 50-cycle Westinghouse variable-speed induction motors built with special reference to the duty required. Speed control of the motors is secured by using for each motor a three-phase Westinghouse crane type controller in connection with auto-transformers, only one set of two transformers being used for all the motors. The controllers are fitted with preventive resistances on contact arms, which effectively prevent sparking at controller contacts. The use of auto-transformers allows of variable voltages being applied to the motors without the losses incident to rheostats. The crane has been fully tried, and is giving every satisfaction.

**London Traffic Commission.**—At the resumed sitting of the Royal Commission, Mr. Philip Dawson, consulting engineer to the London, Brighton, and South Coast Railway, gave evidence. He considered that traffic within the metropolitan area would be best served by surface lines. One great source of trouble to those railways possessing a heavy suburban traffic was the inadequacy of their terminal facilities. Improvements might be made by decentralisation, dividing traffic more evenly between the different termini, by running trains through London over existing lines, or new lines to be constructed, and so extending unloading over a large number of stations instead of discharging all passengers at a single terminus. Connection between the stations of the railway companies and the tubes was relieving the pressure at the termini. Railways should, as far as possible, have facilities to run over each others' lines. Where underground stations for railways were found impracticable, underground stations for tramways might be formed. At Victoria it should be possible to bring subways in under the present station level, and to run tramcars, which could distribute passengers. The same idea, he thought, could be applied at Charing Cross, Holborn, and Clapham Junction. He considered the electrification of the suburban system of railways absolutely necessary, and that it would mean doubling the carrying capacity of the railways. Several companies were now seriously considering that question. The advantages offered by electrification were increased average speed; decrease in cost of operation, combined with increased receipts and consequent possible lowering of fares; and greater comfort to the travelling public. Mr. S. B. Cottrell, chief engineer and general manager of the Liverpool Overhead Railway Company, testified to the advantages of electric traction in Liverpool. In his opinion, the only remedy for London street traffic was to do away with horses, and thereby save the room occupied by them. He was also in favour of limiting heavy traffic along important thoroughfares to certain hours, or confining it to back streets. Dr. A. B. W. Kennedy, vice-president of the Institution of Civil Engineers and chief engineer to the Westminster Electric Supply Corporation, Limited, recommended that in order to promote, as far as possible, co-operation in regard to the opening of streets, all electrical undertakers, public and private, should be put under similar and reciprocal obligations as to the giving of notice. He was opposed to a central authority to regulate the breaking-up of streets, as the local bodies could better judge the most suitable time for operations in their respective areas.

**Competitive Boiler Tests.**—Some interesting trials were recently made at Los Angeles, California, on boilers of the Babcock and Wilcox and Stirling types respectively. A large boiler contract was about to be placed by the Pacific Light and Power Company, and the object of the tests was to see which type of boiler should be used. The full details of the trials will be found in the April number of the *Journal of Electricity, Power, and Gas*, which is published at San Francisco. These details show that every care was taken to ensure a fair trial under similar conditions. The results of the tests may be summarised as follows: Four 10-hour tests were made of each boiler, the period of test extending at intervals from Dec. 4 to Dec. 21 last inclusive, these tests being, first, at a rate of evaporation of from 3½lb. to 4lb. of water per hour from each square foot of heating surface, the second at the rate of 4½lb., the third at 5¾lb., and the fourth and last test to be for the maximum capacity of evaporation which it is possible to obtain. Incidentally, the quality of steam produced, the percentage of entrained moisture, the temperature of escaping gases, the amount of steam used by the oil burners, the performance of oil burners, the evaporation per pound of oil from and at 212deg. F., the heat values of the Whittier and the mixture of Whittier and Los Angeles oils used, and the changes which occurred in the condition of the boilers during the successive stages of the test, were all brought out in surpassing fulness. It cannot be gainsaid, however, but that the chief interest from the commercial rather than the engineering point of view will centre in the decided advantage which the test shows that the Babcock and Wilcox boiler possesses over the Stirling boiler in every count. For instance, in the matter of efficiency, the percentage of gain reached in the efficiency of the Babcock and Wilcox boiler over that of the Stirling in the four tests was respectively 4·93, 5·10, 7·18, and 2·97 per cent. The percentage of moisture in the steam produced by the Babcock and Wilcox boiler exceeded that from the Stirling boiler in

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the four tests by 0·35, 0·38, 0·52, and 0·55 per cent. respectively, and, similarly, the temperature of escaping gases from the Babcock and Wilcox boiler were lower by 16, 53, 81, and 98 degrees F. in the respective tests than that from the Stirling boiler. The evaporation per pound of oil from and at 212deg. F. varied from 13·85lb. in the Stirling boiler during the fourth test to 16·01lb. for the Babcock and Wilcox boiler during the first test, and the increased evaporation for the latter boiler over the former during each of the four tests were respectively 0·70, 0·79, 0·96, and 0·35 pounds, while the percentage of steam used by the burners ranged from 1·96 to 3·42 per cent., both occurring during the first test, and the amounts given being for the Babcock and Wilcox and the Stirling boilers respectively. The minimum and maximum efficiencies attained ranged from 71·50 per cent. for the Stirling boiler during the last test to 83·06 per cent. for the Babcock and Wilcox boiler during the first test; but as the last test was made to show the maximum working capacity that could be reached under the existing conditions without regard to efficiency, no note should be taken of the minimum efficiency of 71·50 per cent. as given. Applying this correction, the minimum becomes 74·05 per cent. for the Stirling boiler in the third test. It will be seen from the above that under the conditions of the test the Babcock and Wilcox boiler gave somewhat better results with the oil fuel used.

**High-Tension Sub-Stations.**—The Home Office has issued a memorandum of recommendations in reference to the construction of sub-stations intended to minimise the danger to life connected with switching or other operations. The first recommendation provides for a minimum height of 7ft. In regard to area for single transformer stations up to 30 kw., a minimum of 4ft. square is generally sufficient. Where a larger capacity is required, it is suggested that the station should be made large enough to accommodate an output of 75 kw., and for such stations it is proposed that there shall be a minimum width of 5ft. and a minimum area of 50 square feet, the actual shape depending on local circumstances. For stations above 75 kw. capacity, it is recommended that for every additional 10 kw. not less than five square feet shall be added to the area. These dimensions are irrespective of the entrance, for which an additional two square feet and three square feet should be provided for the 30-kw. and 75-kw. stations respectively. Where switchboards are provided with cable or other connections at the back, there should be a clear space at the rear of the boards not less than 3ft. wide, so that the chamber will have to be proportionately larger for this class of switchboard unless the current can be entirely cut off while the back of the boards is being examined. Entrance should always be at the end or side of the chamber proper, as if the roof be used for this purpose the floor is exposed to any water that may fall in, the ladder obstructs the working space, and the operator in descending frequently passes very close to live conductors. There should be ample space to walk past the transformers and to work the switches, so that if the station be narrow, it should be long enough to allow of the low-pressure switchboard on one wall not being immediately opposite the high-pressure switchboard on the other wall. Switchboards should be fixed so that the switches can be worked without the operator being in contact with the cases of the transformers. Double-floor stations may be used for twice the output of single-floor chambers of the same area, provided that the height for the working platform to the roof is not less than 7ft., and the height below the working platform and the floor not less than 6ft. The chamber should be rendered impervious to the maximum pressure of water in the surrounding soil, but lest water should through any cause obtain access, it is desirable that the floor be laid on an incline of not less than 1 in 100 towards a sump situate in the entrance annexe, immediately below the manhole. It is recommended that the sump be not connected with the town drainage system. The necessity for good ventilation is emphasised, and it is recommended that the inlet duct be near the floor and the outlet duct near the roof. The sectional area of each duct should be not less than one square inch for every 10 cubic feet capacity of the station, which would give for a 30-kw. chamber an area about equal to that of a pipe of 4in. diameter, and for a 75-kw. chamber 7in. diameter. A cover opening to the full size of the manhole is to be preferred, and the type of cover which provides for the lid being locked back when open is recommended. All high-pressure apparatus should have a colour distinction. It is recommended that telephonic communication be provided between the generating station and the sub-stations. Switch fuses, or other type in which the fuse can be replaced without the handling of live metal, are to be preferred. The passage way or working space should not be obstructed by apparatus. Insulating platforms or indiarubber mats, which should be kept quite dry, are desirable. Great care should be exercised when shutting off the supply to see that it has been cut off from any duplicate or inter-connecting feeder. The foregoing recommendations, which are not intended to apply to mere boxes which a man could not enter, may be taken as the basis of regulations to be issued hereafter by the Home Secretary under Section 79 of the Factory Act, 1901.

**Pyrometers.**—At the meeting last week of the Iron and Steel Institute a communication was presented from a committee appointed by the council to collect information as to the actual working of different pyrometers. This committee consisted of Mr. R. A. Hadfield, Mr. J. E. Stead, and Mr. B. H. Brough, secretary. As a result, information was collected from all the leading makers, which, when illustrated, forms a splendid *résumé* of what has been done in this direction. A large number of the pyrometers depend on electricity for their records, among them being the Le Chatelier pyrometer, illustrated herewith. This instrument was designed by Prof. Le Chatelier, and is made by Mr. W. C. Heræus, of Hanau. It has come into very extensive use, and hence the following recapitulation of its details will be of interest. It depends upon the thermo-electric current for its reading, and has the advantage that the temperature can be recorded at almost any distance from the source of heat. As will be seen from the illustrations, there are two wires, one of absolutely pure platinum, and the other consisting of the same metal alloyed with 10 per cent. of rhodium, which are fused together at one of their ends in the shape of a small ball, and thus form a couple. This ball generates a slight electric current when heated, and, as ascertained by the Royal Physical Institute by comparison with their celebrated air thermometer, such currents are proportionate to the heat applied. Each element is accompanied by a table of results determined in the same manner. To prevent injury to the wires by abrasion, injurious gases, and by alloying with other metals, they are usually enclosed in porcelain tubes, a small tube open at both ends being used to insulate the two wires, and a larger one, closed at one end, covering the whole. The Royal Porcelain Factory at Berlin prepares such tubes from an extremely refractory porcelain base, which resists a temperature of 2,920deg. F., or 1,600deg. C. These tubes can be made up to 50in. in length. The galvanometer used in connection with the

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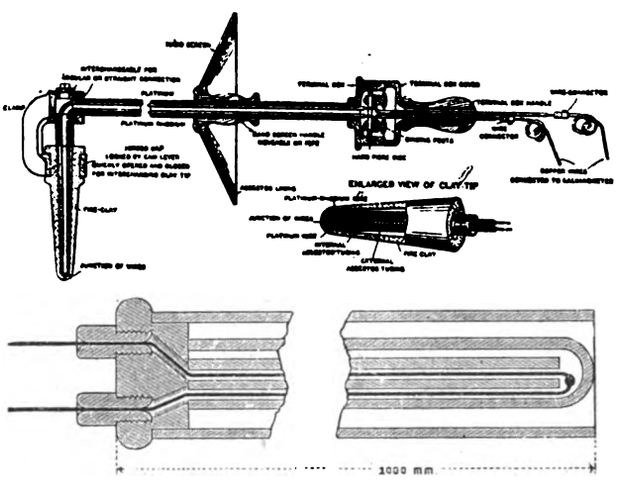
pyrometer is of the D'Arsonval type, and is especially adapted to the measuring of thermo-currents. The current is transmitted to an armature, wound in quadrangular shape, through a fine wire of hard metal which does not oxidise. A small spring of the same material acts as a negative. A strong permanent magnet with iron pole-shoes constitutes a magnetic field, and an iron cylinder in the centre concentrates the magnetic lines of force. The pointer moves over two scales, one of which denotes the E.M.F. of the current in microvolts, thus making it possible to check the readings of the instrument, while the second scale gives direct readings of the degrees of temperature. As soon as the temperature of the thermo-element has risen to that of its surroundings, the deflection of the pointer along the scales will cease. The temperature surrounding the junction of the element wires with the conductors should be 32deg. F. to give correct readings.




Small variations therefrom—up to 65deg. F., for instance—will scarcely be significant for the application of the pyrometer in ordinary practice. Other electrical instruments described in the report are the Baird and Tatlock pyrometer, the Callendar and Griffith pyrometer, the Roberts-Austen recording pyrometer, and the Siemens electrical pyrometer. At the end of the paper a comprehensive list of British patents for the construction of pyrometers is given, and also an interesting bibliography dealing with previous publications on the subject. We would congratulate the Iron and Steel Institute on this publication.

**Electric Arcs.**—At the Washington meeting of the Electro-Chemical Society on the 9th ult., Mr. W. S. Weedon read a valuable paper on the study of the electric arc. In it he draws attention to a number of interesting phenomena in arcs between various substances. On the structure of arcs in general, he remarks that the very middle path is not luminous, but the light is derived from the outer mantle, and most frequently from that portion of the outer mantle next the inner path, as represented in Fig. 1. In the carbon arc the outer mantle is not well defined, owing to the fact that the product of combustion is gaseous. The author considers it probable that the inner non-luminous path above mentioned is in a way comparable to the Crookes dark space. The explanation given for the presence of the latter is that the large number of negative ions present have too great a velocity to ionise the atoms with which they collide, but that farther along the tube, when their force has been diminished by collision, ionisation may take place. Where this occurs, light is given off. In the arc, the inner path may be caused by the fact that the negative ions in very great number are moving rapidly toward the anode, and producing ionisation only where their force has been sufficiently diminished by collision—viz, on the sides of the inner path. There are many changes in the character of an arc during running which are very subtle and of rather obscure origin. In many instances the material depositing on one or both electrodes causes difficulty, and in many instances irregularity in the composition of the material used causes unexpected alterations in the structure of the arc. On the question of whether the cathode determines the character of the arc, the author observes that in studying the characteristics of the arc the first fact which one is apt to discover is that the light given off by an arc is not produced by simple heating of particles present in the arc. For some time the author held the opinion, arrived at after a number of experiments on metallic arcs, that the cathode determines the character of the arc; but here, as in a number of other experiences in the study of the arc, new facts appeared just as the opinion was well established, and made the generalisation impossible. There are cases in which the cathode does not appear to be the determining feature. For instance, two very clear and conflicting cases are as follows: copper cathode and magnetite anode give

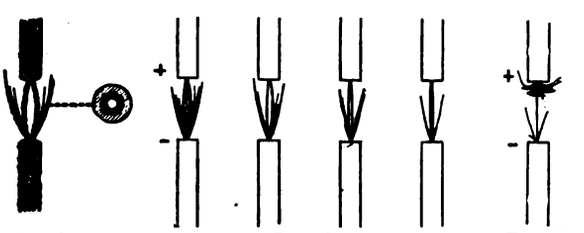



FIG. 1. FIG. 2. FIG 3.

copper arc, while magnetite cathode and copper anode give iron arc. Here the cathode undoubtedly determines the nature of the arc. Copper cathode and thorium carbide anode give thorium arc, while thorium carbide cathode and copper anode give copper arc. Here we have the anode giving character to the arc. Besides these contradictory cases, we have such substances as tungsten, calcium carbide, and zirconium carbide, acting almost as well in one direction as in the other when copper is used as the second electrode. The conditions for the above experiments were in each case as follows: diameter of electrode, ¼in.; arc length, 1in.; current, three amperes; voltage, about 100. These are the exact conditions of the experiments. Some arcs do not behave the same under conditions which are varied only slightly. This may be illustrated by the magnetite-copper arc above described. A vertical arc is used with the magnetite as cathode below. Under the conditions above given with regard to current and arc length, no copper appears in the arc at all. This is true, apparently, at all current strengths tried—from one ampere to fifteen amperes. It does not seem to hold, however, below 0·5 ampere. If a start be made with three amperes for a 1in. arc and the current gradually reduced by throwing in external resistance, the arc changes, as is shown in Fig. 2. When the current reaches 0·5 ampere, however, the character of the arc suddenly changes, and instead of a pure iron arc, the one obtained shows the copper clearly around the anode (Fig. 3). The author remarks that whether we are bordering upon the phenomena of spark discharge here or not, the arc characteristics certainly seem to be changed. Reduction in the supply of cathode material appears to be the most important factor. The copper appears to take a part in the ionisation when the iron fails to be produced in quantity sufficient to feed the arc. The same phenomena above described may be seen if the copper as cathode is placed below, with the magnetite above. At low current the iron flashes out, and the spectrum of the upper portion is that of iron, while the lower portion is purely copper.

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## KETTERING ELECTRICITY WORKS.

The town of Kettering dates back to the early Saxon times, when it went by the name of Katerings. From the Roman remains found in the vicinity it is clear that the Saxon town sprang up amid the ruins of a Roman settlement. The associations around this market town also date back a considerable time. Thus the charter for its market was granted in 1227 by Henry III. to the monks at Peterborough. It is a prosperous town, and the various manufacturers within the area are likely to derive considerable benefit from the introduction of the electricity supply system. This is especially the case in regard to those engaged in the boot and shoe industry and the manufacture of other domestic articles, since electric motors will considerably cheapen the cost of production.

The occasion of the inauguration of the supply on Saturday last was rendered doubly auspicious by the opening on the same date of the public library presented by Mr. Andrew Carnegie to the town at a cost of £8,000, the ceremony being performed by the generous donor in person. All Kettering turned out to witness this event, which, perhaps, detracted somewhat from the interest taken in the subsequent proceedings. In regard to the latter, it was but meet that Mr. C. Saunders, ex-chairman of the Urban District Council, should have been called upon to declare the electricity supply inaugurated, since

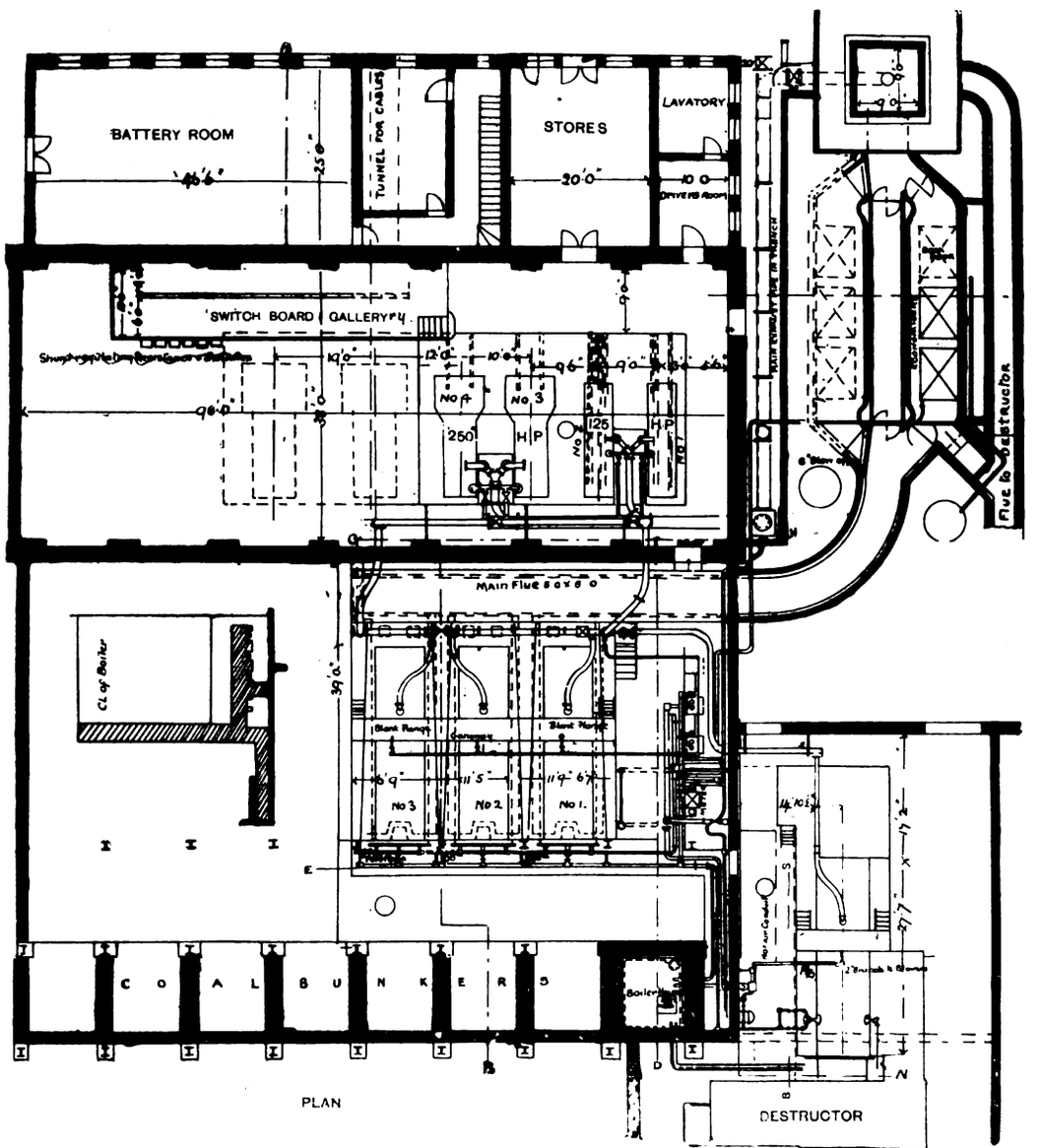


FIG. 1.—Plan of Electricity Works, Kettering.

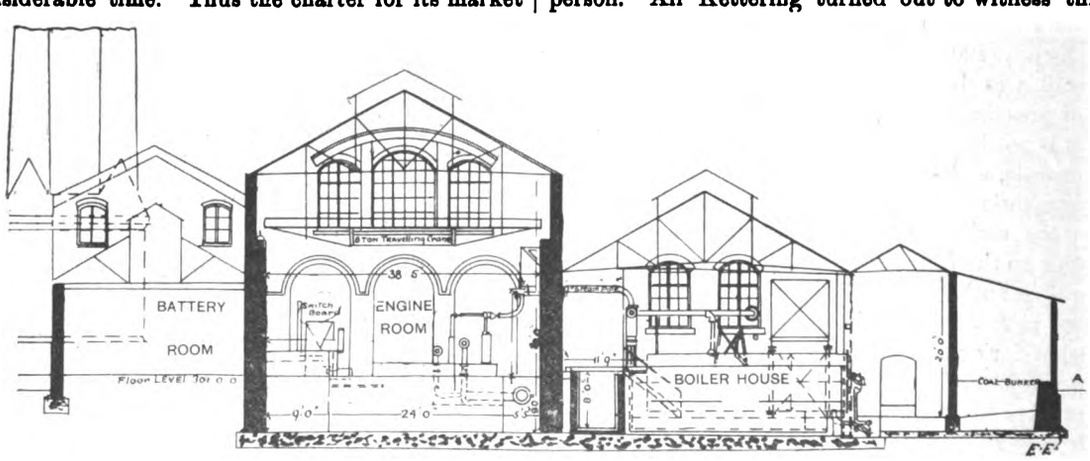


FIG. 2.—Section through Electricity Works, Kettering.

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upon the shoulders of that gentleman, more than any other, fell the work of piloting the scheme through the Council, although its subsequent charge devolved upon the first chairman of the Electric Lighting Committee, Councillor M. T. Gorman. For our part we must congratulate Kettering upon the possession of an electrical undertaking which is up-to-date in every way and already assured of success, since, from the information we have received, the committee have adopted tariffs which will quickly obtain a good load for the station. Thus, the rate for electrical energy has been fixed at 4½d. for lighting, while for power the charge will be 2d. per unit for consumption under 500 units per quarter and 1½d. per unit for the next 1,500 units per quarter. If the manufacturer takes more than 2,000 units in that period, he will be charged a flat rate of 1½d. per unit throughout. The committee have also agreed to a system of assisted wiring and for the hiring out of motors, which is briefly as follows. The work will be done to the borough electrical engineer's specification by one of several local firms who are approved by the engineer. The consumer will then have the option of either paying rent for the work at 6 per cent. per annum, or can take the same on the hire-purchase system for 12½ per cent. over a period of 12 years. Electric motors can be supplied in the same way, but in this case 8 per cent. will be charged as rent.

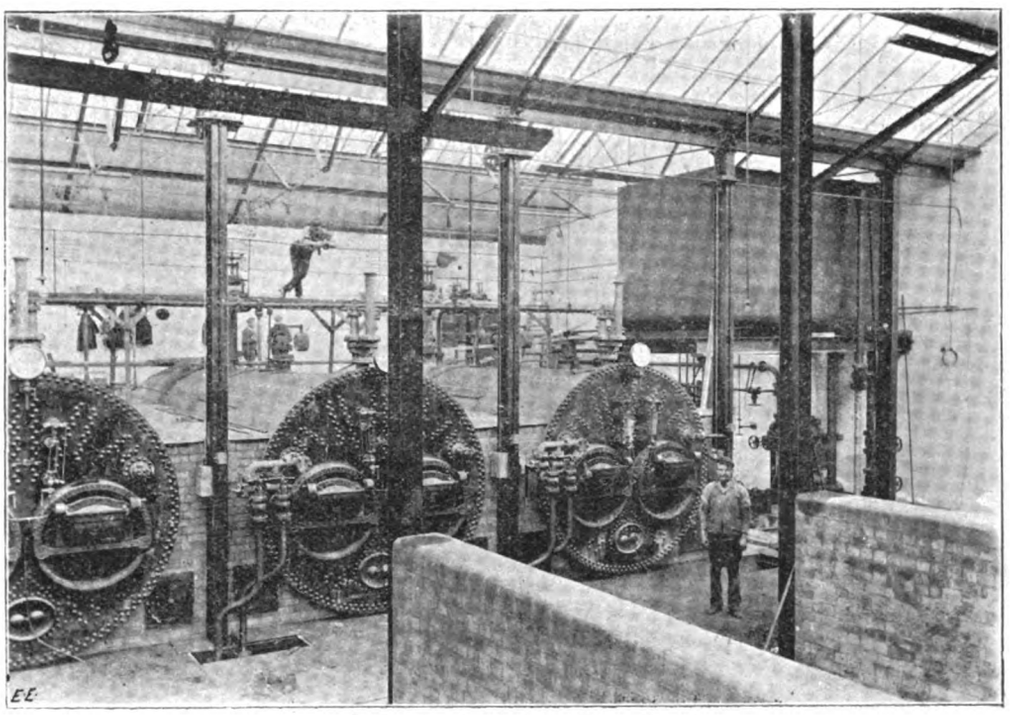

FIG. 3.—Interior of Main Boiler House, Kettering.

The Council have been advised throughout by Messrs. Kennedy and Jenkin as far as the electricity works is concerned, and the surveyor to the Urban District Council, Mr. T. Reader Smith, has been responsible for the design and supervision of the buildings, including that for the refuse destructor, which is to be worked in connection with the electricity supply.

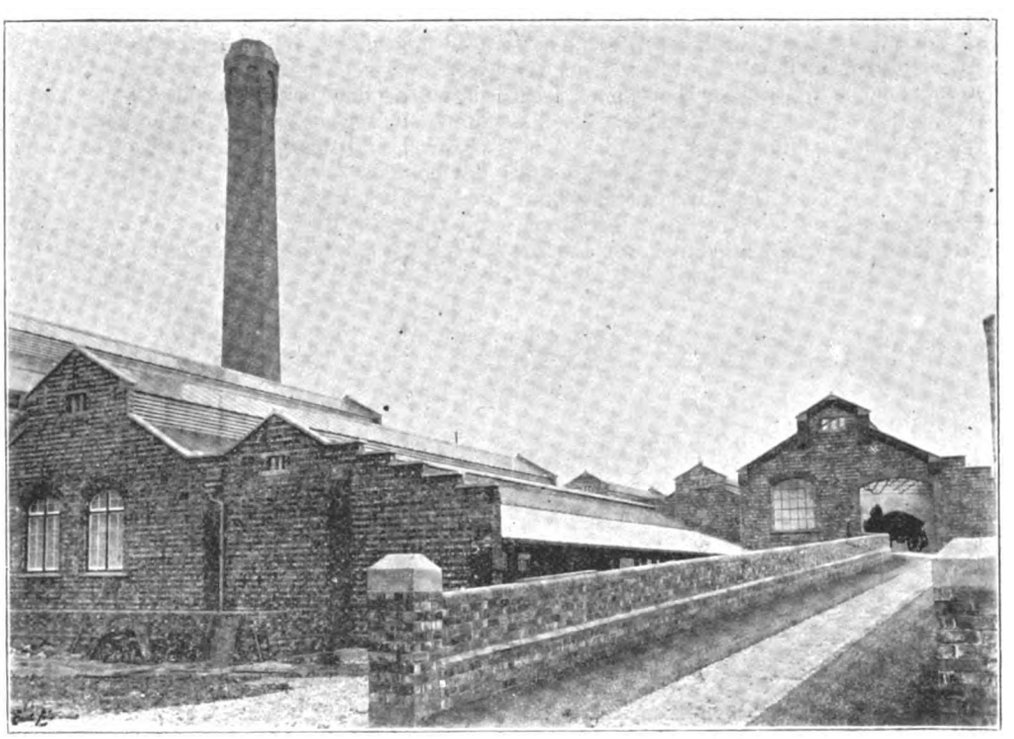

FIG. 4.—Exterior View of Station Buildings, Kettering, showing Coal Approach.

This destructor was supplied by Messrs. Meldrum Bros., of Manchester, and is of their Simplex type, consisting of two cells with divided shafts. It is guaranteed to destroy 17 tons of refuse in 16 hours, though the makers expect it to make a 40 per cent. better performance. A steam jet

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supplies the requisite forced draught. The maximum temperature obtained in the combustion chamber is 2,500deg. F., varying from that amount down to 1,600deg. Before it is allowed to enter the fire, the air necessary for combustion is heated by a Meldrum's patent regenerator to a temperature varying between 300deg. and 400deg. The destructor is hand fired, and owes its efficiency as a heat producer largely to this fact. Objection is sometimes raised on hygienic grounds to the extra handling of the refuse which hand firing entails, but it is a question whether the rapid destruction obtained at a very high temperature does not more than balance matters. There is always a certain amount of dust and fumes from the undestroyed refuse about a destructor, but apart from that we noticed nothing objectionable at Kettering, and the destructor was certainly doing excellent work, generating ample steam in the boiler attached to drive one of the 150-kw. generating sets installed. Indeed, the conditions obtaining in Kettering, where five tons of refuse are equal, roughly, to one ton of coal, are such as to make the destructor boiler a valuable auxiliary, the main purpose being effected at the same time in a thoroughly satisfactory manner. This boiler, it should be mentioned, was supplied by Messrs. Edwin Danks and Co., Limited, Oldbury, as were also the other boilers installed. It is of the Lancashire type, designed for a working pressure of 200lb. per square inch, being 28ft. long by 8ft. diameter. The steam-pipe from this boiler is connected on to the main steam-pipe in the boiler-room through a reducing valve. As the normal working pressure in the station is 160lb, this leaves a margin of 40lb. for steam pressure in the destructor boiler due to the exigencies of firing such a variable combustible as ashbin refuse.

The arrangements in the main boiler-house can be seen in Figs. 1, 2, and 3, while Fig. 4 is a view taken from the coal approach. The coal has to be carted to the station, but it can be tipped from this elevated road into the coal bunkers, so that there is no labour involved in unloading. The three boilers now fixed in this house are of the same type as the above, and of similar dimensions. As already mentioned, they are designed for a working pressure of 160lb. with an ample factor of safety. These boilers are fed by two Weir pumps, which are connected by means of the usual duplicate feed mains. The refuse destructor has an independent Weir feed pump. There are two sets of Green's economisers provided, one being placed in the main flue from the destructor A Kennedy water-meter is used to measure the feed, and the system of feed pipes is such that the feed can be taken either direct from the town mains or from the overhead tank seen in the view (Fig. 3). The water in this tank is heated by means of the exhaust steam from the Weir feed pumps. The pipework connecting the boilers to the engines and also the exhaust pipe from the engines to the centre of the chimney stack were supplied and fixed by Messrs. Babcock and Wilcox. At the time of our private inspection of the station the boilers and steam-pipes were being covered by the Mica Boiler Covering Company with a coating consisting of a mixture of mica and non-conducting cement.

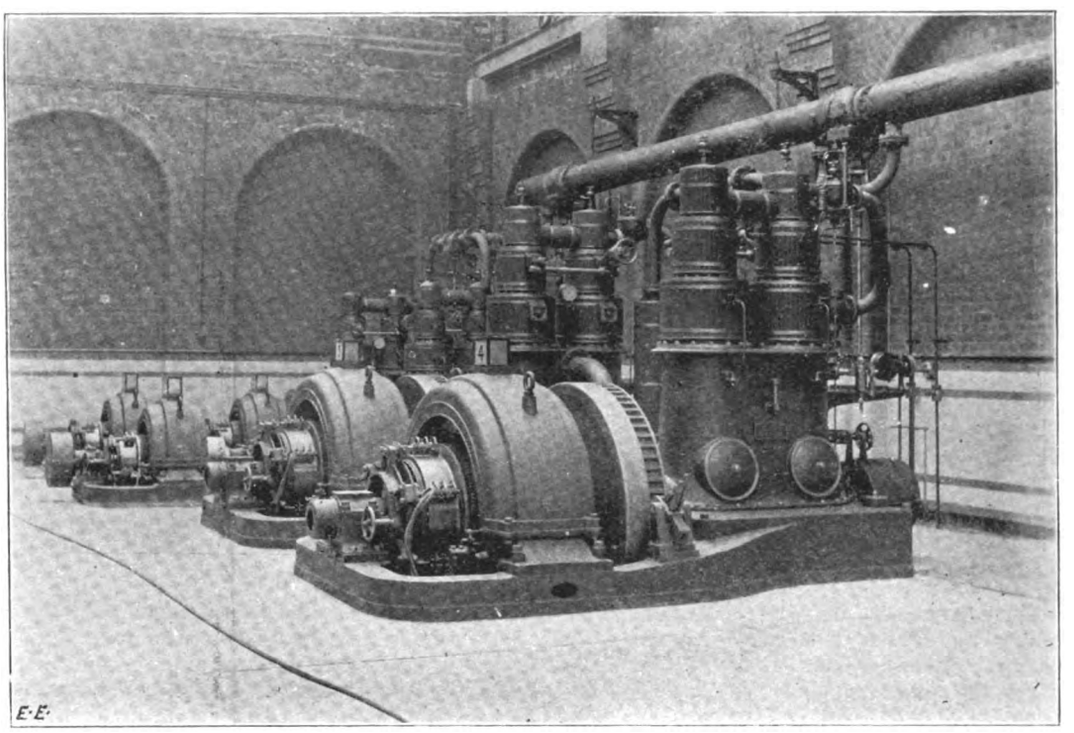


FIG. 5—Engine Room, Kettering.

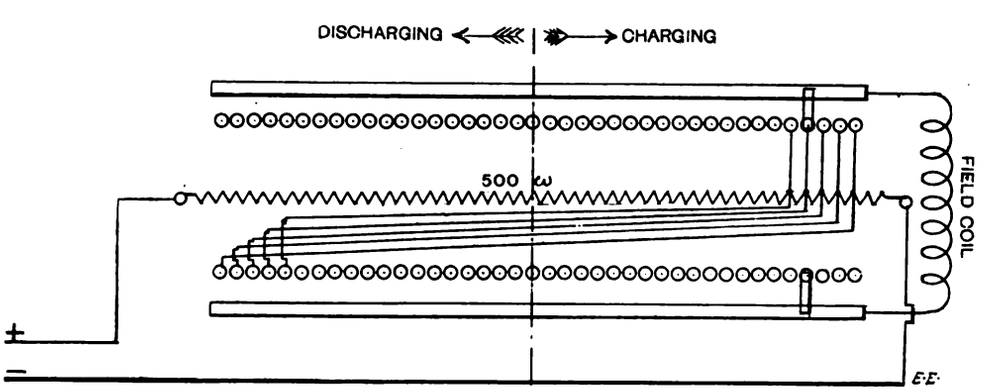


FIG. 6.—Diagram of Booster Regulating and Reversing Switch, Kettering.

The engine-room equipment (Fig. 5) comprises four Willans and Robinson's two-crank engines. The two larger engines are coupled on to two 155-kw. dynamos, supplied by Messrs. Thos. Parker, Limited. These are six-pole

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machines, and shunt-wound. The other two sets are what may be termed steam balancers, as each engine is used to drive two dynamos in tandem. The latter sets are each of 37½ kw. capacity, and are connected on to either side of

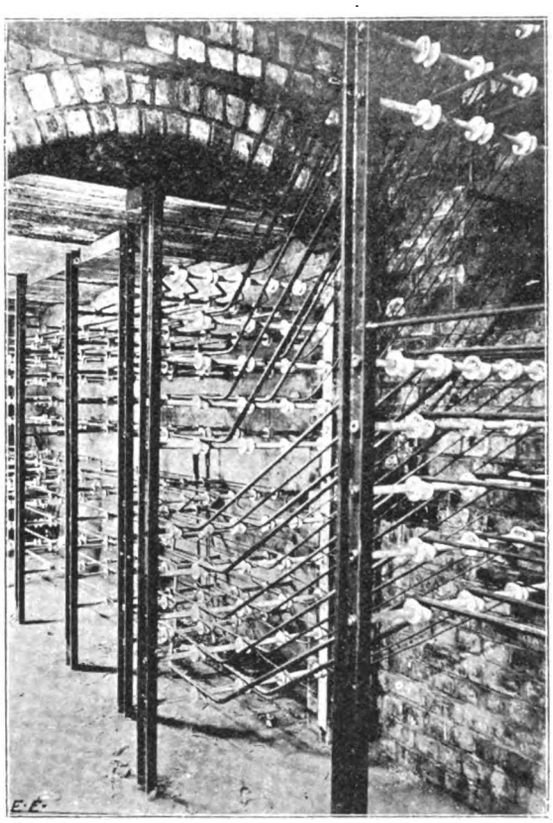

FIG 7. Connections from Machines to Switchboard, Kettering.

the three-wire network. The two dynamos of each set are absolutely interchangeable in every way, and the outer end of the shaft terminates in a half coupling. Thus, if the armature of the dynamo next to the engine should break down, it can be removed and replaced equally by the armature of the other machine. By connecting this machine then on to one side or the other of the three-wire system a certain amount of balancing could still be done.

The accumulators installed are of the Electrical Power Storage Company's make, and have a capacity of 450 ampere hours at a discharge rate of 150 amperes.

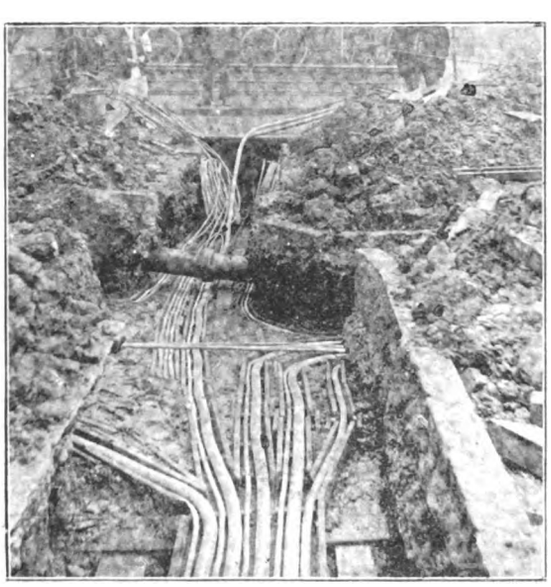

FIG. 9.—Laying Mains, Kettering

There are 240 cells divided into two batteries. These batteries, arranged one for each side of the three-wire system, are always worked as complete units, there being no regulating cells whatever. In order that this may be so, Messrs. Kennedy and Jenkin have installed two reversible motor-boosters. The Lancashire Dynamo and Motor Company are responsible for the supply and design of these. The speed of the sets is 850 revolutions. The motors are connected across the outers of the three-wire system, and the boosters can give 90 volts in either direction when carrying a current of 135 amperes. An interesting feature in regard to their

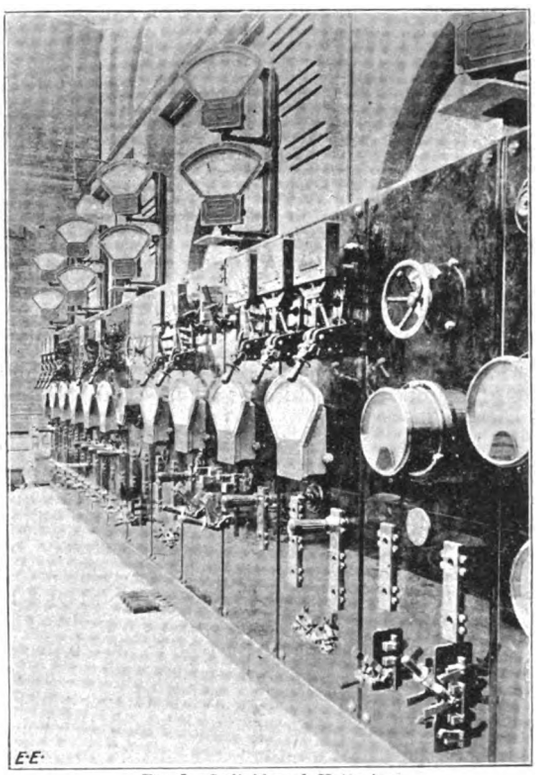

FIG. 8.—Switchboard, Kettering.

connections is the shunt control of the boosters, which is illustrated in Fig. 6. It will be seen from the connections that the polarity of the field of the boosters can be

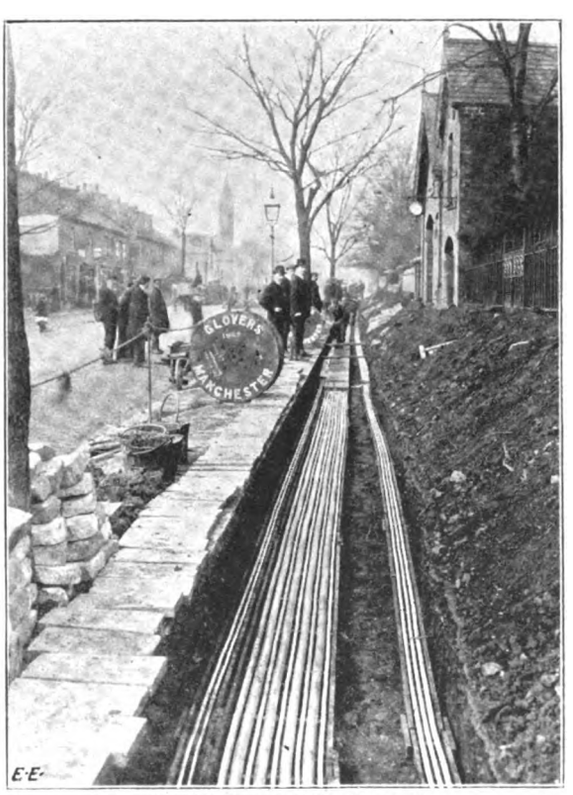


FIG. 10.—Laying Mains, Kettering.

varied gradually to give it full voltage in one direction or full voltage in the other. This field regulator was supplied by Messrs. Cox Walkers, of Darlington, who are the contractors for the switchboard and for the connections from the dynamos, boosters, etc., to the same. These connections have been made in bare copper, erected on insulators

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in the way shown in Fig. 7. An insulated cable is brought through single earthenware tubes from each dynamo into the main conductor run under the station floor. From the ends of these insulated conductors, which are distributed, of course, along the length of the station, all the connections are in bare copper. This entirely prevents the bunching of insulated cables, the coverings of which tend to maintain a fire if once started by an electric arc. It will be seen that the bare copper leads are carried on porcelain insulators, which are threaded on to the horizontal iron rods of the framework. They are bound on to the insulators at the points of support, so as to prevent any sudden displacement in the event of a short-circuit. The system lends itself very readily to extensions.

As regards the switchboard (Fig. 8), this contains 15 panels in all—*i.e.*, two main dynamo, four balancer, two battery, two booster, two motor, one middle wire and earth, and two feeder panels of Messrs. Kennedy and Jenkin's standard design. Special exciter links and switches are provided, enabling any of the machines to be either self-excited or from the bars or batteries.

The cable contract was placed with Messrs. W. T. Glover and Co, Limited, who have supplied and laid the whole of the materials required. This includes four 0·3 concentric feeders, $\frac{1}{3\cdot5}$ square inch single return cable for the middle wire. The distributors have areas respectively of 0·1, 0·06, and 0·01, each being a single cable. The arc mains are $^{7}/_{16}$, and the incandescent mains $^{7}/_{22}$. The whole of these cables are diatrine-insulated, lead-covered. They are laid on the solid system, as can be seen in Figs. 9, 10, and 11. Wood troughing is used filled in with bitumen and covered over all with red tiles. Messrs. W. T. Glover and Co. also supplied the 30 lamp poles for the public arcs. Where the mains enter the station, they are placed in a subway extending some 30ft. underground to the edge of the line owned by the Council. This subway is very convenient for placing the terminal boxes and for connecting up cables on to the switchboard.

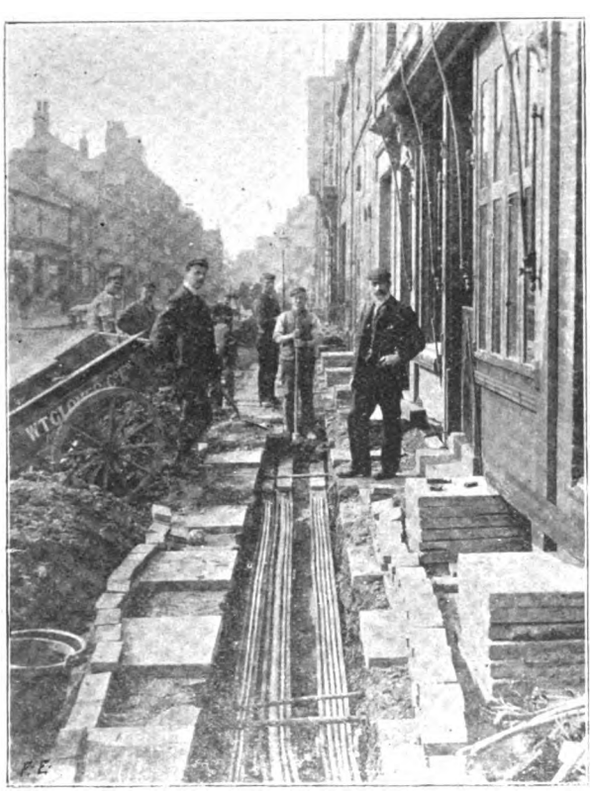

FIG. 1. Laying Mains, Kettering.

As regards the public arc lamps, these were supplied by the Gilbert Arc Lamp Company, Limited, Chingford, Essex. They are of the firm's 6ft carbon type, notable for the economy obtained in working, owing to the long hours of burning. In design they differ slightly from those used on the Thames Embankment, the globes and lamps being smaller and in this instance spherical. No raising gear is provided nor any automatic switches, but the incandescent lamps are carefully arranged with three-way distribution panels and two-way switches in case of a breakdown.

In conclusion, it remains to be added that Mr. F. J. Bakewell, whose portrait we give herewith, has represented Messrs. Kennedy and Jenkin on the spot during the installation of the plant, and has now been appointed resident engineer, a post which his intimate knowledge of the plant renders him peculiarly fitted to hold. We are indebted to Mr. Bakewell for much of the information contained in this article, as also for his courtesy in showing us round the works.

MR. F. J. BAKEWELL, RESIDENT ENGINEER, KETTERING.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 670.)*

### HARMONIC TELEGRAPHY.

*The Johnson-Guyott System.*—Evidently syntony, if perfectly carried out, gives the secrecy which remains up till now a hoped-for future improvement rather than an assured present success. The system referred to above is claimed by the patentees as a satisfactory solution, though the distances traversed have been as yet comparatively small. Its object is to secure immunity from the tapping of messages, and the means of sending messages to one or more of a fleet of vessels, without the others being able to detect or read the messages. One weak point of wireless telegraphy so far has been the want of a perfect method of discriminating between messages when a number are being received at the same time, and ensuring that they shall not interfere so as to confuse the receiver. The point of the patent lies in the employment of combinations of musical notes with electricity (the possible combinations being very great in number), and the patentees claim to have discovered a method or methods of combining these so as to give a system of wireless telegraphy or telephony of a secret kind, and capable at a small cost of meeting commercial requirements. No high poles are required by this system.

The instruments consist of a Ruhmkorff coil transmitter and a receiver (Fig. 32), with a disc on which are mounted the vibrators, consisting of tuning and speaking reeds. By the aid of these the electrical waves are produced and tuned, and messages are transmitted through the earth. The two ends of the receiving instrument are placed in the earth at distances varying according to the size of Ruhmkorff coil used, roughly about 200 times the sparking distance of the coil. This, it will be seen, is a small distance compared with other systems of a similar kind as regards the use of the earth. The armature of the coil consists of a brass reed (Fig. 33), with soft-iron head acting as a vibrator, and just below this—*i.e.*, in the same horizontal plane in Fig. 32—is what is termed the *tuning* reed, identical to the reed in

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the receiving instrument. When the current is passing through the coil the *tuning* reed is caused to vibrate, and *only* when this said tuning reed vibrates does the reed of the receiving instrument respond. By changing the tuning reed, a different receiver may be spoken to. This changing is done as follows. The musical trembler is shown separately in Fig. 33, where E is the speaking reed fitted with a platinum

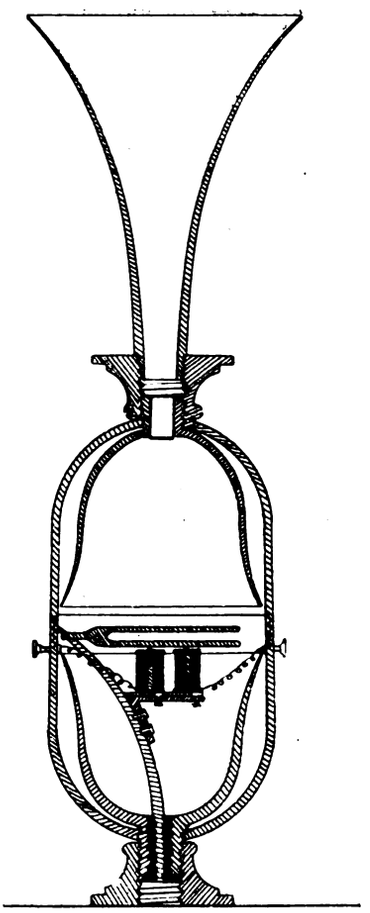

FIG. 32

contact, $E_1$, there being also a tuning reed, $E_2$; the trembler is mounted on an axis attached to a pillar, so that it can be rotated if necessary, and a screw passing through the pillar bears on the contact, $E_1$. The tuning reed of the trembler acts as contact breaker of a Ruhmkorff coil forming part of the transmitting apparatus. The operator at the transmitting station, having ascertained the frequency to be employed, rotates the trembler till the proper tuning and

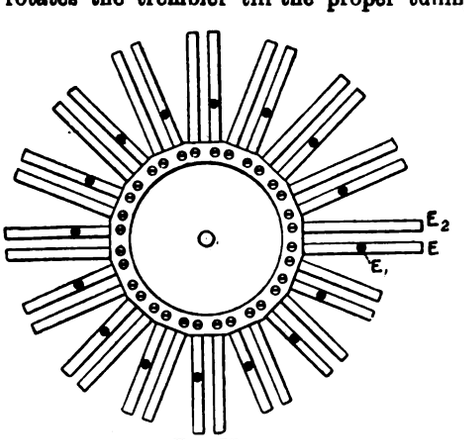


FIG. 33.

speaking reeds ($E_2$ and E, Fig. 33) are in front of the cores of the electromagnet; he then turns the screw before referred to until it bears on the platinum contact, $E_1$, on the speaking reed, closes his circuit, and turns a tuning screw until the tuning reeds vibrates in unison with the speaking reed. This shows him that the electrical impulses are really sent out in unison with the speaking reed. They are received at the other station by a vibrator similar to that shown in Fig. 33. A Morse key and Morse printer or sounder may be employed to give long and short signals in the usual way. When the tuning reed at the transmitting station does not "speak," it shows that the reed at the distant station will not receive the impulses. The ingenious arrangement of keys and circuit with battery for sending the current, and actuating the coil and trembler, need not be further referred to here. No reed or vibrator can possibly make another respond unless the distant one is properly tuned to it, so that messages sent by this means can only be tapped by receivers having a proper vibrator in tune with the sending instrument. Some recent experiments with this system were carried out on the Thames between two launches, but owing, it is said, to a defect in one of the coils, the messages were only conveyed about 700 yards, but it is hoped that before long, with improved coils, the messages may be sent a very much greater distance. The method is, we understand, to be tried by the Admiralty if found successful experimentally. This description should have been given under an earlier heading as regards the use of the earth, but as *tuning* is the important part of the invention it is inserted here.

There is little doubt that systems of this kind will be more heard of in the future, and it seems likely that what has been described contains the germs of successful syntony or selective transmission in wireless work. If the inventors were to use Hertz-wave methods—and the mention in the patent of the transmission of messages through earth, *air*, or water seems to foreshadow this — instead of earth conduction, they would be much more likely, in the writer's opinion, to attain that success in regard to *distance* which they have already achieved in regard to secrecy, or selective working; especially if a telephone the diaphragm of which has the same natural period of vibration as that selected for the transmission of the message were employed in the receiving apparatus.

*Mr. Anders Bull's Selective System.*—Herr Anders Bull, of Christiania, Norway, has invented a selective system which is based upon mechanical principles, and which gives promise of affording a solution of the selective problem in wireless telegraphy. The transmitting and receiving of the signals is done in the usual way by means of induction coil, aerial wires, coherer, etc. Thus, for obtaining the electric connection, this system may be combined with any one of the existing systems based on electric resonance. The distinguishing feature of Herr Bull's system is the manner in which the wave impulses are sent out and received. In the case of other systems the signals are dispatched as rows of impulses, each impulse following another in regular rapid succession; a short row standing for a dot, a long row for a dash. By the system now referred to, however, rows or series of impulses are used, each series consisting of a fixed number of impulses succeeding each other at pre-arranged short (and usually *unequal*) intervals of time.

The transmitting station is provided with an adjustable mechanical arrangement for forming the series. Suppose, for instance, the apparatus is adjusted to send out a certain series consisting, say, of four impulses, the intervals of time between them being one-twentieth, one thirty-fifth, and one fifty-fifth of a second respectively, then it is not possible by this apparatus, without readjustment, to send out impulses except in series of the said form. The apparatus is connected up with a Morse key, which is used in the ordinary way. In sending a dot the key is pressed for a short interval of time, whereby the mechanism is released for a moment and sends out one series of wave impulses. In sending a dash the key is pressed for a longer time, which causes the mechanism to transfer a sequence of uniform series of the kind referred to.

The receiving station is fitted with an apparatus for transforming the series into legible signals. The receiving apparatus acts in the following way: Every wave impulse striking the aerial causes an electromagnet to work a movable mechanism. The apparatus is adjustable, and has to be adjusted to correspond with the series dispatched. When thus adjusted, the mechanism will close a local circuit containing a Morse inker each time a series of the given shape arrives. One series is registered by the Morse inker as a dot, a sequence of series as a row of dots (a dash). Any incident wave impulses having other time intervals than the series for which the receiver is adjusted, will not

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be registered by the Morse inker at all. In this way the inker of a receiving station, A, will merely record dispatches intended for this station. When signalling to another station, B, a differently shaped series is used, and the wave impulses transmitted through the ether in the form of this new series affect only the receiver at B, which has been properly adjusted to receive this series. In like manner, the one transmitting station may, by using a third series of different shape, communicate only with a third station, C, which has been apprised beforehand of the series adopted for its use. As the variety of series which may be employed is very great, many different stations may be communicated with, and without risk of the several stations receiving messages not intended for them.

It is even possible to interchange different signals simultaneously between different stations without mutual interference. The mechanism by which this result is attained is rather complicated, and would require for its full description many drawings. It may, however, be stated, in passing, that the author of the system has used various devices. One way in which he secures the desired result is by having at the transmitting station a *disperser*, consisting of a horizontal disc which can be rotated at constant speed about a vertical axis. To this disc are attached a large number of vertical steel springs, arranged concentrically round the circumference of the disc, their upper ends protruding through radial slits in a second disc mounted above the first. There is a ring and ∩-shaped guide for the upper ends of the springs, so that in a revolution the springs glide either within the *ring* or in the ∩-shaped groove. A portion of the ring is cut away at one place and a bronze piece fitted, which deflects the springs towards an inner electromagnet, the coils of which are constantly excited by a battery. A number of contact pieces arranged at predetermined intervals round the outside of the disc make contact with those steel springs which are within the ∪-groove, but do not touch those within the ring. Another electromagnet, excited when the sending key is depressed, determines the springs which shall be within the ring. Thus, when the key is held down for a very short time, all the springs—which under normal circumstances of non-transmission are within the ring—remain in the ring, except one which is brought within the groove, and makes contact successively with each of the outside contact pieces during a revolution. This contact allows current from a battery to excite the interrupter magnet, the armature of which is attracted, causing current to flow through the sending induction coil, and on subsequent opening of the circuit of the latter, a spark discharge takes place between the secondary terminals of the coil, causing a wave impulse to be sent out through the ether. At the receiving station the wave impulses strike the receiving aerial, lower the resistance of the coherer, causing the relay to become excited. The collector magnet is shunted with the tapper of the coherer (in cases where a coherer requiring tapping is employed), the collector being constructed similarly to the transmitter, a steel spring for every wave impulse being brought into the groove and by contact completing a circuit in which is the Morse inker. The angular distances between the springs brought into the groove are proportional to the time intervals between the impulses, and the contact pieces outside being set for a certain series with given intervals, the arriving impulses will affect the contact pieces simultaneously if at the proper time intervals apart, in which case only is the Morse inker affected and brought into action. Thus, when impulses of the prearranged kind are received, all the springs make contact and a dot, (—), or if the sending key is depressed for a longer period a succession of dots equivalent to a dash, —, is received, and hence a readable message is obtained. A series of any other form will not affect the Morse inker at all. There are various ways of rendering messages unintelligible to an outsider who has set up an ordinary sensitive (non-tuned) receiving apparatus. One way is to send two series of different time intervals, one for the dots and another for the dashes. These are received by properly arranged disc receivers, but, being very much alike, cannot be distinguished if registered by an ordinary receiving device.

Another way is to use a short series and send out, in the spaces between the dots and dashes of the message, a series of such a form as will not affect the receiver telegraphed to. This latter series is used merely as a blind, but completely puzzles the person who receives it on the ordinary apparatus of a receiving station; or one series only may be used, the duration of which is relatively long. In sending a dash the individual series are made to succeed each other at time intervals which are shorter than the duration of a single series. In this way the series overlap each other, and the signals become quite illegible if recorded in the usual way.

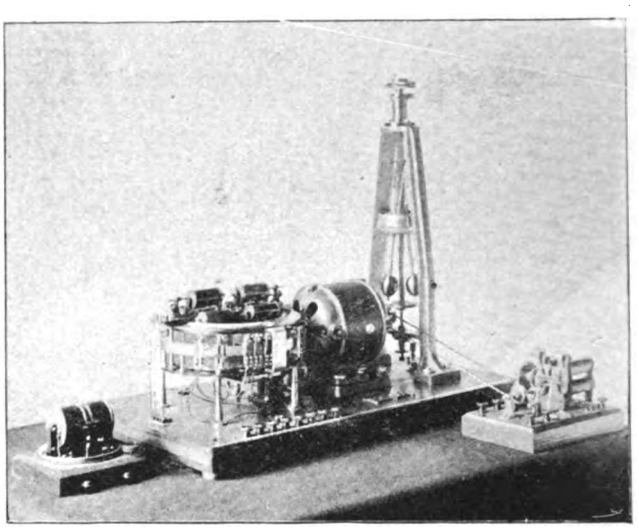

FIG. 34.

It may be pointed out, in conclusion, that it is not at all necessary that the apparatus of the transmitter and receiver shall move synchronously. Fair working is conditioned only by an approximate isochronous speed of the propelling device. The system has lately been tried successfully in the neighbourhood of Frinton-on-Sea and Chelmsford. The more important portions of the apparatus used in those experiments are, by the courtesy of the inventor, depicted in Fig. 34.

The circuit employed successfully, after various alterations, is shown in Fig. 35, taken from illustrations kindly supplied by the inventor, and where quickness of action is secured by having the coherer, C, attached at one end to a T-piece fastened to the armature of the electromagnet, M.

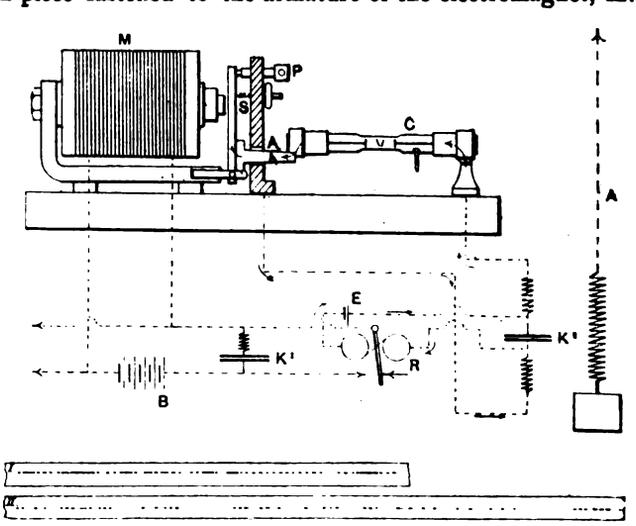


FIG. 35.

This armature is held by the insulated spring, S, against the contact screw, P. Thus the movement of the armature is limited to about 1mm. On the coherer becoming conducting, owing to the incidence of the electric waves from the distant station received through the earthed aerial, A, current from the cell, E, flows as indicated by the arrows, magnetising the relay, R, which closes the secondary circuit, including the stronger battery, B, the collector magnet referred to in the foregoing, and the electromagnet, M. As soon as M is magnetised it attracts the armature, interrupting the relay current, its tongue or switch going

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back to the "off" position almost before the coherer has ceased to vibrate. The coherer is tapped *twice*, first on the armature striking the core of M, and again on the armature coming back into contact with P under the pull of the spring, S. Thus the decoherence is rendered complete, and extra vibrations are to a large extent avoided, moving parts being light. After the proper adjustment of the apparatus—it being found advisable to "earth" the end of the coherer nearest M, so as to prevent the extra capacity of M from having the usual evil effect due to want of symmetry when M is connected to the coherer—messages from Chelmsford were received perfectly at Frinton, the distance being about 35 miles, whilst the ordinary Marconi receiver printed the message as an unintelligible jumble. Tapes I. and II. (lower portion of Fig. 35) are exact reproductions of the message, "Do you (u) get this?" as received and printed by Mr. Bull's apparatus and the ordinary receiver respectively. The reader can easily read the first by referring to the Morse alphabet previously given. The message as printed by the ordinary receiver is unintelligible.

*(To be continued.)*

## EARTH RETURNS FOR HIGH-POTENTIAL CURRENTS.

The *Elektrotechnische Zeitschrift* publishes a notice of a report by the commission appointed by the Société Internationale des Electriciens to investigate the use of the earth as a return conductor for high-potential currents. Two electricity works were placed at the disposal of the commission for the purpose of experiment, one near Lancez and the other at Bergés. The plant available included a direct-current generator of 250 kw. capacity at 600 volts and an alternator yielding current at 110 volts and 42 periods.

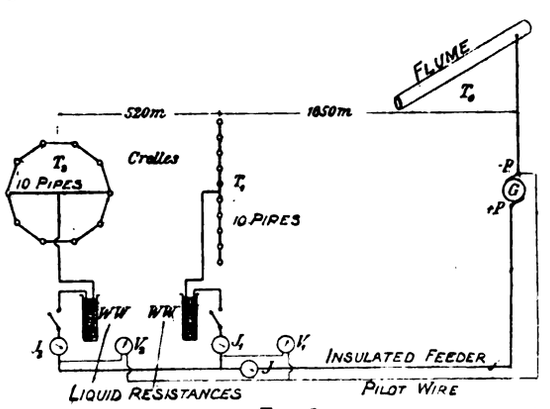


FIG. 1.

The direct-current machine was connected on its positive side through an insulated copper conductor of 8mm. diameter, with a receiver situated in a field at Crolles, distant 1·7 km., the negative pole being similarly connected to a long iron flume conveying water under pressure to the turbines at Lancez, this flume constituting the earth, $T_0$, marked on the accompanying diagram (Fig. 1). The electrodes at the receiving end consisted of cast-iron pipes 2·9m. long, 16·5cm. outer diameter, and 10mm. thick, buried vertically. There were two groups provided, each consisting of 10 such pipes. The pipes comprising one of these groups or earths, $T_2$, were arranged in a circle of 30m. radius, and electrically bonded with each other. The distance separating each pipe from its neighbour on either side was consequently 18·5m. The second group was arranged at a distance of 500m. from the first, as shown at $T_1$, intervals of 10m. being allowed between the pipes in this case. Switches were provided in connection with the latter group by means of which successive pipes could be connected in parallel. Other switches enabled the earths, $T_1$ and $T_2$, to be separately or jointly paralleled with the positive conductor. Between this insulated conductor and each of the earths, $T_1$ and $T_2$, there was provided a variable liquid resistance filled with salt water. The attendants in the generating stations were requested to keep the voltage constant.

For the experiments with alternating current the generators installed at Bergés were used, one pole being connected to earth at $T_0$ (see Fig. 1), and the other to the insulated conductor as before. A pilot wire was laid between the negative pole, – P, and the experimental ground at Crolles. The results of three separate tests with direct current are given in the following table, wherein

J represents the total current delivered by the generator at $T_0$.
$J_1$ represents the current received by the electrode $T_1$.
$J_2$ represents the current received by the electrode $T_2$.
$V_1$ represents the potential between $T_0$ and $T_1$.
$V_2$ represents the potential between $T_0$ and $T_2$.

| — | — | $J_1$ | $J_2$ | J | $V_1$ | $V_2$ | $\frac{V_1}{J}$ | Mean value. |
|---|---|---|---|---|---|---|---|---|
| 1 | $T_0$ and $T_1$ connected ... | 79 | 0 | 79 | 144 | — | 1·825 | 1·817 |
| | | 99 | 0 | 99 | 177 | — | 1·790 | |
| | | 200·5 | 0 | 229·5 | 384 | — | 1·835 | |
| 2 | $T_0$ and $T_2$ connected ... | 0 | 75 | 75 | 171 | — | 2·275 | 2·247 |
| | | 0 | 120 | 120 | 263 | — | 2·195 | |
| | | 0 | 178 | 178 | 404·5 | — | 2·272 | |
| 3 | $T_0$, $T_1$, and $T_2$ connected | 106 | 85 | 191 | 201 | 190·5 | 1·055 | 1·058 |
| | | 166 | 133 | 299 | 316 | 297·5 | 1·062 | |

The mean values determined from these figures represent the resistance of the electrodes, inclusive of that of the feeders.

$$T_0' + T_1 = 1{\cdot}817 \text{ ohms.}$$
$$T_0' + T_2' = 2{\cdot}247 \text{ ohms.}$$
$$T_0' + \frac{T_1 \cdot T_2'}{T_1 + T_2'} = 1{\cdot}058 \text{ ohms.}$$

Hence
$$T_0' = 0{\cdot}106 \text{ ohms.}$$
$$T_1 = 1{\cdot}711 \text{ ,,}$$
$$T_2' = 2{\cdot}141 \text{ ,,}$$

and allowing for the feeders
$$T_0 = 0{\cdot}100 \text{ ohms.}$$
$$T_1 = 1{\cdot}711 \text{ ,,}$$
$$T_2 = 1{\cdot}975 \text{ ,,}$$

The results of connecting $T_0$ and $T_2$ in parallel, as also individual pipes of $T_1$, were likewise observed in order to determine the improvement effected in the conductivity of the electrode combination by the addition of a single pipe. The following values were obtained :

| — | $J_1$. | $V_1$. | W. | $\frac{1}{W}$ |
|---|---|---|---|---|
| $T_0$ parallel with $T_2$ and one pipe of $T_1$ ... | 36 | 415 | 10·75 | 0·092 |
| $T_0$ parallel with two pipes of $T_1$ ..... | 64 | 405 | 5·93 | 0·1685 |
| $T_0$ parallel with three pipes of $T_1$ ..... | 85 | 403 | 4·425 | 0 226 |
| $T_0$ parallel with four pipes of $T_1$ ..... | 97 | 394 | 3·78 | 0·2642 |
| $T_0$ parallel with five pipes of $T_1$ ..... | 109·5 | 386 | 3·242 | 0·3082 |

From the above table, in which W represents the resistance of the earth $T_1$, we gather that the value of the resistance with a single pipe is 10·75 ohms and the conductivity 0·092 mho, but that by the addition of a second or third pipe the conductivity is not quite doubled or trebled, measuring less, in fact, than would be expected. The mean value for the conductivity of the earth through a single pipe based on the resistance with a group of five pipes is $\frac{0{\cdot}3082}{5} = 0{\cdot}061$ mho.

A further series of experiments had for its object the tracing of the distribution of the potential in the ground. For this purpose the potential was measured between the pole – P and a metal rod driven into the ground at different points along the track, O G, O C, and $O_1$ B (see Fig. 2), while a current of about 200 amperes flowed between $T_0$ and $T_1$. The results of these measurements are shown in Fig. 3. The potential differences corresponding to the different distances $O_1$ B are set down as ordinates, B′ B′, B″ B″, etc, while those corresponding to the distances $O_1$ C appear as abscissæ, as likewise the

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ordinates G' G', G'' G'', corresponding to the distances $O_1$ G. It is seen from the course of the curves that along the path $O_1$ C the potential drop at 5m. distance was equal to half the value existing at $O_1$, at 20m. two-thirds, 40m. five-sixths, and 100m. nine-tenths, the remaining one-tenth distributing itself over

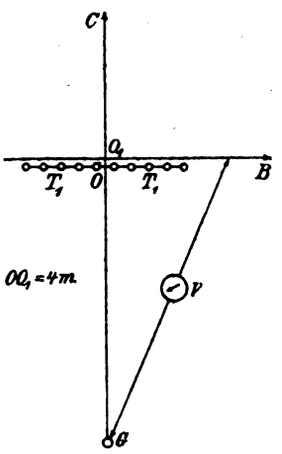


FIG. 2.

900m. beyond this point. The potential drop along the path $O_1$ B is not quite so abrupt. Comparing these results with the estimated values, we find that the hypothesis based upon equipotential spherical surfaces for the distribution of the current in a medium of infinite thickness is apparently more correct than the assumption of cylindrical surfaces as points of equipotential. Experiments were also made with alternating

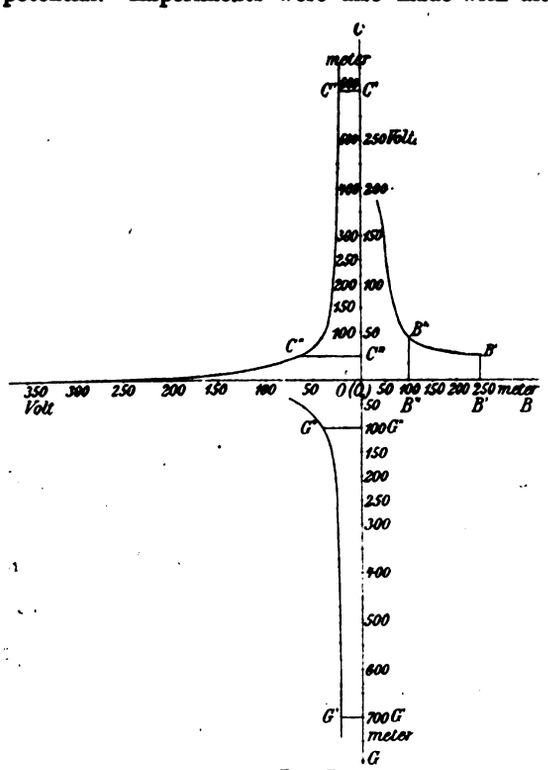


FIG. 3.

current in order to determine the effects on neighbouring circuits carrying weak currents. The results obtained, however, were not conclusive, and further experiments are being made.

## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

*(Continued from page 718.)*

*Actual Experience of Steam-Turbines.*—To anyone with experience of large turbines there can be little or no question about any of these points, but as a great deal of information as to actual experience has not yet been published we may briefly refer to results obtained at Wallsend. We attach curves showing the steam consumption* of a 1,500-kw. to 2,000-kw. turbine which was installed at the end of 1901 (Fig. 2). The tests given were made after the turbine had run about 900 hours. After running 6,000 hours practically the same tests were repeated, and within the limits of observation the same results were obtained. The following table shows the hours of running, oil consumption, etc.:

LOG OF NO. 10 TURBINE INSTALLED AT THE NEPTUNE BANK POWER STATION OF NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY.

| Period. | Hours running. | Hours out of commission. | Remarks. |
|---|---|---|---|
| December, 1901, to August, 1902... | 2,090 | — | Thrust adjusted. |
| August, 1902, to September, 1902 | 471 | 4 | Ditto. |
| September, 1902, to October, 1902 | 516 | 2 | Thrust examined. |
| October, 1902, to November, 1902 | 502 | 12 | Governor overhauled. |
| November, 1902, to August, 1903 | 1,788 | 18 | Relay valve examined, thrust examined, new oil disc fitted. |
| August, 1903, to December, 1903. | 1,596 | 4 | Thrust examined. |
| December, 1903..... ..... | 549 | 12 | Repairs to governor throttle-valve chest. |
| | 7,512 | 52 | |

Total hours run, 7,512; out of commission for inspection and repairs to turbine, 52 hours; oil used, 150 gallons at 3s. 6d. per gallon.

*Reliability of the Steam-Turbine.*—It will be noticed that the 2,000-kw. turbine ran 7,500 hours without ever having been opened up, and only on two occasions have the bearings needed any resetting in order to keep the clearance correct, although they were three times examined and the clearance tested. In fact, the only faults of any kind which it has been necessary to repair have been the relining of one of the governor throttle-valve chests and the renewal of an oil disc.

*Benefit of Steam-Turbines to Power Schemes.*—Steam-turbines seem in every respect to be specially suitable for power scheme purposes, and although they have taken many years to develop, it is probable that had there been a demand 10 years ago for 2,000-kw. generating sets, turbo-alternators would have been the only large size generating units in extensive use at the present day. Their earlier commercial success was prevented by the fact that there was only a demand for small sizes (300 kw. and under), at which sizes any superiority which the turbine even at the present time possesses over reciprocating engines is due to saving of labour and oil rather than to either lower cost or reduced steam consumption. In large units the adoption of turbines materially reduces the capital cost of a power station. This reduction amounts to from 15 to 20 per cent. over the whole station even on present market prices, and it will be much greater when the manufacture of turbines has become as completely standardised as that of reciprocating engines; if the reduction be calculated on the engine and dynamo alone, the percentage is naturally very much greater. The mere fact that this saving is not available in small sizes greatly assists a power company in its competition with private plants, as a private user utilising, as he must, relatively small units does not reap anything like the same advantage as a power company from the adoption of turbines either in first cost or in steam consumption. We are here discussing a station for power supply which involves alternating units, as large continuous-current turbo-generators, due to the troubles of commutation at high speed have a still somewhat limited field.†

* Paper read before the Institution of Electrical Engineers.

* The data are taken from the log-sheets of the Newcastle-upon-Tyne Electric Supply Company, who have operated two 2,000-kw. turbo-alternators at their Neptune Bank power station, and who are now installing a further 10,000 kw. of turbines at their new Carville station. It is thought that the facts stated justify conclusively the installation of the trial turbines three years ago and the orders for new turbines which the company have since placed.

† In cases where it is necessary or desirable to generate continuous current, turbo-alternators plus rotary converters, even when the latter have to be installed in the same building, are frequently justifiable. If it be a question of a 500-volt network for traction or lighting and the radius to be dealt with does not justify one or two sub-stations, rotary converters would be installed in the power-house, and the generators would be of the revolving-field type and wound for 330 volts so as to avoid step-down transformers. Switchgear between generator and rotary would be dispensed with and each rotary and turbo set would be treated as one unit. The result would be: *Capital Cost.*—Rotary plus alternator as against low-tension direct-current generator, an increase in first cost of perhaps £1 per kilowatt, which should be more than saved by the reduced cost of turbines compared with reciprocating engines. The rotary would not, of course, cost as much as the continuous-current dynamo for the same output. *Annual Cost.*—A loss of, say, 5 per cent. in the rotary converter, as against the saving in steam, oil, and repairs, by the use of turbines.

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*Gas-Engines.*—The high thermal efficiency of gas-engines has long rendered their use attractive to power station engineers, more especially in the South of England, where coal is expensive, but although we may eventually look forward to the time when a gas motor fulfilling the requirements of a power station will be obtainable, it can hardly be denied that, for this purpose, the gas-engine has not at present attained the same perfection as the steam-turbine.*

*Superiority of Steam-Turbine over Gas-Engine.*—It is hardly open to question that steam-turbines with a given amount of spare plant give greater security of supply than gas-engines. It is also evident that the use of steam-turbines simplifies the remainder of the power station and generally the system as a whole. Even if we say nothing about the difficulties attending the use of rotary converters of 40 or 50 cycles fed through long lengths of cable with gas-engine-driven plant, we doubt whether a balance-sheet can be drawn so as to come out favourably to the gas-engine at the present moment.† The saving of coal varies, of course, in different localities, but even allowing for slight differences in favour of the gas-engine compared with the steam-turbine in this direction, we would at present for all ordinary power station purposes in this country decide in favour of the steam-turbine. We would draw our balance-sheet as follows:

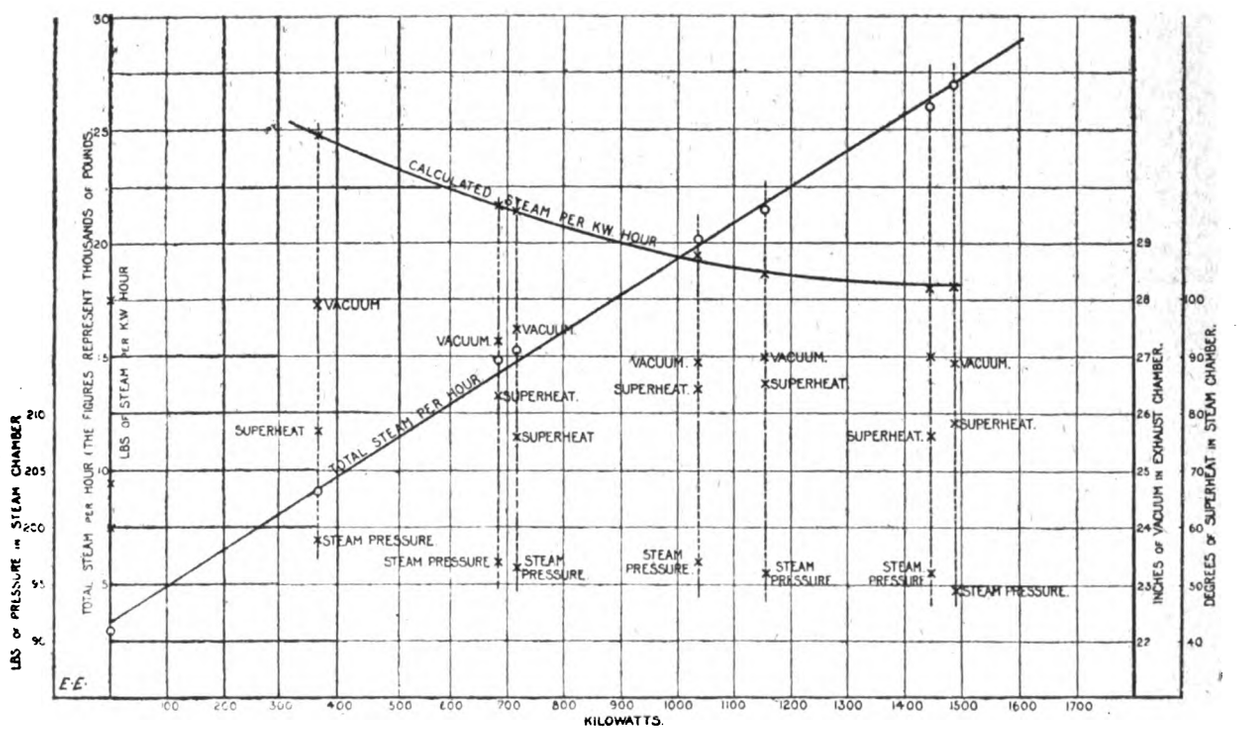
| *Gas-Engines.* | *Turbines.* |
|---|---|
| Low coal bill. | |
| High oil costs. | Low oil costs. |
| High labour costs. | Low labour costs. |
| High repair costs. | Low repair costs. |
| and (most important of all) | and (most important of all) |
| High capital costs. | Low capital costs. |

*Low Capital Costs* are even more important in this connection than in others, as depreciation charges are necessarily higher in gas-engines than in turbines. Of course, such improvements in gas-engines may be made as will result in their superseding steam-turbines, but if the advocates of gas-engines are correct in stating that the present type of gas-engine is being rapidly improved upon, it is the more advisable to instal at first a cheap plant in order to diminish the cost of superseding it when gas-engines approach finality in development.

## 2. General Arrangement.

*Location of Power Station.*—As we are dealing more particularly with a station for power supply, we must necessarily assume that land is reasonably cheap and that the site is of ample area in order to allow for future extensions. It is also desirable in order to permit the transmission cables to radiate in all directions that the site should be located well within the area to be served, and not at its extreme boundary—though this latter consideration may be outweighed by the necessity of choosing the site so as to secure as cheaply as possible the raw material necessary, whether coal, waste gases, water, or stores.

*General Lay-out of Buildings.*—The buildings necessary for a large power station and its operation are: (*a*) main buildings containing the generating machinery; (*b*) switch-house; (*c*) offices; (*d*) stores and repair shops. The above buildings are frequently grouped into one block, and although this may result in some saving, it would seem a mistake if we follow out the principle of sub-division. In the case of a steam station it is necessary, in order to avoid undue losses in steam-pipes, to put the boiler-house adjacent to the engine-house.* The offices, stores, and repair shops, however, should, in the opinion of the authors, always be placed away from the main power station buildings. The advantage of doing this is that they need not be built so substantially, and all fire risks are avoided. Their relative position, however, both to the first instalment of the power station and to extensions requires careful consideration. In deciding upon their location the following points should more especially be borne in mind: (1) ease of extension of the auxiliary buildings themselves; (2) ease of transport of apparatus from the stores to the repair shop, and from both to the main buildings; (3) delivery of goods to stores; (4) position relative to the works main entrance; (5) any outside purpose—*i.e.*, in addition to dealing with the power station—which the auxiliary buildings may be called upon to serve. In commencing the construction of a power station, the auxiliary building, repair shops, stores, and all sidings should be put down before the main buildings are started. This will enable considerable economy to be effected in the cost of constructing the main building. Figs. 3 and 4 show the general arrangement of auxiliary buildings at Neptune Bank and Carville.†


CALCULATED STEAM PER KW HOUR
TOTAL STEAM PER HOUR
VACUUM
SUPERHEAT
STEAM PRESSURE
LBS OF STEAM PER KW HOUR
TOTAL STEAM PER HOUR (THE FIGURES REPRESENT THOUSANDS OF POUNDS)
LBS OF PRESSURE IN STEAM CHAMBER
INCHES OF VACUUM IN EXHAUST CHAMBER.
DEGREES OF SUPERHEAT IN STEAM CHAMBER.
KILOWATTS.
E.E.

STEAM CONSUMPTION TEST—PARSON'S TURBO ALTERNATOR. 1,500 K.W.

Fig. 2.

* Apart altogether from the importance of utilising more efficiently the heat energy in coal, there are large possibilities in utilising gas which is a waste product, or which is obtainable in conjunction with some manufacturing process. These possibilities make it particularly desirable to utilise gas direct in the prime mover without the agency of steam. This paper, however, refers essentially to the design of power stations where coal is the fuel, either in a boiler or in a gas retort. The conclusions drawn under this section must in no sense be taken as implying that in the opinion of the authors gas-engines are impracticable for power stations where waste gas from blast furnaces or other source is available. (See next footnote.)

† It is at present almost essential to use 40 or 50 cycles for power supply in order to deal with alternate-current lighting. If gas-engines were used it would probably pay to utilise asynchronous alternators on the gas-engines, and to have one turbine always running on the circuit to keep the turning moment steady, and generally to control the system. It is the intention to do this in the Blaydon power station which the authors are at present erecting.

* Some engineers prefer to keep the switchgear in an entirely separate building, and there is much to be said in favour of this course, especially if the number of feeders is greatly in excess of the number of generators. A modification of the idea would be to build a separate feeder house. A decision on this point must to a great extent depend upon local conditions, the extent of the system, and the importance which the power station under consideration bears to the system as a whole.

† It will be observed in the case of Carville (*a*) that the offices, stores, and fitting shop are all separated from the main buildings, as is also the North-Eastern Railway sub-station; (*b*) easy communica-

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*Main Buildings, the Complete Unit System.*—With regard to the general lay-out of the main buildings, the modern station is tending towards what may be called the complete unit system.* For a large power station this tendency might with advantage be carried further than is the general practice at present, so that the only junction between the various units will be (1) at the railway siding or other source of coal supply; (2) at the river or other source of circulating water supply; (3) at the main 'bus bars. In fact, a large power station might with advantage be so designed that the boiler-house plant, the steam-piping system, the generating system, and the switchboard, may all be entirely sub-divided into different units. The adoption of very large generating units has increased this tendency in recent power stations, which are now, in many cases, designed more after the lines of what might be termed marine practice—that is to say, each large generating set is provided with its own boilers and auxiliaries, and it is, therefore, under normal conditions entirely separate from the other units.

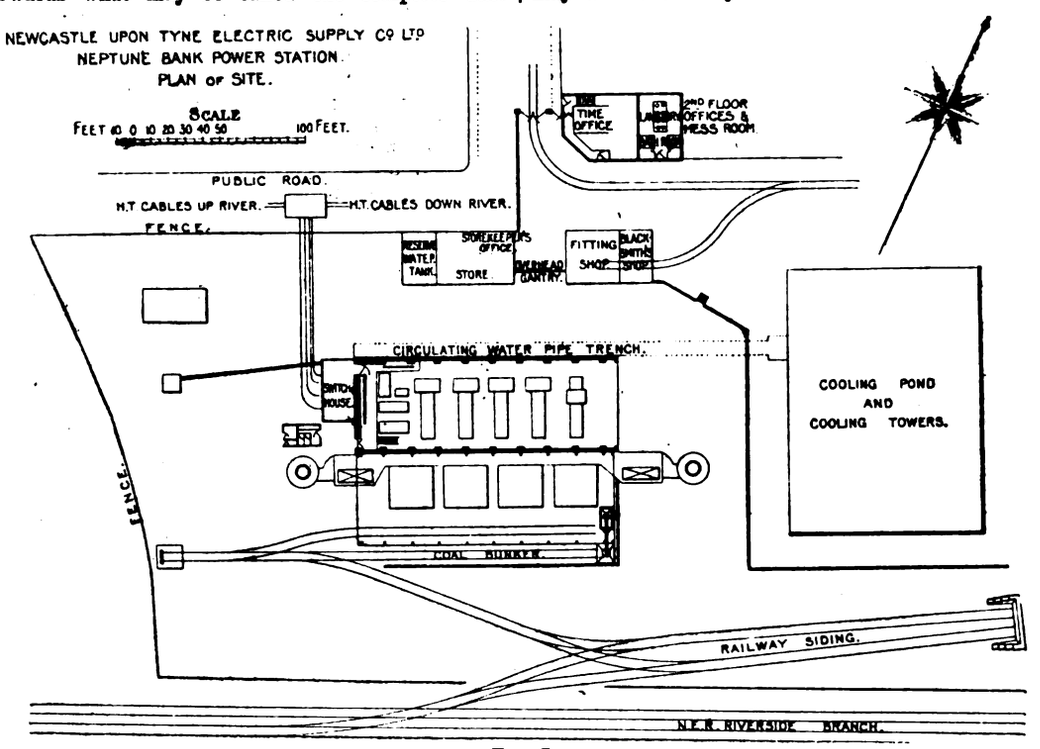


FIG. 3.

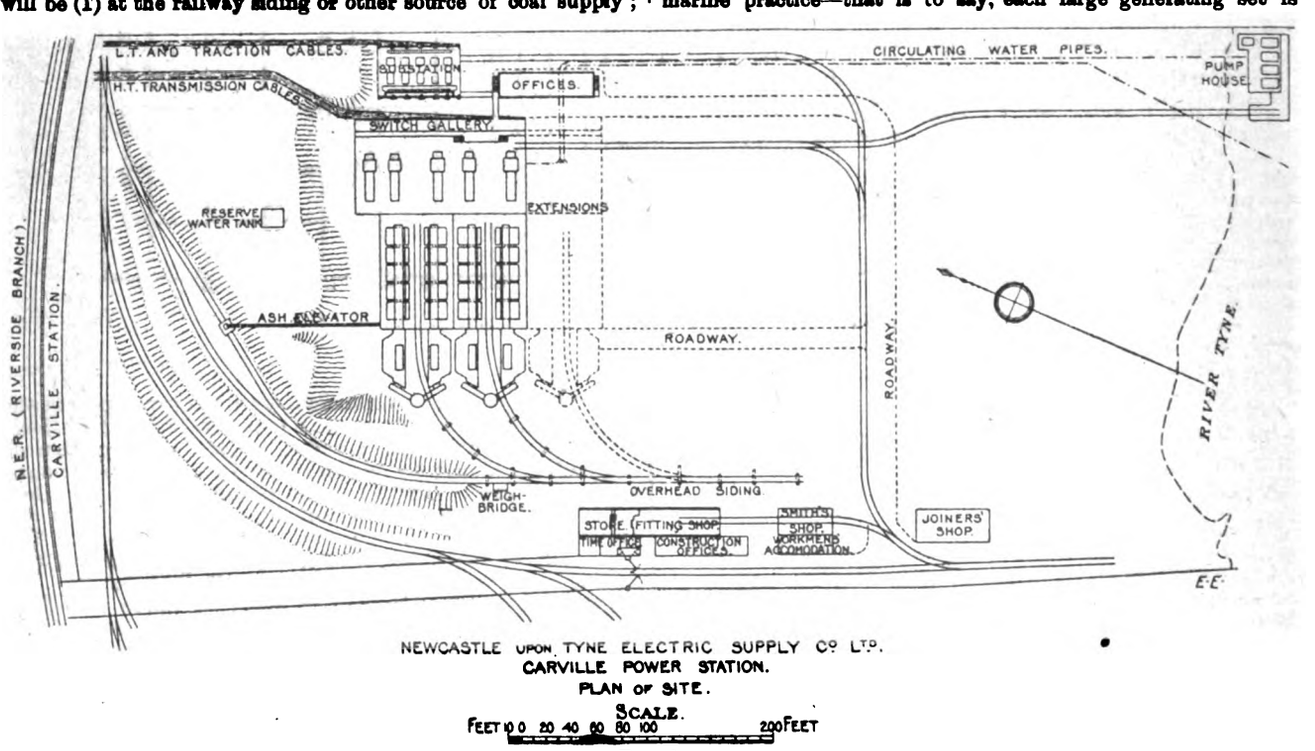


FIG. 4.

*Main Building should consist of a Steel-Framed Structure.*—So far as the nature of the building itself is concerned, this is governed solely by the necessity for keeping down capital expenditure, and it is, practically speaking, in no way affected by questions relating to reliability of supply and low running cost. On this account the structure may be treated merely as a shell to contain effectively, but as cheaply as possible, the generating plant. A steel-framed structure is in every way the most satisfactory, the filling in between the various columns being merely of the nature of a weatherproof screen wall, depending for its stability on the steel framing. This screen can be of brick, concrete, or corrugated iron—the last has the

tion has been provided between the offices, the main switch gallery, and the North-Eastern Railway sub-station by means of an overhead enclosed gangway; (*c*) siding communication is provided between the stores and repair shops and the main buildings; (*d*) an overhead hand traveller connects the stores and repair shops; (*e*) both a railway siding and a road run into the stores; (*f*) stores and construction offices are combined with time office and main entrance to works. It may be mentioned that in this particular case these buildings also act as construction offices and repair shops for the whole of the Newcastle Company's system.

* By a complete unit is not necessarily meant one generating set. A unit may consist of two or more generating sets with boilers and auxiliaries.

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advantage that it can be more easily altered.* The complete buildings will consist of three components: (1) the boiler-house (or gas-generator house) to which the coal is delivered; (2) the engine-room containing engines, generators, and auxiliaries; (3) the switch galleries or separate switch-house, from which the generation of energy is controlled and from which the cables emerge.

*Relative Position of Boilers, Engines, and Switchgear.*—In order that each of these sub-divisions may permit of general systematic extension to meet as far as possible all future engineering developments, the switch galleries must run parallel to the longitudinal axis of the engine-room,† the boiler-house being placed along the side of the engine-house opposite to the switch gallery. In the boiler-house provision will be required for coal and ash-handling plant, and for the storage of a considerable quantity of coal, so that even if a sudden strike should cut off the usual supply, the station staff may have a sufficient coal reserve to allow of them negotiating for a supply from other sources. In order to secure the shortest possible steam-pipe, it is imperative that the boilers should be located directly opposite the engines they normally supply. For similar reasons these engines should be closely adjacent to their condensers, which, in turn, should be almost directly above the circulating water inlet and outlet mains. On the electrical side similar reasons hold, the generator panels should be as close as possible to their respective generators. In short, the whole lay-out should be designed with the idea of avoiding crossings and of obtaining the shortest and most direct run of all connections, whether piping or cables.

*(To be continued.)*

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The following is a synopsis of the continued discussion on Messrs. Merz and MacLellan's paper:

**Mr. B. M. Jenkin** considered the paper particularly useful to consulting engineers, as it appealed to them in the design of central stations from their own point of view. He thought the authors' suggestion as to the possibility of moving the generating station as the system expanded scarcely practicable. He agreed with the idea of dividing the station into units, but would not like to go so far as each generator having its own group of boilers. The arrangement of the boilers at right angles to the engine-room was a good one. It was better to keep the boiler-house complete in itself and independent of the generators. He emphasised the importance of adequate spare plant, and recommended two spare sets. Speaking of switchboards, he was glad to see that the authors gave plenty of room, and he agreed with the principle of their arrangement.

**Mr. E. W. Cowan** agreed with the authors' statement that oil-break switches were now recognised as essential, but was inclined to regret that this should be the case, because they were not an ideal form of switch under all circumstances. He compared the advantages and disadvantages of different types of switches, and considered that an ideal one would be that which gradually reduced the current to zero before opening. In regard to automatic contrivances, he pointed out that the object was really to increase the reliability of service, not to save labour. The transition referred to in the paper in connection with remote control and isolation of switchgear was a move in the right direction. He appealed to engineers to give some encouragement to British manufacturers in regard to high-tension switchgear.

**Mr. A. H. Dykes** compared present-day stations with those of only a few years ago, and pointed out the two radical changes that had occurred—development and increased permanence of switching gear, and the modification of boiler-house arrangement resulting from the introduction of steam-turbines. [Here the President interposed and requested speakers to defer any observations upon turbines till the forthcoming paper on that subject, as time was limited.] He did not think the authors had quite done justice to gas-engines, because the relation between the cost of generating and boiler plant should also be considered. There was a general feeling that gas-engines would increase in importance, but everybody was a little doubtful about them at the moment. He quoted cases from his own experience to show the saving that might be effected with gas-engines by utilising the residual products. He thought everybody would like to know a little more in regard to repair costs. The capital cost of gas-engines and plant had come down considerably during the last few years. He remarked that there would be a certain overload capacity with gas-engines as with steam-engines.

**Mr. W. Geipel** considered the paper very opportune. It was exactly 10 years since Colonel Crompton read his memorable paper on the cost of electric supply, in which he showed that electricity might be generated at the then astonishingly low price of 3d. per unit. The principal points in that paper were the effect of capital charges and the coal bill. The present authors said that the capital and operating charges were not so much considered in the earlier days. It had always been a difficulty to reduce capital cost so as to compete with cheap gas in this country. On the Continent and in the United States the trouble was less, because of the higher cost of gas. To show that the authors were erroneous in saying that earlier engineers had neglected the question of capital cost, he read an extract from the views expressed by Prof. Kennedy and others some years ago. Mr. Geipel reverted to some figures he gave on a previous discussion, which figures were designed to show that, with an ordinary lighting load factor, the cost per unit might come down to 2d., including distribution expenses, whereas the authors' estimate was apparently exclusive of this. He thought that perhaps a more interesting way of showing the effect of capital charges than drawing curves for varying load factors and for price per kilowatt would be to include the two, and treat capital cost as so much per unit on output. To cover charges for improvements to plant, he thought 10 per cent. a much fairer figure than 15 per cent. He agreed with what the authors said as to securing the shortest possible steam-piping, but he noticed that in the Carville plant the boilers were so arranged that the pipes were about as long as they could possibly be. If the boilers, engines, and auxiliaries had been divided into sections, as the authors advocated, he thought they would have been able to arrange much shorter steam-pipes. He agreed generally with the authors' reasons for using electrically-driven auxiliaries, and suggested a time fuse for breaking the smaller excess currents, and also a circuit breaker with an extra excess which would act instantaneously. In conclusion, he deprecated the indiscriminate use of the term "unit," and suggested that it be restricted to the kilowatt-hour.

**Mr. L. Andrews** explained that seven years ago experiments had been made with the reverse-current circuit breaker referred to by the authors, but had been abandoned owing to the difficulty with alternating currents. He had endeavoured to obviate this, and had designed a cut-out that would allow of a 75 per cent. pressure, which was about as low as was likely to occur with an alternating current.

**Colonel Crompton** referred to his prophecy, which had been recalled by Mr. Geipel, and observed that when he made his calculations he had to allow for such impositions as heavy municipal taxes. The low load was the factor which had to be eliminated in securing cheap supply. Once the coal bill and labour bill for firing the boilers and working the plant became an important factor, the whole question of generating energy entered upon a new phase. He thought that credit had scarcely been given to the earlier engineers for the possibilities they had developed in the way of design, which were really the basis of present attainments. He mentioned that he had recently installed a mixed plant at Calcutta, and found that internal-combustion engines were cheaper for stations up to 1,000 h.p., but he had not yet had any experience as to repairs. Every advantage of turbines could be applied to gas-engines. He did not think, however, that steam would be superseded, and paid a tribute to Mr. Parsons for his great work in regard to turbines. He hoped to read a paper on the method of utilising the cheapest class of fuel in boilers.

**Mr. W. H. Booth** would like the authors to explain their statement that "a power station has a comparatively low efficiency, not more than 10 per cent." He distinguished between power stations for lighting and traction, as the load factor in the former did not exceed 12 per cent., while the running factor might be 100 per cent. The authors seemed to doubt the value of automatic stokers, but these, he pointed out, had more than one function. Boilers, especially those of the Lancashire type, could be run at a much more uniform temperature with automatic stokers, thus tending to preservation. Gas-engines would put steam-engines out of court unless the latter were provided with all necessary accessories.

**Mr. E. K. Scott** agreed that office buildings and stores should be kept separate. Non-inflammability was a great point to aim at. The steam and electrical apparatus should be kept on separate floors, and there should be two stairways.

**Mr. J. J. Steinitz** observed that if the importance of keeping down capital cost was fully understood 10 years ago, as stated by Colonel Crompton, it had apparently been forgotten after a lapse of five years. He had found very few cases in which station plant and buildings cost £40 per kilowatt. Where it had, it was due to the arrangement of the auxiliary plant. The authors laid down a hard-and-fast rule that there should be no basement, but he found that a basement formed itself naturally.

**Mr. W. L. Madgen** acknowledged that Mr. Geipel, Prof. Kennedy, and others had undoubtedly drawn attention some years ago to the importance of keeping down capital costs, but Mr. Geipel did not, perhaps, remember what had occurred during the interval. Many municipalities had put up stations which had not been designed for economy. One comparison he had seldom seen made was that in certain public services, including electric supply, the capital was not turned over annually. Taking an average of the representative supply stations, the ratio of gross revenue to capital expenditure amounted to something like 12½ per cent., representing a turnover of capital once in eight years. This 12½ per cent. had to meet interest, sinking fund charges, and dividends. One important aspect of the capital question was, not what could be achieved by a single generating station, but what could be effected by diminishing the number of stations in a given area.

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**Milan Exhibition**.—As the completion of the Simplon tunnel is not likely to occur in 1905, it has been decided to postpone the exhibition until 1906, which will allow time for the better preparation of exhibits. The administration earnestly request the co-operation of tramway and light railway authorities on the subject of the organisation of transport business and the staffs connected therewith.

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* This feature—namely, that it should be possible with the minimum of expense to take advantage of radical improvements—is also worthy of consideration in connection with the site chosen.

† This is advisable whether they are in a separate building or not. One serious objection to the placing of the switchboard at the end of the building is the concentration of leads running to the board, the practical impossibility of avoiding crossings of cables, and the fact that the width of the building limits the possible extension of the switchgear.

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THE

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### TO CORRESPONDENTS.

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*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## ELECTRIC AUTOMOBILES.

The last five or six years have unquestionably been remarkable for the rapid increase in the use of automobiles, and while to many it is only the numbers to be seen that call for comment, it is the extension of their sphere of usefulness that is not the least surprising feature of this development. During this short period vehicles of all sorts have been propelled in various ways by means of the three leading methods now generally adopted—steam, oil, and electricity—and it is well worth while considering what has been the result of valuable tests resulting from extended use under regular service conditions. For some time steam and oil propelled carriages were in use in about equal numbers, and the lighter electrically-driven type was not long in appearing. The continued use of these types of cars resulted in recognition of the fact that larger vehicles travelling at higher speeds could be employed satisfactorily, and it is in connection with this branch of the industry that the use of steam and electricity has been found less desirable. Weight has proved to be an all-important factor in design, and for the larger, and it might truthfully be said for all high-speed passenger carriages, imposes limits which exclude the use at present of any other form of motor than the oil-engine.

The type of electric vehicle which has met with some degree of success is the brougham or landaulet for town service, and in London alone there are a very considerable number in constant service. Their behaviour on the road has been reliable, and while the conditions of running are not severe and the low speeds permit the use of accumulators—which after ingenious weight paring are still undeniably heavy—their continued use is a welcome hint that for this purpose at all events they can hold their ground, and in the course of use and years pass through changes which are not merely changes but improvements also. It must, however, be remembered that a large proportion of these electric broughams receive very careful treatment. The cells in particular are kept in good condition, and electrical engineers know that they require, and benefit largely from the little, done when it is wanted. It must not be inferred from this that these electric carriages receive unnecessary care, or what might be called "nursing," for this would be incorrect. Mr. W. Worby Beaumont—a recognised authority on the subject—made some remarks appertaining to the care and attention of public service vehicles in a series of lectures delivered before the Society of Arts just a year ago, which are as applicable now to electric vehicles as at the time they were made. Briefly, he said that until public service or constant service automobiles received just the same constant care that railway locomotives receive, they would be a failure. Turning from the subject of high and low speed passenger cars to what will ultimately prove of greater importance—namely, commercial vehicles—it is interesting to note that at present steam wagons and lorries preponderate, and those who were present at the May Day parade of motor trade vehicles, held annually under the auspices of the Automobile Club of Great Britain and Ireland, may have noticed that not more than 3 per cent. of those present were electrically driven. It is worth observing that one vehicle among this small percentage was a prize winner, and this is suggestive because the prizes were offered for vehicles found to be in the best condition, taking into account their age and mileage. The winning car was a Fischer petrol electric van, owned by Messrs. Hampton and Sons. It has run many thousand miles and continues in service, and it may, therefore, be surmised that it has proved itself to be a serviceable vehicle. The combination of petrol motor, dynamo, accumulator, and motor or motors

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must mean the carrying of a large proportion of non-paying weight, but as the permissible and practicable weights are greater, there should be greater scope for those constructors already concerned with the design of electric goods lorries and trucks.

At present the accumulator-equipped type has received most encouragement, but the Fischer system so greatly extends the distances that may be travelled without necessary stops that it will in time assert itself, particularly as it shares the improvements and advances made in the petrol motor branch of the industry. There is, therefore, ground for belief that now that the tare weight limits enforced by the Motor Car Act and Local Government Board regulations are less stringent, that greater activity in the manufacture and use of electric goods vans will follow. The North-Eastern Railway Company, who are showing great foresight in equipping some of their lines electrically, have recently put into service a petrol electric motorcar for branch-line purposes, and the results of the use of this form of railway vehicle will be watched with interest. It would appear to meet the requirements of a busy suburban line well, for if the speed is not high the service could be ideally continuous, and some of the difficult traffic problems might be solved.

Mention has been made of the assistance which the electrical engineer has received from the motor car engineer in matters relating to car construction and mechanical details, but attention should be directed to the almost universal use of electric ignition devices for motor car purposes involving the use of accumulators, transformers, circuit interrupters of various forms, and, to a less extent, light dynamo machinery for the same purpose, used either in conjunction with accumulators or independently in magneto form. Enough has been said to show that there is activity and some real development in electrical automobile matters, and were this not an age of mechanical miracles, with too many mechanical people hardened to them, some satisfaction might be experienced.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### CAN ACCUMULATORS BE CHARGING AND DISCHARGING SIMULTANEOUSLY?

SIR,—According to at least two of the leading "trade catalogues" they can, but according to circumstances over which we have no control, they can't.

Am I right, or is it a fib? Let any doubting Thomas consider the following: seeing that charging and discharging accumulators (if it were possible) evolves the crossing of currents, and this is incompatible with the underlying principle of the long-established Wheatstone bridge.

It thus appears that before accumulators can be *simultaneously* charged and discharged, the Wheatstone bridge must be disestablished. Who is right?—Yours, etc.,

J. ISAACS.

11, Highfield-terrace, Somerby-road, Grantham.

## THE NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION'S ANNUAL DINNER.

The first annual dinner of the National Electrical Manufacturers' Association came off most successfully at the Hotel Cecil on Wednesday under the presidency of Mr. Walter Davenport. The following firms were represented: Armorduct Manufacturing Company, Limited; Berliner Telephone Manufacturing Company; Berry, Skinner, and Co.; D. H. Bonnella and Son, Limited; Consolidated Electrical Company, Limited, Northampton-grove, Canonbury, London, N.; Croggon and Co., Limited, 16, Upper Thames-street, London, E.C.; Davies, Kent, and Stewart, 17, Berners-street, Oxford-street, London, W.; Edison and Swan United Electric Light Company, Limited; Electric and General Stores Company; Electric and Ordnance Accessories Company, Limited; Electrical Fittings Company, 36, Conduit-street, Regent-street, London, S.W.; Electrical Power Storage Company, Limited, 4, Great Winchester-street, London, E.C.; Escarde and Denelle, Limited; Fuller, McLeod, and Co., Limited; General Electric Company, Limited; Hart Accumulator Company, Limited; Improved Electric Glow Lamp Company, Limited; International Electric Company, 55, Red Cross-street, London, E.C.; Johnson and Phillips, Old Charlton, Kent; Jas. Littauer; A. P. Lundberg; Monté-Callow and Co.; Nalder Bros. and Thompson, Limited; Ernest Roberts; St. Helens Cable Company; Simplex Steel Conduit Company; Sunbeam Lamp Company, Limited, Gateshead-on-Tyne; Sun Electrical Company, Limited, 118, Charing Cross-road, London, W.C.; Torque Electrical Engineering Company; Union Cable Company, Limited; Union Electric Company, Limited; Verity's, Limited; B. Johnstone and Co., Limited.

Amongst the guests we noted the following members of the joint committee: W. R. Rawlings (president, National Electrical Contractors' Association), A. Rashleigh Phipps, and T. McDermott.

The toast-list was a short one, and the speeches were, on the whole, of commendable brevity. After the loyal toasts had been duly honoured, the members settled themselves down to enjoy a quiet smoke and an excellent programme of music under the direction of Mr. Alfred Hays. Contributions by the following artistes were heartily appreciated: Miss Ruby Wilson, Miss Agnes Tandy, Mr. Herbert Emlyn, Mr. Randell Jackson, and Mr. J. M. Campbell. Mr. Mansell Stevens presided at the piano.

The "Imperial Forces" were proposed by Mr. F. H. Nalder and responded to by Lieutenant E. J. Hogan, while the toast of the evening, "Success to the Association," was taken care of by the Chairman, who had every reason to congratulate the association on its rapid success during the short time of its existence. He said they numbered now 64, the last balance-sheet showed a substantial balance, and £100 had been invested in consols since Jan. 1. He dwelt upon the excellent relations which existed between this and the National Contractors' Association, the smooth working of the joint committee, and expressed his belief that these friendly relations would lead to arrangements beneficial to members of both institutions, as a strong desire was shown to solve in a friendly manner all and any sort of difficulty which might arise. In a brief reply, Mr. C. S. Northcote sketched out a plan for the formation of sub-sections and the combinations of the various branches by affiliation. Their badge—a magnet—had proved very attractive.

The other toasts were: "The Electrical Profession and Industry," proposed by Mr. H. Hirst, responded to by Mr. W. M. Madden; "Guests and Visitors," proposed by Mr. G. Verity, responded to by Mr. W. R. Rawlings; "The Chairman," proposed by Mr. David Smith, responded to by the Chairman.

Mr. Northcote and Mr. Nalder, after a few words of introduction by the former, then presented the chairman (who is also, needless to remind our readers, the indefatigable secretary of the association), on behalf of the members, with a very handsome silver salver and tea and coffee service suitably inscribed, as a token of their esteem and in appreciation of his valuable services. Mr. Davenport feelingly acknowledged the gift, and "Auld Lang Syne" concluded the meeting.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on May 5 the following were the candidates balloted for:

*Members.*—H. Fox, 9, The Avenue, Lidgett Park, Roundhay, Leeds; M. MacLaren, British Westinghouse Company, Trafford Park, Manchester; H. S. Meyer, British Thomson-Houston Company, Rugby; W. Summerscales, White Gate House, Bramley, Leeds.

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*Associate Members.*—R. L. Acland, Corporation Electricity Works, Chesterfield; J. W. Beauchamp, Byron Cottage, Nether Edge, Sheffield; H. Bell, Corporation Electricity Works, Soulcoates-lane, Hull; J. H. Bowden, River Lodge, River-terrace, East Greenwich; A. G. Engholm, Great Western Hotel, Birmingham; C. C. Metcalfe, Municipal School of Technology, Manchester; E. S. Reid, 1, Oxford-court, Cannon-street, E.C.

*Associates.*—W. E. Cooke, 22, Derry-terrace, Buitenkant-street, Cape Town; W. Kirkham, 436, Liverpool-street West, Seedley, Manchester; Dr. W. Martin, West Villa, Akenside-terrace, Newcastle-on-Tyne; A. M. J. Ogilvie, General Post Office, E.C.; A. J. Smith, Parkstone, Morland-road, Croydon; W. G. Smith, A.R.C.Sc.I., 22, Hamlet-road, Chelmsford.

*Students.*—E. W. Adams, 81, Duke-street, Lower Broughton, Manchester; J. C. Aston, Campion House, Swinton Park, Pendleton; W. Barrs, 24, Cooke-street, Old Trafford, Manchester; J. L. Bowers, 169, Hamilton-road, Longsight, Manchester; A. W. Brown, Elleralie, Oswald-road, Chorlton-cum-Hardy; L. G. Cooper, Beckfoot, Birch Hall-lane, Longsight, Manchester; H. S. Dransfield, 4, Stanley-grove, Sale, Cheshire; H. Fasnacht, The Hollies, Clayton Bridge, Manchester; W. Fazackerley, 9, North-road, Longsight, Manchester; G. N. S. Fitton, Lilacs, Elms-road, Heaton Moor; J. B. Foote, 4, Nansen-street, Gorse Hill, Stretford; J. A. Forrest, 127, Queen's-road, Cheetham, Manchester; C. J. Fox, 125, Northenden-road, Sale; H. F. Gallaway, Farleigh, Bramhall, Cheshire; W. H. Gatley, 28, Pemberton-street, Brooks Bar, Manchester; W. Gillespie, 11, The Crescent, Salford, Manchester; G. E. Gledstone, 16, Birch-grove, Levenshulme, Manchester; D. Gray, St. John's Lodge, Blackburn; H. R. Greenyer, 19, Henrietta-street, Old Trafford, Manchester; J. Gregory, Hill Side, Romiley, Cheshire; W. Guildford, Owens College, Manchester; N. E. Hall, 7, Carlton-avenue, Old Trafford; C. Hargreaves, 201, Trafford-park, Manchester; E. C. Haccius, 33, Shrewsbury-street, Old Trafford, Manchester; J. R. Halliwell, 9, Princess-road, Crumpsall, Manchester; E. Hamer, 14, Barlow-street, Oldham; W. Hanna, 168, Albemarle-street, Ashton-under-Lyne; G. Harlow, Princess-street, Knutsford; H. M. Harrison, 278, Brookland-terrace, Worsley-road, Swinton, Manchester; N. Hart, Dalton Hall, Victoria Park, Manchester; W. Hartley, 32, Stockport-road, Ardwick, Manchester; A. Hawes, 27, Exeter-street, Ardwick, Manchester; F. Heapy, 67, Peel-street, Macclesfield; E. P. Hill, 2, Elm-mount, Helsby, Warrington; J. N. Hindle, Albion Lodge, Hollingworth, near Manchester; E. J. Hitzen, 97, Burlington-street, Greenheys, Manchester; R. Hodge, 105, Cheetham Hill-road, Manchester; H. Hoggart, 26, Barlow Moor-road, Chorlton-cum-Hardy; W. Holmes, 239, Stockport-road, Ashton-under-Lyne; A. O. Holt, 11, Hawthorn-grove, Heaton Moor, near Stockport; G. D. L. Horsburgh, 14, Bradshaw-street, Moss Side, Manchester; H. Howarth, 325, Stockport-road, Longsight, Manchester; T. I. Illingworth, 371, Chester-road, Manchester; C. W. Jackson, 8, Byron-street, Todmorden; A. E. Jepson, 8, Bristol-street, Manchester; A. M. Johnson, 2, Railway-road, Urmston, near Manchester; H. Jones, 76, Stanley-grove, Longsight; J. W. Jones, 14, Ducie-grove, Chorlton-on-Medlock, Manchester; P. C. Jones, 42, Harriet-street, Stretford, Manchester; H. Kay, Pennine House, Mossley-road, Ashton under-Lyne; R. K. Keer, 147, Portland-street, Southport; R. Kendall, 292, Oldham-road, Newton Heath, Manchester; R. S. R. Kneale, 517, Stretford-road, Manchester; W. H. Lee, Arncliffe, Crumpsall, Manchester; A. C. T. Lemon, Ivy Cottage, Taylor's-road, Stretford; R. C. Leslie, Faraday House, Charing Cross-road, W.C.; R. C. M. Lewis, 34, Moreton-avenue, Stretford, Manchester: J. L. Lovell, 5, Cross-street, Manchester; H. Mackay, 15, Edna-street, Crumpsall, Manchester; E. J. McWilliams, 95, Wingrove-avenue, Newcastle-on-Tyne; H. V. Mahler, Claremont, Beaufort-avenue, Brooklands, Cheshire; J. W. Maitland, 2, Alfred-street, Bury, Lancashire; V. Mellalieu, Brownhill, Dobcross, near Oldham; H. Marshall, 24, Royds-street, Rochdale; R. C. Mather, Wrenwood, Prestwich, Manchester; P. T. Maybury, 48, Manley-road, Whalley Range, Manchester; C. J. Melbourne, 33, Meadow-street, Moss Side, Manchester; J. Mercer, Halebank, Widnes, Lancashire; F. Moore, 3, The Crescent, Northwich, Cheshire; C. E. Moorhouse, 11, Stockton-street, Moss Side, Manchester; G. Morris, 41, Wellington-road, Heaton Chapel; F. Morton, 6, Richmond-road, Chorlton-cum-Hardy; E. G. L. Mosley, 32, Carter-terrace, Greenheys, Manchester; G. Moss, Rock Bank, 94, Monton-road, Eccles; G. I. Murray, Broad Oak Park, Worsley; T. Nadin, 48, Brook-street, Chorlton-on-Medlock, Manchester; J. E. Noake, Higher Wood-street, Middleton, Lancashire; A. L. Ohlson, Cedarcroft, The Chase, Clapham, S.W.; W. O'Keefe, The Villas, Fourth-avenue, Trafford Park, Manchester; G. Ollongvist, 8 or 18, Ackers-street, Chorlton-on-Medlock, Manchester; J. A. Orme, 517, Stretford-road, Manchester; J. Paterson, 42, Cooke-street, Old Trafford, Manchester; F. R. Pendergast, 39, Swan-lane, Bolton; J. H. Potts, Field View, Park-lane, Macclesfield; W. D. Redfern, 10, Claremont-grove, Didsbury, near Manchester; A. E. Ricketts, 22, Alfred-street, Harpurhey, Manchester; J. Roberts, jun., 23, Derby-street, Chorlton-on-Medlock, Manchester; A. W. Robinson, 29, Camberwell-green, S.E.; J. W. Ross-Jones, 8, Albion-place, Lower Broughton, Manchester; T. Rushworth, 12, Addison-terrace, Victoria Park, Manchester; D. L. Sands, Highfield House, Mary-street, Harpurhey; F. Shaw, Municipal School of Technology, Manchester; R. M. Sheppard, Hawsted, Buckhurst Hill, Essex; G. M. Sime, 21, Milton-street, Chorlton-on-Medlock, Manchester; S. A. Skinner, 74, Cyprus-street, Stretford, Manchester; G. Smith, The Elms, Queen's-park, Manchester; G. E. Smith, 64, New-street, Altrincham, Cheshire; G. J. Smith, Ashlands, Sealands, Chester; T. W. J. Smith, 15, Eastnor-street, Old Trafford, Manchester; J. A. Somerset, 292, Upper Brook-street, Manchester; B. E. Stott, 38, Railway-road, Leigh, Lancashire; J. Summers, 12, John-street, Sale, Manchester; H. Taylor, 2, Ivy-road, Bolton, Lancashire; P. Thomason, 15, Lotherton-street, Harpurhey, Manchester; L. S. J. Thompson, 54, Worthington-street, Old Trafford; E. Thornley, Poplar-grove, Compstan, near Stockport; H. T. Thorp, Moss Bank, Whitefield, Manchester; H. Thorpe, Westlands, Wavertree, Liverpool; E. T. Torbitt, 77, Everton-road, Chorlton-on-Medlock, Manchester; T. G. Travis, Shirley Lawn, Derbyshire-lane, Stretford; M. Wadsworth, 110, Droylsden-road, Droylsden; R. W. Wainwright, Demesne-road, Manchester; B. Walker, Marland, Swinton-park, Pendleton; E. Walter, Redclyffe House, Barton-on-Irwell; F. G. Warburton, 13, Humphrey-street, Seymour-grove, Old Trafford; J. C. Ward, 100, Shrewsbury-street, Brook's Bar, Manchester; S. T. Webster, Hope House, Hermitage-road, Hale; W. Weeds, 8, The Park, Eccles, Manchester; G. W. Williamson, 2, Irlam-view, Broad-road, Cheshire; R. W. Willis, Camel Bank, Range-road, Whalley Range; H. Wilson, Electricity Works, Middleton, Lancashire; W. D. Wilson, Fern Bank, Urban-road, Sale, Cheshire; W. M. Winstanley, Gibson-road, Sale, Cheshire; A. L. Wood, Elm House, Clifton, Manchester; E. Wooler, 99, Bishop-street, Moss Side, Manchester; K. Younghusband, 15, Derbyshire-lane, Stretford, Manchester.

## FORTHCOMING EVENTS.

FRIDAY, MAY 13.

**Institution of Electrical Engineers.**—Dublin Section: At 8 p.m., ordinary general meeting.

**Royal Institution.**—At 9 p.m., "The Queen Victoria Memorial," by Mr. M. H. Spielmann.

SATURDAY, MAY 14.

**Electrical Engineers (R.E.) Volunteer Corps.**—At 8 p.m., at Headquarters, Bohemian concert.

MONDAY, MAY 16.

**Electrical Trades' Union.**—At 8 p.m., smoking concert.

TUESDAY, MAY 17.

**Royal Institution.**—At 5 p.m., "Meteorites," by Mr. L. Fletcher. Lecture III.).

WEDNESDAY, MAY 18.

**Institution of Electrical Engineers.**—Students' Section: at 7.30 p.m., annual general meeting. The following paper will be read: "Some Notes on Steam-Turbine Testing," by Mr. C. G. Seeley. Birmingham Section: afternoon, visit to Birmingham Small-Arms Works. At 7.30 p.m., annual general meeting. Paper by Mr. F. O. Hunt, associate member: "Motor-Starting Switches and Resistances."

**North-East Coast Institution of Engineers and Shipbuilders.**—Newcastle: at 7.30 p.m., general meeting.

**Wimbledon District Council.**—(To 28th inst.) public electrical exhibition at Worple Hall, Wimbledon.

**Hastings.**—Opening of electric tramways.

THURSDAY, MAY 19.

**Municipal and County Club.**—Dinner.

FRIDAY, MAY 20.

**Junior Institution of Engineers.**—At 8 p.m., "Practical Notes on the Running of Motor Cars and Cycles," by Lieutenant W. G. Windham.

**Royal Institution.**—At 9 p.m., "Radiation and Emanation of Radium."

**Association of Municipal Engineers.**—At Buxton, general meeting.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

**Institution of Mechanical Engineers.**—Chicago Meeting, May 31 to June 3.

**British Association of Waterworks Engineers.**—Annual meeting, June 9 and 10. June 11-18, visit to Belgium.

## BIRKENHEAD ELECTRICITY ACCOUNTS.

Below we give an abstract of the revenue account of the Birkenhead electricity department for the year ended March 31, 1904.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 2,820 | 14 | 7 |
| Distribution of electricity | 276 | 19 | 6 |
| Attending and repairs to public lamps | 261 | 2 | 10 |
| Rents, rates, and taxes | 495 | 0 | 0 |
| Management expenses, salaries, etc. | 697 | 7 | 9 |
| Special charges | 83 | 1 | 8 |
| Balance transferred to net revenue account | 6,784 | 12 | 1 |
| | £11,418 | 18 | 5 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter | 10,720 | 4 | 4 |
| Rental of meters on consumers' premises | 635 | 6 | 9 |
| Rental of motors | 29 | 19 | 2 |
| Miscellaneous | 33 | 8 | 2 |
| | £11,418 | 18 | 5 |

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## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

687. Compare the advantages of using for traction work (*a*) compound dynamos in parallel, and (*b*) separately-excited machines partly excited by the outgoing current.—E. V. C.

688. It is proposed to equip a colliery with an electric winding plant, the data being as under: depth of pit, 450 yards; output of pit in 10 hours, 2,500 tons; weight of coal raised per wind, 5 tons; weight of coal per tram, 25cwt.; number of trams per wind, 4; tare of each tram, 10cwt.; weight of each cage, 2 tons; weight of rope, 2 tons 10cwt.; weight of balance rope, 2 tons 10cwt. Note.—Cages, ropes, and trams are balanced. Net load is weight of coal = five tons. The following information is required, also give calculations for same: horse-power required to start load and accelerate same up to top speed; time required to accelerate load; maximum winding speed; horse-power required to wind at top speed; time winder will run at top speed; time of retardation. Assuming the winding will be done on the Illquer system, give the horse-power of the motor and weight of flywheel and speed of same. COAL.

### ANSWERS.

*Question No.* 680.—When a battery has dropped in capacity is it correct to charge at the original rate—viz., a 600 ampere-hour battery has dropped down to a maximum 200 ampere-hours. Original charging rate 100 amperes. Should this rate be lowered? Give reasons for and against.

*Answer to No.* 680 (*awarded* 7*s.* 6*d.*).—There is only one answer to "C. G.'s" question: the charging current must be reduced. The various reasons why are given below; the arguments against cannot be stated, as there are none. As the charging current rate depends on the area of active material exposed, if this area is lessened the charging current must be reduced in exactly the same proportion. We know the active surface is less through the fact that the capacity is less. We also know by how much it is reduced, and a simple proportion sum will give the proper charging current for the case in question—viz., 33 amperes.

There is nothing more detrimental to accumulators than an excessive charging rate, except, of course, over-discharging. Buckling is certain to be caused, which may even be so serious as to short-circuit some of the plates; even if it does not go so far, it causes the active material to become loosened from the grids and liable to fall out. Further, it disintegrates the material, and small particles are carried away by the excessive gassing; these, after the electrolyte has become still, sink to the bottom of the cell and are known as sediment. The current which causes the liquid to boil is, of course, wasted, and over-charging can be most easily detected by the furious gassing of the plates. One reason, therefore, of reducing the charging rate is that it is more economical to do so. If sulphating is present—and what ordinary battery in the state described by "C. G." is free from this ravaging disease?—the charging current must be still further reduced, owing to the fact that the sulphate forms a more or less impenetrable layer of skin over portions of the plate, and thus reduces still again the available area of active material. Where sulphating is present, the charging current should be one-third less than if the plates were free from it. In this case, therefore, "C. G." should charge at 22 amperes till the sulphate is removed, which will take weeks and weeks of patient, tedious charging.

Enough has been said as to why the charging current should be lessened when capacity is lost, but it might be well to remark that the cells in their present state, in the opinion of the writer, at least, are only fit for renewing, either the positives only or entire new sections being procured before the winter loads come on again. There is little doubt but that the cells are subjected to more or less the same discharge rates and discharges—as far as the cells can do it, at least—as when originally installed, and this, unless the cells are very old, must have been none too light a duty judging from their loss of capacity.—F.

*Answer to No.* 680 (*awarded* 7*s.* 6*d.*).—A battery after being in use some time gradually falls in capacity, and the less attention and care it receives the quicker will it deteriorate. Let us consider the battery in question, and see what are the probable reasons of the drop in capacity from 600 ampere-hours to 200 ampere-hours, and then we shall be able to decide as to whether it would not be advisable to charge at a lower rate. In practical working, it very often happens that a battery is unavoidably over-discharged. The battery may be in a small lighting station and be left on the 'bus bars at night to take the night load. A fault develops on the outside network, and the battery burns the fault out if it can, much to the detriment of the battery plates; or an engine may have to be shut down and the battery left to take the load, the question not being, will doing so spoil the battery, but will the battery do the work?

When a battery is over-discharged there occurs that destructive action known as scaling, which is probably caused by abnormal chemical action due to the weakness of the acid solution. This scale is got rid of by either prolonged charging at a low rate or by scraping the plates, and the scale is deposited on the bottom of the cell. I have seen brown sediment quite 2in. in thickness lying in the bottom of the cells of a battery after only six months' working. The battery was a poor one to start with, and had been badly treated. This deposit represents so much material wasted, as the plates will have so much less paste in them, and, therefore, the capacity of the battery is reduced. Again, according to Mr. Wade in a paper read before the Institution two or three years ago, the capacity of all negative plates steadily decreases in course of time, though to look at they are still in excellent condition. Possibly in course of time the negative plates get less porous, and thus the acid cannot circulate so freely into the interior of the plates; the chemical reactions, therefore, are chiefly confined to the surface of the plates. Then, again, the positive plates, after a few years' hard work, are found to be more or less buckled. A certain part of a plate is nearer the negative plate than the other parts of it. The current during charging will, therefore, tend to flow through the electrolyte more at this particular point than any other, and consequently this part of the plate will receive more charge than any other. If the discharge is carried on until the whole plate is discharged, then this bulging part will be over-discharged, and consequently damaged.

To sum up, I think that the two principal causes of the drop of capacity in the battery are: firstly, loss of active material through the paste sulphating and falling to the bottom of the cell; and, secondly, through the plates becoming less porous and hindering the diffusion of the acid amongst the active material of the plates. Both the charge and the discharge rates should be lowered in dealing with the battery in question. I should suggest charging at about 50 or 60 amperes. Batteries stand a lot more chance of a long life and greater efficiency than they have ever done now that the use of the reversible booster has become common. The use of regulating cells has been done away with, except for very small installations. They were the cause of more than half the complaints against batteries. They were only on discharge and charge for short periods, and were the greater part of their time standing idle. A rather common practice of the man in charge of a battery was to take the regulating cells out as they got faulty, place them in the centre of the battery, and take other cells (in good condition) and make them the regulating cells. This was done in the hope of getting them in good condition again, but the practice generally seemed to result in gradually spoiling the whole battery. The reversible booster, whether hand regulated or automatically regulated, has changed all this, and the battery is usually charging or discharging all day long, and every cell receives exactly the same treatment, since there are no regulating cells.—W. A. T.

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*Answer to No.* 680 (*awarded* 5*s.*).—The battery referred to in the question is presumably of the "pasted" type, the loss of capacity being brought about by the loss of active material from the plates. The discharge obtainable from a cell depends upon the amount of lead that takes part in the chemical changes, and this quantity depends upon the amount of material exposed to the solution. When the peroxide of lead is converted during discharge into lead sulphate, expansion takes place; and during charging, the reconversion into peroxide is attended by contraction. This continual expansion and contraction during the life of the battery tends to loosen the paste in the grids, and to cause it ultimately to become detached. Other causes may also be at work, such as "sulphating"—that is, the presence of $Pb_2SO_5$. If the original maximum charging current be passed through a cell after its plates have lost some of their capacity, the active material available may be insufficient to absorb the whole of the energy of the current. The surplus energy of the current will then be spent in decomposing the water of the electrolyte—giving rise to "gassing"—and also in heating the liquid. This will mean a waste of energy. If when the cell is in good condition a charging current greater than the maximum be passed through it, the cell may be made to gas long before the completion of the charge, the oxygen liberated at the positive plate being generated more quickly than it can be absorbed. Therefore, if the capacity of the cell be reduced, and, on charging at the original rate, it be found that "gassing" sets in too early, it will be more economical to reduce the charging current. "Gassing" is an evidence of waste of energy. As the sulphate, $PbSO_4$, on the positive plate becomes converted to lead peroxide the material to be acted upon by the current diminishes, and the current becomes too great. It would always be more economical to prevent "gassing" by reducing the charging current as the charging proceeds; but in practice this cannot be done, as the time required to charge would be too long. While recommending a continuance of the charge at the normal rate until the electrolyte "boils," some makers advise that when this stage is reached the current must be reduced, and kept so, till the end of the charge. "Gassing" does no harm to the plates, and has been found to be beneficial; but there is a danger, when the paste is loose, of having much of the active material removed by the agitation of the liquid.

If the paste be in the form of pellets, passing right through the plate from surface to surface, the removal of any of these pellets may leave the plate with its superficial area considerably reduced. And not only may the original charging current be too great for the active material to be acted upon, but the superficial area of the plate in contact with the liquid may be too small. In this case "buckling" may take place, especially if the positive plates be "sulphated."—H. J. W.

*Answer to No.* 680 (*awarded* 5*s.*).—Whether the charging rate should be lowered or not depends on the causes operating to reduce the capacity: therefore this question really requires more than one answer.

(*a*) The loss in capacity may be due to inattention, which has resulted in short-circuits, caused either by bridging between the plates or by mud at the bottom of the cells. The charge rate need not be altered; the only remedy is a little attention and elbow-grease. It may also be of use to remind the battery attendant that "there are others."

(*b*) If the battery is an old one, the loss is due to the over-forming of the positive plates through repeated charges and discharges, whereby the conducting frame of the plates has been separated from close contact with much of the active material. New positive plates will cure this trouble, but until these are in position the charging rate should be lowered to 30-35 amperes without increasing the duration of the charge, because at the original rate energy is wasted in forming loose active material that only discharges locally, and not through the external circuit.

(*c*) If sulphating is the cause of the trouble, lower the charging rate to about 25 amperes, and give charges of very long duration until the original capacity shows signs of having returned.

(*d*) Have the electrolyte analysed for traces of nitric acid, diphenylamine, or bruceine. Give the best tests. If this is found in any of the cells, replace the original acid by *pure* dilute sulphuric acid. This will improve the capacity to a great extent, but if nitric acid is in a battery it is very difficult to thoroughly eliminate it. The charging rate must be maintained at its full value.—B. P.

*Question No.* 681.—Describe, with sketch, the simplest and best method of finding a short in an armature.

*Answer to No.* 681 (*awarded* 7*s.* 6*d.*).—A short-circuit in an armature may be of two kinds, direct short between the coils, and between the coils and the armature core. If the insulation be faulty between one point only of the armature winding and the core, the remainder of the conducting system being insulated from earth and dynamo frame, no inconvenience should be experienced. If the insulation of the winding be faulty at two points or more, currents will flow through the core, the magnitude of the currents depending upon the difference of potential at those places and the resistance of the core which the current traverses. To test for a fault between winding and core, connect as shown in Fig. 1, where G is a galvanometer or current

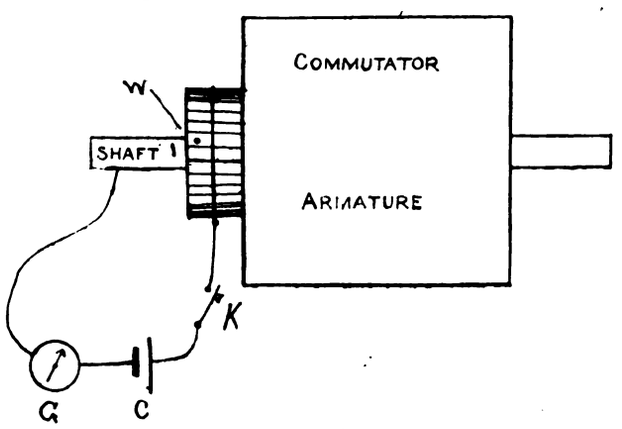


FIG. 1.

detector, C a cell, K a key for opening and breaking the circuit. A lead is taken from K to W, which latter is a length of copper wire twisted tightly round the commutator to ensure good contact. Another lead is taken from G, having one end pressed against the shaft or any other convenient point in metallic contact with the armature core. If the winding is in contact with the core, a deflection will be obtained on G when K is closed.

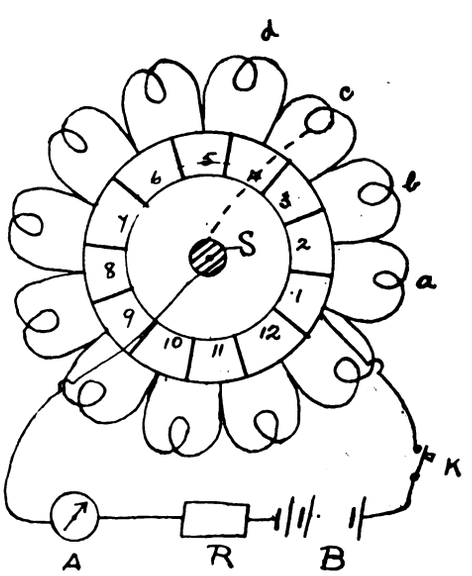


FIG. 2.

In Fig. 2, *a*, *b*, *c*, etc., represent the armature winding, 1, 2, 3, etc., commutator bars, and S the armature shaft. R is a variable resistance, B the source of current, A an ammeter, and K a switch. One lead is taken from A to S, another from K to commutator bar 1. A fault is supposed to exist between coil, C, and armature core, the dotted line completing the circuit through the fault. A strong current is passed through the armature and kept constant. If the two terminals of a galvanometer be connected to bars 1 and 2 respectively and then to 2 and 3 a deflection of

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the galvanometer will be obtained, and will be of the same amount in each case. If the leads be connected to 3 and 4 the deflection obtained will be different from the two previous ones, except when the resistance of the winding lying between the fault and bar 1 is the same on either side. If in the same manner the terminals be successfully connected to bars 1 and 12, 12 and 11, . . . 6 and 5, equal deflections will be obtained which will again differ from the readings obtained at 3 and 4.

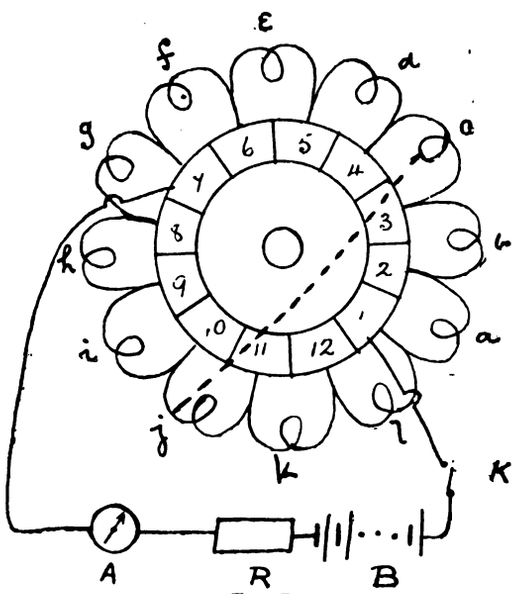


FIG. 3.

If, as in Fig. 3, a short-circuit exists between the coils, *c* and *j*, and strong current be passed through as before, and the galvanometer terminals be connected to bars 1 and 2, 2 and 3, 3 and 4, the first two readings will be equal, but different from the last, which will indicate a fault in the winding between 3 and 4. Similarly, readings obtained by connecting to 1 and 12, 12 and 11, 11 and 10, will indicate a fault in the windings between 11 and 10. Should the fault at *c* and *j* exist at points equidistant from 1, they will be points of equal potential, and no current will flow through the faults. Hence the deflections when any two consecutive bars are connected will be the same. This can be altered. For instance, if current be led in at bar 2 instead of bar 1, leaving the armature at bar 8 instead of 7, then the points *c* and *j* will *not* be points of equal potential, and the deflections obtained, say, between 3 and 4 will be different from that obtained between 2 and 3.

Numerous cases of faults may occur—the above are only special cases—where the rule of procedure may require slight alteration, and instead of connecting the leads of the galvanometer (or any instrument capable of indicating small differences of potential) to two consecutive bars, one lead may be kept connected to bar 1, and as the other terminal is passed from one bar to the next, equal increments of readings should be observed until the faulty section is arrived at.—H. J. W.

*Answer to No.* 681 (*awarded* 7*s.* 6*d.*).—In the case of a parallel-wound armature where the commutators bars are not cross-connected, the easiest plan to locate a "short" is to pass a small current from one brush position to another on the opposite side, all intervening brushes, if any, being lifted. If the line voltage is available, the shunt of the faulty machine can be utilised for getting the above current. By means of a milli-voltmeter, the difference of potential should then be measured between each pair of commutator segments, and a zero or low reading will indicate a "dead" or partial "short." Fig. 1 shows the connections. The same procedure can be followed for a multipolar series-wound armature, but in this case a short-circuited coil will not show a zero reading, although a short in the commutator would. Fig. 2 illustrates a short-circuited coil, B, in a series four-pole armature having 91 commutator bars and coils. Only half the potential difference will be obtained across segments 23 and 24 as compared with the other pairs of segments. To find which of the two coils, A or B, is faulty, separate potential readings must be taken between 23 and 69, and 69 and 24. A rather more difficult fault to locate is when one coil makes contact with

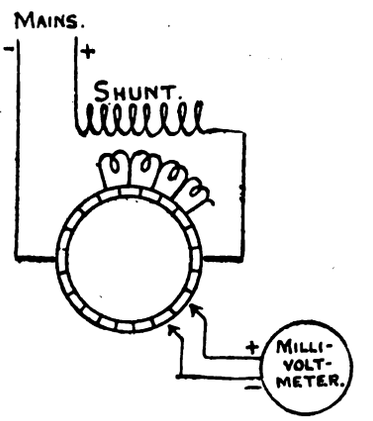


FIG. 1.

another several segments apart, so short-circuiting all the coils in between, but with a little experience it is easy to trace where the trouble lies by trying the fall of potential

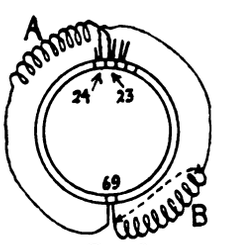


FIG. 2.

between various points on the commutator. These tests are, of course, made before unsoldering any connections. Another method is to pass alternating current through the armature and detect the faulty coil by its local heating.—DISPAR.

*Answer to No.* 681 (*awarded* 7*s.* 6*d.*).—No single method of finding a short in an armature can be termed the "simplest and best," owing to the fact that so much depends on the conditions under which the test is made. For instance, in the factory where armatures are built special testing apparatus is used which cannot be obtained on an isolated plant. Consequently the writer proposes to describe several practical tests to meet the ordinary condition.

The "transformer" or "choke" test is universally adopted in factories for testing armatures after they have been wound and coupled up. Fig. 1 shows the

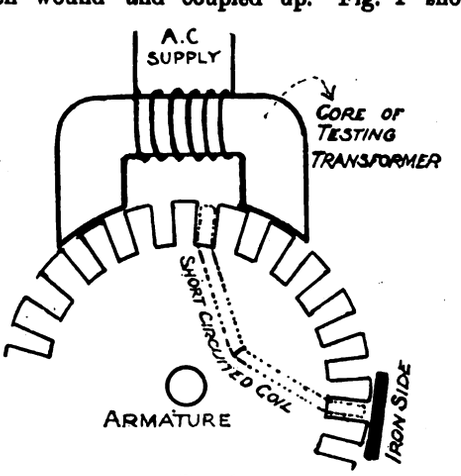


FIG. 1.

apparatus required for this test. The core of the testing transformer is built up of laminated sheet iron and is so made that it fits on the armature under test, covering about a quarter to half of the total circumference on small machines and rather less on larger ones. The iron circuit is completed through the core of the armature. In Fig. 1 a short-circuited coil is shown beneath the testing core (the other coils being left out for clearness). Now, as soon as this

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core is excited off an alternating supply, a considerable current will flow round the short-circuited coil, which will act like the secondary coil on any alternating transformer. When testing a newly-wound armature, the latter is placed beneath the testing core, and the alternating current exciting current switched on If there is a short between the coils the shorted coil will very quickly warm up, due to the heavy current flowing in it, as stated above. But in place of waiting for the coil to warm up, a small iron slab can be passed round the periphery of the armature. This slab will be attracted at once by the field set up round the short-circuited coil, if one is present in the armature. As the transformer only covers a part of the armature at a time, the test has to be repeated with the armature in different positions until the transformer has covered the whole circumference.

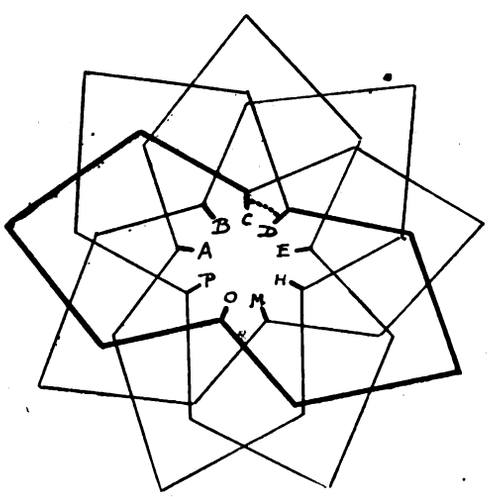



FIG 2.

Another test very commonly adopted is that known as the "milli-voltmeter" or "drop" test. In Fig. 2 an armature winding is diagrammatically shown, and it is assumed that a short has occurred between C and D. A current of, say, one or two amperes is passed into the armature at the armature at the points B and E, the terminals of the milli-voltmeter being connected to C and D. There will be no reading on the meter when in this position, due to the fact that the short allows the current to pass directly across from C to D in place of going round the coils, C to O and O to D; and it is clear that if there is no current in the coils C to O and O D, the meter cannot measure the drop of potential in the coils. Also, it is interesting to note that a reading of half the normal value will be obtained if the meter leads are connected to M and O. This is due to the fact that the coil O C will act merely as an extension

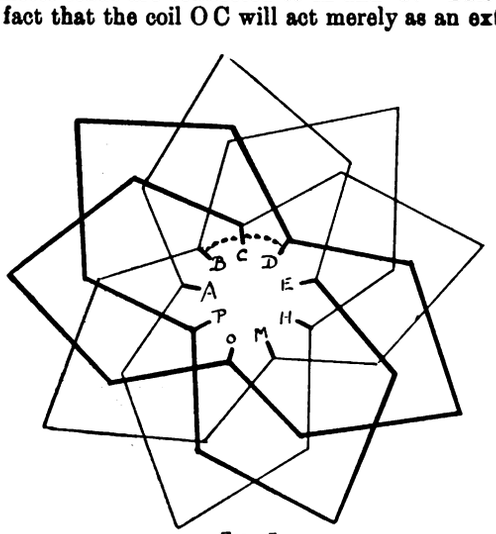


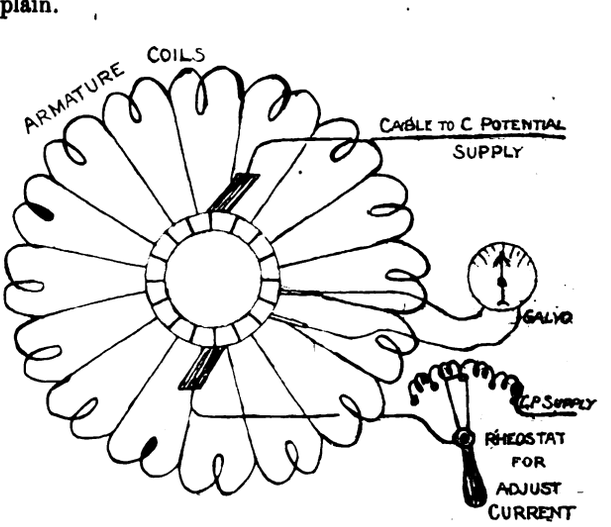

FIG. 3.

of the meter lead, as no current is passing through it, as stated above. The reading obtained with the leads on M and O will be the drop in the coil C to M only.

Referring to Fig. 3, it will be seen that the two adjacent plates, B C and C D, are shorted. In this case the four coils, marked in thick lines (C to O, O to D, D to P, and P to E), will not carry any current. Consequently, with the milli-voltmeter leads on M and O, a reading of only half the normal value will be obtained; in fact, the reading would be identically the same if the leads were on M and C. With the leads on O and P, zero reading will be obtained and half the normal value again between P and A. This test is practical both for the factory and for isolated plants, as it is only necessary to place a few lamps or wire resistance in series with the supply current to allow the necessary amperes to pass into the armature; and it is usually possible to obtain a milli-voltmeter or galvanometer for reading the volt drop per coil.

If an earth occurs on an armature due to the insulation between the coil and the core breaking down, it can be easily detected if a pair of leads are run from the nearest supply circuit with a lamp in circuit to keep the current down. One lead should be fixed to the armature shaft or other mechanical part, and the other lead passed round the commutator from plate to plate, until the lamp is seen to glow, showing that a circuit is completed between the commutator plate and the armature shaft due to the coil connected to that plate being earthed to the core —P.

*Answer to No.* 681 (*awarded* 5*s.*).—"T. W." will find that by resorting to the following methods a short-circuit may be easily located: If the armature has not been uncoupled or removed, run it on open circuit for a short while, then stop and examine, feeling the commutator segments or bars. The short-circuited coil will be considerably hotter than the remainder. This is due to the coil being closed on itself. The closed coil forming a loop, and cutting through the field, generates E.M.F. This E M.F. is low, but the resistance of the loop is considerably lower in proportion, hence a big current circulates within this coil, not going to the outer circuit. As the heating effect is proportional to the current, it will at once be seen that the shorted coil will get abnormally hot. If the armature has been removed, say sent to shop, for supposed short-circuit to be found, the following method will be found to give great satisfaction. Mount the armature on a pair of trestles (or other supports), fit pair of brushes (if bipolar) to commutator diametrically opposite; to these connect pair of cables from a constant-potential source (preferably secondary cells), inserting in the circuit a resistance so that the current flowing shall be equal, or near about its rated capacity. Get a low-reading voltmeter or galvanometer; to it join flexible leads ending in stiff metal points. When the current is flowing through the armature, measure the D.P. between adjacent segments by connecting them to the galvanometer, as shown (the stiff metal points are to ensure good contact). On coming to a short-circuited coil there will be no D.P. owing to the coil forming a closed loop. The accompanying sketch will explain.




Another method is sometimes adopted, but it does not indicate with the same accuracy and certainty as the one just mentioned—briefly it is this. Pass current through the armature precisely same as in previous method. Rest a delicate-balanced magnetic needle close to the winding (in line of brushes). Turn the armature around slowly by

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means of handles fixed to shaft. If the armature is right the needle remains in a definite position, owing to the field set up by the current in the coils. When a short-circuited coil passes the needle, the needle changes its position—if a dead short, swings right-about-face.

Again, a rough and ready method has been used with good effect by holding a bottle or glass tube, containing glycerine and iron filings, close to the winding, while the armature is rotated as before. So long as no short appears the filings set themselves in a definite direction, but alter when the shorted coil comes within range, thus indicating a difference in the direction of the magnetic field set up by that coil. If the armature has separate and distinct windings, paralleled under the brushes, it is easy to see if they are touching one another by testing with galvanometer or detector for non-contact, as when trying non-contact between two wires. It is customary in some shops where armatures are built to finally test them for shorts, etc., by passing alternating current, high-tension (2,000 volts), through the winding, the armature being stationary. If there is a short, it breaks down under this treatment.

"T. W." will easily see that the methods adopted (excepting the one used when running) will not only indicate dead shorts, partial shorts, but also defects relating to bad connections, broken circuits, partial broken circuits, want of balance, cross coupling (deflection opposite way), etc., but as this is beyond the range of the question I will not further take up valuable space. The first galvanometer test I commend to "T. W.," as being in my judgment the best and simplest method of finding short in armature. In measuring the D.P. between the commutator segments of double, treble wound, etc, armatures, the galvanometer leads should be applied to every other segment, or every third, as the winding may necessitate.—W. B.

# COMPANIES' MEETINGS AND REPORTS

## CALLENDER'S CABLE AND CONSTRUCTION.

The report of the directors for the year ending Dec. 31, 1903, states that there is a balance at the credit of profit and loss for the year's working of £52,646. 18s. 8d., to which must be added the balance brought forward from 1902, £24,480. 9s. 2d., making together £77,127. 7s. 10d. From this must be deducted interest on debenture stock, £9,000; dividend on preference shares, £10,000; appropriation for depreciation of plant and machinery, £11,480. 1s. 2d.; for depreciation of office furniture, £191. 3s. 8d.; leaving an available balance of £46,456. 3s., which it is proposed to deal with by the payment of a dividend on the ordinary shares at the rate of 10 per cent. per annum, £17,500; the payment of a bonus of 2s. 6d. per share, £4,375; carrying forward to next year's account, £24,581. 3s. The outturn from the factory was slightly in excess of that of the preceding year, but once again severe competition was experienced in all branches of the Company's business, with the result that the prices obtainable were still further reduced, leaving but a small margin of profit. The Company suffered severely from the unprecedented rainfall of 1903. The cost of carrying out street work and cable-laying was considerably enhanced thereby. Heavy expenses were incurred at the factory at Erith from the same cause. These two items caused an abnormal expenditure, amounting to many thousands of pounds, which, of course, has been met out of the year's profits. Owing to the general financial stringency, few new installations were undertaken, and in municipal work especially orders for cable were considerably restricted for the same reason. The directors are glad to note that in the last few weeks there is a distinct tendency towards better trade, and although competition continues very keen, and prices are still low, there is some hope of better results during the present year's operations. Reference was made in last year's report to the various companies operating under parliamentary powers for the supply of electricity over large areas, in some of which this Company is closely interested. During the past year considerable progress has been made in this important branch of the electrical industry. There appears to be little doubt that as soon as these companies are at work, great developments will take place in the use of electricity throughout Great Britain, and the directors are more convinced than ever that the policy which they have adopted with regard to these electric supply companies is the right one. During last summer circumstances arose with the Anchor Cable Company, Limited, which in the judgment of the Board of that company rendered it advisable that their business should be disposed of to one of the larger cable-makers, and negotiations were entered into with this Company. After carefully examining the property, and considering the possibilities of their factory at Leigh, the directors completed arrangements by which they acquired the whole of the shares of the Anchor Cable Company, Limited. The original Board retired, the directorate of the Anchor Company is now almost identical with that of this Company, and the business is under its control. For various reasons it has been considered necessary not, as yet, to amalgamate the two concerns, but to run the Anchor Company separately, and this course will be followed for the present. In addition to the purchase of those shares, this Company has found the working capital which is necessary for the Anchor Company. The total amount of this investment and advance is shown in the balance-sheet. A special loan has been obtained from the Company's bankers to enable this to be done, but at an early date it may be advisable to take the requisite steps for clearing this off. The directors are convinced that the acquisition of the Anchor Works has had most satisfactory results in many ways on the business of the Company.

## BRUSH ELECTRICAL ENGINEERING.

The annual general meeting was held on Tuesday at Salisbury House Lord Vaux of Harrowden (the chairman) presiding. Particulars of the report appeared in our last issue.

**His Lordship** observed that substantial progress had been made during 1903. The net profit of £28,000 which remained after paying the interest on debenture stock, placing £6,500 to depreciation fund, and meeting all charges, was substantially better than that of the previous year, and would be sufficient not only to pay the preference dividend for the year in full which the Board recommended, but also to provide a dividend on the ordinary shares. The directors thought it more prudent, however, to strengthen the general reserve fund, especially as the increased business they were doing made it necessary to carry much larger stocks of raw material and finished parts in order to secure prompt delivery. They enjoyed the reputation in the car and truck department of their business of being second to none in this country. They were being entrusted with the orders for the greater portion of the trucks required for electric tramway and electric railway cars in the United Kingdom. They had given up the manufacture of the Universal engine, and had adopted instead the reciprocating type. They had made good headway with it, and also with their steam-turbine. Their sales of other electrical apparatus had also improved. With regard to the automobile department, the wet season last year had a bad effect on their sales, which fell short of their expectations, but they had made a better start this year.

The report was adopted.

## CALCUTTA ELECTRIC SUPPLY.

The seventh annual meeting was held at Salisbury House last Friday, Colonel A. J. Filgate presiding. Particulars of the report appeared in our last issue.

The **Chairman**, in moving the adoption of the report and accounts, said that whereas at the end of 1902 the number of houses served by the system was 965, and the lamps and motors connected were equivalent to 80,762 8-c.p. lamps, at the end of last year the Company's customers had increased to 1,379, and the lamps and motors connected reached the equivalent of 121,878 8-c.p. lamps. The demand for current was steadily increasing. Practically the whole of the houses in the European quarter of the city were being wired for light and fans by the builders, and there had also been a good demand among the native community; in fact, their business all round was steadily increasing, and promised excellent results for the future. The Company now had 45¼ miles overhead and 63 miles of underground mains, or 108¼ miles in all. The Board recommended a final dividend for the half-year at the rate of 8 per cent. per annum, making, with the interim dividend already paid, 7 per cent. for the year.

**Mr. E. Boulnois, M.P.**, seconded the motion, which was unanimously agreed to, and the proposed dividend adopted.

## WESTERN TELEGRAPH.

The report of the Western Telegraph Company, Limited, for the half-year ended Dec 31, 1903, to be submitted to the meeting on the 17th inst., states that the revenue for the period amounted to £222,020 and working expenses to £93,140. After providing £13,579 for debenture stock and debenture interest and sinking fund, and £2,622 for income tax, there remains £112 679, to which must be added £2,640 brought forward, making a total of £115,318. Interim dividends, amounting to £62,379, have been paid, and after transferring £30,000 to general reserve fund and £18,000 to maintenance ships' reserve fund, there remains £4,939 to be carried forward. The revenue includes £11,808 dividends upon the Company's investments in other telegraph companies, and £6,632 interest on reserve fund investments.

## BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

The report for the year ended Dec. 31 states that the dividends on the shares held by the Company for 1903 amount to £43,970, and after adding sundry receipts and the amount brought forward, there is a balance to credit of revenue account of £52,102. After deducting income tax and general charges in London and expenditure in Brisbane, including the insurance undertaken by this Company under its contract with the tramways company, there remains a net balance available of £46,654. The debenture stock interest has absorbed £18,168, and an interim dividend has been paid on the preference shares amounting to £8,857. The directors recommend that £5,000 be put to reserve fund and the payment of the balance dividend on the preference shares, making up the full dividend at the rate of 5 per cent. per annum, carrying forward £5,673.

## BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT.

The adjourned meeting of the debenture-holders was held at Winchester House last Friday for the purpose of sanctioning certain modifications of their rights under the trust deed. In our last issue

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we gave particulars of the meeting held the previous week, which had to be adjourned as there were not sufficient debenture-holders present to constitute a quorum. On the occasion under notice the resolution was adopted unanimously.

## GRAVESEND AND NORTHFLEET ELECTRIC TRAMWAYS.

The third annual general meeting was held on Monday last, Mr. W. G. Bond in the chair. Particulars of the report appeared in our issue of the 29th ult. The number of passengers carried during the year was 3,037,799, and 329,611 miles were run.

The **Chairman** stated that the Company expected to have some new cars shortly, and hoped to effect a reduction in operating cost.

The report was unanimously adopted.

Mr. Robertson, the director retiring by rotation, was re-elected, as were also the auditors, Messrs. Ward and Wilding.

## CRAIGPARK ELECTRIC CABLE.

The first annual general meeting of the shareholders of this Company was held in Glasgow. Mr. James T. Tullis, chairman of the Company, presided.

In moving the adoption of the report, the **Chairman** said the removal of the works from Craigpark to Springburn had caused considerable dislocation during some six months of the year. As the directors had expected, there was very little profit on the year's working, but in spite of the removal they were able to keep up the production. The establishment was now in perfect order.

The report was adopted.

## EASTERN EXTENSION AND CHINA.

The sixty-first half-yearly ordinary general meeting was held on the 4th inst. under the presidency of Sir John Wolfe Barry, K.C.B.

The **Chairman** observed that the receipts for messages showed a net decrease of £20,850, which was a lower figure of diminution than was estimated by the Company, and might, under all the circumstances, be considered as a not unsatisfactory result under all the conditions now existent. This decrease was spread over a large number of different traffics. Practically all the American traffic exchanged with Australasia, China, Japan, and the Philippines had been diverted to the new Pacific cables, as was only natural, considering the geographical position of these countries. A proportion of the traffic between Australasia and Great Britain had also been diverted to the Government Pacific competing line, but the actual loss of revenue from the competition of both the British Government and the Commercial Pacific cables had been less than was anticipated. The reduction in tariffs with China, Japan, and the Philippines had been largely compensated for by an increase of traffic. Considerable increases had taken place in the through traffic with the Straits Settlements and the Dutch Indies, and in the number of messages exchanged between India and China, Japan, and the Straits Settlements. He alluded to the increased traffic resulting from the Russo-Japanese war, and stated that in consequence of the sealing by the Russian authorities of the Vladivostock ends of the cables connecting Japan with the Russian land-line system, the bulk of the Japanese traffic was for a time forwarded by the southern route. No further action had been taken by the Federal Government of Australia respecting the agreement entered into with the Company for extending to Melbourne and Brisbane the privileges, enjoyed by the Company in the other State capitals in Australia, of dealing direct with the telegraphing public, and the projected conference to be held between the Governments interested in the British Pacific Cable to consider what effect the agreement might have upon the Pacific Cable, and other questions, had not yet been held. Pending a decision being come to, the tentative arrangement, by which the Company is permitted to have its own offices and deal direct with the public in Melbourne, remains undisturbed. In the meantime, active competition had been carried on between the Pacific Cable Board and the Company for the Australasian traffic, but the former had not been able to secure a materially larger proportion of the traffic than hitherto. This severe competition, however, had entailed a considerably increased expenditure at all their Australasian stations, with the result that the Company's cable system in Australia was scarcely remunerative, the receipts at the present time barely covering the working expenses. He proceeded to criticise at some length the conditions under which the Pacific Cable's competition was carried on. In conclusion, he moved the adoption of the report.

**Mr. Walter S. Seton-Karr** asked for information as to the probability of the Marconi system competing with the submarine system.

The **Chairman** replied that, as he had stated on several previous occasions, he considered wireless telegraphy extremely valuable within moderate limits and where speed and secrecy were not essential, but he did not think it need be regarded as a serious competitor to cable enterprise.

**The Marquis of Tweeddale** seconded the resolution, which was carried unanimously.

Mr. F. A. Bevan and the Hon. A. G. Brodrick were re-elected as directors.

## GLOBE TELEGRAPH AND TRUST.

The report of the Globe Telegraph and Trust Company, Limited, for the year ended April 30, 1904, to be submitted at the meeting on the 17th inst., states that the net revenue for the year, after deduction of expenses, amounts to £203,010, and makes, with the balance of £3,071 brought forward, a total of £206,081. From this amount there has been distributed the sum of £131,917 in interim dividends, leaving an available balance of £74,165. The directors recommend a final dividend of 5s. each on the ordinary shares, making 5½ per cent., leaving £3,057 to be carried forward. During the year the Company's holding in the West African Company's shares, and the balance of the holding in Western Telegraph Company's 4 per cent. debentures, also 500 shares in the American Telegraph and Cable Company, have been sold. Most of the proceeds have been already invested in other suitable telegraph securities. The owners of a majority of the capital stock of the Commercial Cable Company, having sold and delivered their stock to the Mackay Companies in exchange for preferred shares and common shares in those companies, and the opportunity having been afforded to all other stockholders in the Commercial Cable Company to do the same, the directors decided, in the interest of the shareholders, to exchange the 450 shares of the Commercial Cable Company held by this Company for preferred shares and common shares of the Mackay Companies.

## AUCKLAND ELECTRIC TRAMWAYS.

The meeting of shareholders took place last Friday, under the presidency of Mr. C. G. Tegetmeier. Particulars of the report were given in our last issue.

The **Chairman** remarked that by a very narrow majority of the citizens of Auckland they had obtained permission to run their trams on Sundays, but judging by the way the trams were used by the people this would seem to supply a requirement of the community. If their average receipts of £2,100 per week were maintained, it was easy to calculate that their total receipts would be well over £100,000. It was evident to the directors that to meet the requirements of the public increased facilities would be necessary. Since the issue of the report they had received a telegram that the ratepayers of Auckland had decided by vote to allow the City Council to extend the company's tenure of the trams by two years—till 1932 in the city and 1934 in the suburbs.

The report was adopted.

## WEST INDIA AND PANAMA TELEGRAPH.

The report for the half-year ended Dec. 31 states that the amount to credit of revenue is £32,399, against £31,062 for the corresponding half-year of 1902. The expenses have been £25,243, against £20,679, leaving a balance of £7,156, to which is added interest on investments, and £2,068 brought from last account, making a total of £11,079. It is proposed to pay 6s. per share on account of arrears of dividend to Dec. 31, 1903, on the first preference shares, absorbing £10,368, and £711 is carried forward. The revenue account has been credited with £1,485, being a balance after the closing of the accounts attendant upon the loss of the ss. "Grappler," and also with £1,500 accumulated after adjustment in respect of income tax, but now no longer required. The directors regret to report that, without these transfers, the profits for the half-year would not have enabled them to recommend the payment of 6s. per share on account of arrears of dividend on the first preference shares. The expenses of repairing cables during the half-year amounted to £10,251, being £2,576 in excess of those for the corresponding period, attributable to a larger quantity of cable having been used in repairs. A further sum of £934 has been charged to reserve for cable used in the partial renewal of the St. Lucia-St. Vincent section, which was interrupted by volcanic disturbances in May, 1902, and, after being repaired, was again interrupted by the same cause in the following September. After much difficulty, the repair of this section was successfully completed in February last.

## MARKET DRAYTON ELECTRIC LIGHT AND POWER.

Mr. H. C. Donaldson-Hudson, of Cheswardine, presided at the annual meeting on Saturday. The report showed that the Company, although only formed during the past 18 months, had made very satisfactory progress. The year's workings to Dec. 31, 1903, produced a net profit of £396, which, with the previous balance of £82, gave a total of £478. Out of this it was decided to write off £40 from the preliminary expenses, to carry £360 to a reserve for renewal fund account, and the balance of £78 to take to the next account. The report was unanimously adopted. Mr. C. W. Clifford, who retired as a director, was re-elected. During the year the number of connections had been increased from an equivalent of 1,981 to 4,759 8-c.p. lamps.

## WILLANS AND ROBINSON.

At a meeting on Wednesday the poll in regard to remuneration of new directors, referred to in our issue of the 29th ult., was taken, and resulted in the confirmation, by a very large majority, of the resolution proposed at the previous meeting. Thus Mr. J. C. Peache will receive a fixed salary of £2,000 per annum, together with a contingent share of profits.

# NEW COMPANIES REGISTERED.

**Rapid Motor-Vehicle Company, Limited.** — Capital, £100. Object: to carry on the business of manufacturers of and dealers in all kinds of motor and other carriages.

**Topsham Electricity Supply Company, Limited.**—Capital, £3,000. Object: to carry on in Devonshire or elsewhere in the United Kingdom the business of electricians and suppliers of electricity in all its branches.

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**Electric Circuit Breaker, Limited.**—Capital, £12,000. Objects: to adopt an agreement between A. Parsons and G. Hall, and to carry on the business of ironfounders, mechanical engineers, etc.

**John Lucas, jun., and Co., Limited.**—Capital, £5,000. Objects: to acquire the business carried on at Sheffield as John Lucas, jun., and to carry on the business of iron, steel, and file manufacturers, electrical and general engineers, etc. Registered office: Love-street, Sheffield.

**Hope-Smith Electrical Company, Limited (Edinburgh).**—Capital, £3,000. Objects: to take over as a going concern the business of E. P. Smith, engineer, of 1, Forth-street, Edinburgh, and to carry on the business of electrical, mechanical, and general engineers, etc.

**Wallace Lamp Syndicate, Limited.**—Capital, £35,000. Objects: to acquire certain patents for the manufacture of electric lamps or parts thereof, to adopt an agreement with G. Wallace, and to carry on the business of electric lamp manufacturers, electrical and mechanical engineers, electricians, etc.

**Oulton Broad Electricity Company, Limited.**—Capital, £5,000. Objects: to acquire the business of electric light and power suppliers, electrical and general engineers, boat builders, &c., carried on by Messrs. Barber, Croft, and Co., at Oulton Broad, Suffolk, and to carry on the business of an electricity company in all its branches.

**Electric Light Insurance and Maintenance Company (1904), Limited.**—Capital, £5,000. Objects: to acquire and carry on the business heretofore carried on by the Electric Light Insurance and Maintenance Company, Limited, to adopt an agreement with the Sir Hiram Maxim Electrical and Engineering Company, Limited, etc.

**J. C. Lyell and Co., Limited.**—Capital, £2,000. Objects: to acquire and carry on at 55, Victoria-street, Westminster, the business of electricians, mechanical engineers, manufacturers of and dealers in all apparatus used in the generation, supply, accumulation, and employment of electricity, etc. Registered office: 55, Victoria-street, .W.

**Church Stretton Electric Supply Company, Limited.**—Capital, £10,000. Objects: to adopt an agreement with the Church Stretton Land Company, Limited, and to carry on at Church Stretton, Salop, or elsewhere the business of suppliers of electric light, constructors and fixers of cables, wires, lines, accumulators, lamps and works, distributors and suppliers of electricity, etc. Registered office: 1, Adam-street, Strand, W.C.

### Liens Registered.

**Alexandra Simplex Motor Company, Limited, London, E.C.** Mortgage registered May 3, for £240; secured on the undertaking and all the property, including the uncalled capital.

**British Electric Traction Company, Limited, London, W.C.**—Trust deed registered April 30 for £250,000 second debenture stock, with power to issue further stock, ranking *pari passu*, up to half the subscribed capital. Trustee: Electric and General Investment Company, Limited. Charged on the undertaking and property, present and future.

**Hamilton Motor Company, Limited (Coventry).**—A debenture dated April 8, 1904, to secure £200, charged on the Company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: E. Phillips, Coventry.

## APPOINTMENTS VACANT.

**Foreman,** mechanical section, Ipswich tramways. Salary £140 per annum. Applications by 23rd inst. See advertisement in last issue.

**Switchboard Attendant,** Burnley. Wages 30s. per week. Applications by 9 a.m. on May 21. See advertisement.

**Improver,** Corporation Electricity Department—sub-station, office, and outside work. Premium, 50 guineas; salary after few months. See advertisement.

**Assistant Clerk** Woolwich Electricity Department. Salary, £90 per annum, rising by annual increments of £7. 10s. to £140 per annum. Applications by May 23. See advertisement.

## PERSONAL.

Mr. R. D. Binsted, of the General Post Office, St. Martin's-le-Grand, has been appointed controller of the telegraph department in Edinburgh in succession to Mr. J. W. Plackett, promoted. Mr. Binsted enters on his new duties next week.

The salary of the tramways manager at Southport has been advanced from £182 to £200 per annum.

The staff of the Middlesbrough Corporation electricity department held their second annual dinner last week at the Zetland Hotel. Mr. H. M. Taylor, the borough electrical engineer, presided, and a very pleasant evening ensued. The Mayor (Councillor Chas. Dorman), who is also chairman of the Electricity Committee, was unable to be present, but sent congratulations to the staff upon the successful year's work of the department, and thanking the staff for the work which they had done. It was decided to make the dinner an annual event to be held in May of each year.

The salary of Mr. Dalrymple, deputy tramway manager of Glasgow, has been increased from £550 to £600.

The salary of Mr. Jones, electrical engineer, Batley, has been increased from £150 to £175 per annum.

The workmen in the electrical department of Fairfield Shipyard have presented their chief (Mr. Wm. Briggs), who is about to sever his connection with the department that had been under his charge for the past few years, with a handsome silver tea and coffee service.

On Friday last the employés of the Lowestoft Corporation tramways and electric light undertakings had their first annual dinner at the Imperial Hotel, Denmark-road. The company numbered about 120, and Councillor L. F. Orde, deputy mayor, presided.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tenders for rails and other material.

**Utrecht (Holland).**—The Municipality require tenders for supply and laying of electric cables by 31st inst.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Neath.**—The Corporation invite tenders for electric light mains, feed pillars, and switchboards in their area. Specifications may be obtained from the Borough Engineer, Gwyn Hall, Neath. Tenders by May 16.

**Penrhiwceiber (Wales).**—The Penrikyber Navigation Colliery Company, Limited, Penrhiwceiber, R.S.O., Glam., invite tenders for 12 months' supply of various stores, including electric lamps and fittings. Tenders by June 2.

**Mexborough.**—The Urban District Council invite tenders for two 100-kw. steam dynamos. Specifications, etc., may be obtained on application to the Engineer, Electricity Works. Tenders by 31st inst. See advertisement in last issue.

**Handsworth.**—The Urban District Council invite tenders for lighting feeders, mains, and roadwork. Specification, etc., can be obtained from Mr. H. Ward, Council House, Handsworth, near Birmingham. Tenders by May 25.

**Rugby.**—The Urban District Council invite tenders for paper-insulated, lead-covered, armoured service cables. Specification, etc., may be obtained from Mr. T. M. Wratislaw, clerk. Tenders by 20th inst. See advertisement in last issue.

**Rochester.**—The Corporation invite tenders for the construction of permanent way and overhead lines. Specifications, etc., can be obtained at the office of Mr. E. Rotter, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders by June 3.

**Warrington.**—The Electricity Committee invite tenders for (1) four mechanical stokers, (2) water softener and purifier, for the electric light station. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by 30th inst.

**Bristol.**—The Electrical Committee invite tenders for one 750 to 1,000-kw. single-phase turbo-alternator. Specifications can be obtained from the City Electrical Engineer. Tenders by noon on May 16. See advertisement in former issue.

**Walthamstow.**—The Urban District Council invite tenders for the supply of tramcars. Specifications, etc., may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on May 20. See advertisement in former issue.

**Hackney.**—The Council invite tenders for electricity supply mains (feeders and distributors). Specifications, etc., may be obtained from Mr. R. Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by May 26. See advertisement in former issue.

**Coventry.**—The Corporation invite tenders for supply and erection of a 15-ton electrical crane and pipework for the electricity works extension. Specifications, etc., may be obtained from Mr. J. A. Jeckell, Corporation Electricity Works. Tenders by 25th inst.

**Stretford.**—The Electricity Committee invite tenders for a 400-kw. steam-driven generator. Specifications, etc., may be obtained from Mr. T. L. Miller, M.I.C.E., 19, Brazennose-street, Manchester. Tenders by 18th inst. See advertisement in last issue.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant: excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc. Tenders by May 17. See advertisement in former issue.

**Salford.**—The Tramways Committee invite tenders for the supply of 20 cars and also two rail-cleaning and watering cars. Particulars may be obtained on application to Mr. Ernest Hatton, Tramway Offices, 32, Blackfriars-street, Salford. Tenders by 16th inst.

**Brighouse.**—The Corporation invite tenders for laying cables in their borough. Specification, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster, on and after 7th inst. Tenders by the 19th inst. See advertisement.

**Royton (near Oldham).**—Tenders are invited for overhead equipment and cables for the Royton and Crompton tramways. Specifications, etc., may be obtained from Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on May 28.

**Pietermaritzburg.**—The Corporation invite tenders for the supply of six completely-equipped electric tramcars, double-deck and single-truck type. Specifications, etc., may be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W. Tenders by 16th inst.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for a number of four-ton electric wharf cranes for Clydebank Dock. Specifications may be obtained at 16, Robertson-street, Glasgow, from Mr. Geo. H. Baxter, mechanical engineer. Tenders by noon on May 23.

**Sunderland.**—The Corporation invite tenders for the supply of one 500-kw. three-phase induction motor-generator for traction purposes. Specifications, etc., can be obtained from the Borough Elec-

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trical Engineer, Town Hall, Sunderland. Tenders by 27th inst. See advertisement.

**Abergavenny.**—The Building Committee of Visitors of the Monmouthshire Asylum invite electrical lighting schemes for the asylum and tenders for carrying out the same. Particulars can be obtained from Dr. James Glendinning, medical superintendent. Tenders by 10 a.m. on May 24.

**Manchester.**—The Tramways Committee invite tenders for (*a*) two steel boilers for heating purposes; (*b*) one steel boiler for steaming purposes. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 1 p.m on May 14.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for 12 months from May 31. Specifications, etc., may be obtained from Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by 25th inst. See advertisement in former issue.

**Hammersmith.**—The Borough Council invite tenders for the supply of two 1,500-kw. steam turbines or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters, capable of evaporating a total of 40,000lb. of steam per hour. Tenders by May 18. See advertisement in former issue.

**Greenwich.**—The London County Council invite tenders for the supply of 10 water-tube boilers, with superheaters, and for the erection of the same at the electricity generating station at Greenwich, for the electrical working of portions of tramways. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 17th inst.

**Partick (Scotland).**—The Town Council invite tenders for water-tube boiler, economiser, feed pump, hot-well tank, and pipework; also condensing plant, oil separator, cooling tower and cast-iron tank, and pipework. Specifications, etc., can be obtained at the office of Mr. Jas. Donaldson, town clerk, Burgh Chambers, Partick. Tenders by 12 noon on 24th inst.

**Argentina.**—Tenders are invited for the construction of a system of electric overhead trolley tramways between the Plaza de Mayo, Buenos Ayres, and the townships of Ortuzar, Devoto, and General Urquiza. Particulars may be obtained at the office of the Section of Public Works, Secretariat of the Municipality of Buenos Ayres Tenders by 2 p.m. on 30th inst.

**Rotherham.**—The Corporation invite tenders for single vulcanised-bitumen (covered) cables of various sizes; electricity meters of sizes for maximum currents of 2½, 5, 10, 25, and 50 amperes (the supply pressure is 230 and 460 volts continuous current), for 12 months from July 1. Particulars can be obtained from the Borough Electrical Engineer. Tenders by 31st inst. See advertisement.

**Canterbury.**—The Lighting Committee invite tenders for the following: One Lancashire or dry-back marine boiler, superheater, steam-pipes, a 300-kw. steam dynamo, switchboard and connections and extensions to economiser. Specifications, etc., may be obtained from Mr. Hammond, 64, Victoria-street, Westminster, S.W. Tenders before 10.30 a.m. on June 1. See advertisement in last issue.

**Hornsey.**—The Town Council invite tenders for the following: (Section D) condensing plant; (E) water-cooling apparatus; (F) pipework and valves; (G) water softener and purifier; (H) switchboards and connections. Specifications, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by 30th inst. See advertisement in last issue.

**Ayr (Scotland).**—The District Lunacy Board invite tenders for the following plant: (Section 1) boiler, pump, feed-water heater, piping, etc.; (2) building, chimney, flues, foundations, and iron roofing; (3) engines, dynamos, and main switchboard; (4) electric wiring and mains, etc. Specifications, etc., may be obtained from Mr. W. Maxwell Stewart, 55, West Regent-street, Glasgow. Tenders by May 20.

**Burslem.**—The Corporation invite tenders for water-tube boilers, steam-piping, pumps, water-softener, etc., engines, dynamos, balancer, and boosters, switchboard, cables (including laying), arc lamps, accumulators, and refuse destructor plant. Specifications, etc., may be obtained from Mr. A. Bremner, A.M.I.E.E., Market-buildings, Burslem. Tenders by 12 noon on May 14. See advertisement in former issue.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant in connection with electric lighting and tramways for the burgh: (Specification No. 11) overhead equipment, trolley wires, poles, and brackets, etc.; (12) rolling-stock; (13) wiring of generating station and car-shed. Specifications, etc., can be obtained on and after 10th inst. from the Town Clerk. Tenders by 12 noon on the 28th inst. See advertisement.

**Manchester.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection on the southerly side of Dock No. 9, 20 movable electric cranes (with spare gear therefor) for cargo working purposes. Specifications, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders before 10 a.m. on May 25.

**Antwerp.**—With reference to the notification issued by the Board of Trade on the 23rd ult. respecting calls for tenders by the Municipality for (1) the installation of additional heating apparatus in the Flemish Theatre and (2) the installation of heating apparatus in the gymnasium of the State secondary school, a dispatch has now been received from H.M. Consul-General at Antwerp reporting that the adjudication of the tenders has been deferred from the 3rd to the 17th inst.

**London County Council Tramways.**—The London County Council invite tenders for the following switchgear—namely: (*a*) one extra-high-tension three-phase board, with operating table and instrument board; (*b*) one low-tension combined direct-current and three phase board; (*c*) one combined extra high-tension and low-tension sub-station board; and (*d*) one extra high-tension and low-tension transformer board; and for the erection and connecting-up of the same at the Council's electricity generating station, Greenwich. Tenders by May 17. See advertisement in former issue.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

## RESULTS OF TENDERS.

**Wigan.**—The Corporation have accepted the tender of E. Wood and Co., Limited, Manchester, for erection of central car-sheds, Seven Stars, Wallgate.

**Withington (Lancs.).**—The Guardians of Chorlton Union have accepted the tender of Wm. Sprowson and Co., 21, Spring-gardens, Manchester, for one electric bed lift to be erected in the new pavilions.

**Preston.**—The Corporation have placed an order with I. Storey and Sons, Limited, Empress Foundry, Manchester, for condensing plant, cooling tower, and pipework at the tramways generating station.

**Loughborough (Leics.).**—The Corporation have accepted the tender of Mr. A. Faulks, Sparrow-hill, Loughborough, at £24,365, for erection of buildings for their electricity supply station to be erected on land in Bridge-street.

**Halifax.**—The Electricity Committee have accepted the tender of J. Sunderland and Co. for the work of changing the system of supply from alternating to direct current at Mr. Metcalf's residence, Heath Bank, at £12. 10s.

**Poplar.**—The Borough Council have under consideration the tender of Alfred Williams and Co., 815, Old Ford-road, for supplying and fixing an electric motor, together with well engine and pump complete, at the baths for £509.

**Middlesbrough.**—The Electric Lighting Committee have accepted the tender of H. Walker, Linthorpe, Middlesbrough, at £3,056. 10s., for extending the present boiler-house and engine-house, together with certain other works in connection therewith, at the electricity works, Snowdon-road.

**Birmingham.**—The Corporation have placed an order with the British Westinghouse Electric and Manufacturing Company, Limited, for three-phase generating plant of an aggregate capacity of 3,000 kw. This will consist of one 1,500-kw., rotating-field, 25-period, 5 000-volt generator, running at 166⅔ r.p.m., and three similar machines of 500 kw. each, running at 250 r.p.m.

**London County Council.**—The following tenders have been received for the supply of 7,000 electric lamps of British make: Sunbeam Lamp Company, £235. 10s. 5d., 2½ per cent. discount (recommended for acceptance); Edison and Swan United Electric Light Company, £237. 14s. 2d., net; Mackey's Electric Lamp Company, £244. 11s. 8d., 2½ per cent.; Sir Hiram Maxim Electrical and Engineering Company, £248. 15s., 2½ per cent.; General Electric Company, £280. 6s. 3d., 2½ per cent.

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**London County Council.**—The House of Commons Committee have passed the preamble as regards the following proposed electric tramways: Peckham Rye; Crystal Palace-road to Forest Hill Station; Woolwich to Abbey Wood; and a deviation of a quarter of a mile from the authorised line to Eltham. Other lines are being considered. An extension of the Waterloo-road terminus to York-road has been refused The Council contemplated the construction of a tramway from Hammersmith to Harlesden. The electrification of the Brixton line is proceeding very rapidly. The receipts for the week ended 30th ult. amounted to £10,684, against £8,455 for the corresponding period of last year, and for the month of April the receipts were £47,435, against £37,646 last year.

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# BUSINESS NOTES.

## TRACTION.

**Leicester.**—The opening of the electric tramways has been definitely fixed for the 18th inst.

**Bradford.**—The Corporation have given instructions for the construction of a line to Greengates.

**London United Tramways Bill.**—Clauses having been adjusted, this measure has been reported to the House of Commons for third reading.

**Sheffield.**—A trial trip was successfully carried out last Friday over the new Shoreham-street section. The new route is about a mile long, and later on will be extended.

**Darlington.**—There is considerable prospect that the tramway system will be in operation by Whitsuntide. The Tramways Committee appointed motormen on Tuesday.

**North-Eastern Railway Company.**—The company have announced that the electric train service will on the 16th inst. be extended to Tynemouth, a 15 minutes' service being maintained.

**Derby.**—At the last meeting of the Town Council it was stated that the contractors were now making good progress. It is expected that the route from Alvaston to the Midland-road will be finished in three week.

**Preston-Blackburn.**—The Lancashire and Yorkshire Railway Company have petitioned the House of Commons for leave to be heard by counsel against the Preston and Blackburn Tramway Bill when the committee stage is reached.

**Gloucester.**—The *Gloucester Journal* has issued a souvenir supplement to its publication of the 7th inst. to commemorate the opening of the tramways. The history and a full description of the undertaking is given, together with several illustrations.

**Birmingham.**—The Tramways Committee had another long sitting this week, when the general scheme of tramways for the whole of the city and the plans of the city surveyor respecting the thoroughfares were again under consideration, and it is reported that good progress was made.

**Rochdale.**—In reference to our note of the 29th ult., stating that the Town Council would be recommended to authorise an extension of the electric works in order to secure the additional energy needed for the tramways, this proposal was adopted at the meeting of the Council last week.

**Swansea.**—The Corporation have made arrangements with the Glamorgan County Council by which the former are to work the half-mile of tramway being constructed beyond the borough limit at Morriston in the direction of Clydach until the County Council can take it over.

**Auckland.**—It was reported at the last meeting of the Rural Council that the promoters of the proposed electrical tramway for the district had decided to leave the West Auckland and Etherley sections out of the system for the present, owing to difficulties with the North-Eastern Railway Company.

**Leeds-Guiseley.**—Following on our note last week, the Councils of Rawdon, Yeadon, and Guiseley have now decided to take into consideration the question of contribution on the lines asked for by Leeds, and that a deputation from each of the Councils meet the Tramways Committee to negotiate matters.

**Bury.**—The Limefield section will be ready for Whitsuntide. The recommendations of the tramways manager in regard to fares have been adopted, his opinion being that it was a mistake to charge very low fares. Passengers desirous of travelling at workmen's fares must fill up a form stating their occupation and where employed.

**Belfast and County Down Railway.**—As the company is threatened with competition from the projected Belfast-Holywood tramway, they have considered the feasibility of electrification. They have come to the conclusion, however, that the cost of the conversion would be prohibitive for a line of comparatively light traffic.

**Scarborough.**—The cars began running last Friday. The Sabbatarians are protesting against Sunday running, but the company, after a full discussion, decided to continue the running on Sunday to meet the public requirements. It was decided to give the conductors instructions not to ring the bells in passing places of worship.

**Hastings.**—After a lengthy discussion the Corporation have adopted the recommendation of the Roads Committee that an agreement be entered into with the company providing for payment by the latter of the actual cost of the wood blocks on the portions of the roadways which would be repairable by the company under certain circumstances.

**Bath.**—The Board of Trade having forwarded a copy of the proposed regulations with respect to the use of electrical power on the Bath and district light railways, and requested the Corporation to state any observations they might have to make on them, it has been decided to make certain recommendations in regard to brake power, speed limit, and trolley poles.

**London and North-Western Electrification.**—It is stated that the London and North-Western Railway Company are completing preliminary arrangements for the electrification of their Newport-Pagnell branch line, which leaves their main route to the North at Wolverton, a distance of four miles. The fourth-rail system is to be adopted, as in the case of the Lancashire and Yorkshire Railway.

**Bolton.**—The accounts show a falling-off in the profits for the past year, being only £2,260 as against £4,966 in the previous twelvemonth. The traffic receipts showed an improvement, being £95,095, as against £85,703, but the expenditure increased from £80,737 to £92,835. The Town Council are considering a plan for the reduction of the expenses without inconvenience to the public.

**Sutton-in-Ashfield.**—The Mansfield and District Light Railway Company having forwarded plans of the proposed tramways, the District Council have instructed the clerk to communicate with the other councils concerned with respect to the appointment of a tramway expert. It has been reported that the Mansfield Woodhouse Urban Council had agreed to join the other local authorities in obtaining the opinion of an expert upon the plans of the proposed tramways.

**Nottingham.**—At the last meeting of the City Council it was stated that the tramways contributed £13,000 to the Council's revenue last year, against £18,000 the previous year, about £5,000 having to be provided as a sinking fund. Last year the tramway had had the benefit of a complete year's running, and had also had the advantage of an additional branch line down Hartley-road for a portion of the year. The £5,000 in aid of the sinking fund brings the reserve up to £34,000.

**Worcester.**—The new tramways in High-street, Sidbury, and London-road, Worcester, were inspected last Friday by the Board of Trade, the only objection being that at one corner in High-street the line was 8in. too near the pavement. The City Council will probably assent to the widening of the pavement, as until the deadlock is removed the trams cannot run on the new route, and it is estimated that the company are losing about £7 a week, while the Corporation are losing some £2 a week for electric current.

**Bristol.**—The Corporation have approved the agreement with the tramways company, by which the terms of purchase for the new lines will be the same as for the old lines. All the protective clauses of the 1898 Act have been maintained. The Corporation have agreed to a by-law allowing six inside passengers and two outside in excess of the authorised number on special occasions so as to obviate a continuation of the prosecutions for overcrowding. Westbury-road and Downend-road are to be widened. The Westbury District Council have come to terms with the Bristol Tramways Company in regard to the projected extension.

**Paisley.**—At the last meeting of the Corporation it was reported that at a conference with the Glasgow Corporation the representatives of the latter stated they had done everything in their power, and any further negotiatiations must be on the company's side. It was also reported that the first portion of the Paisley system was to be inspected by the Board of Trade yesterday, and it was suggested that it would be advisable to wait and see what action the company took then, and in the event of their failing to run cars immediately, the Corporation should ask an interview with the company, and failing a response the Corporation would have to appeal to the Board of Trade.

**Yarmouth.**—The tramways accounts for the year ending March 31 show that the total income was £7,876. 4s. 6d., made up of £7,717. 11s. 5d. traffic revenue and £158. 13s. 1d. miscellaneous. The expenditure was: power, £1,803. 12s.; traffic costs, £2,376. 3s. 7d.; general expenses, £1,000. 16s. 11d.; repairs, £757. 15s. 2d.—total, £5,938. 14s. 8d.; leaving a balance of £1 937. 9s. 10d. Adding on the balance due for the previous year, less sinking fund arrears of £405. 19s. 7d., there was £2,343. 9s. 3d. available on revenue account. From this £1,569. 19s. 9d. is taken as interest, and £582. 6s. 2d. appropriated to sinking fund, leaving in hand a net balance of £191. 3s. 4d.

**Spen Valley.**—The Cleckheaton District Council have decided to lodge a protest with the Board of Trade against the application of the British Electric Traction Company to waive the construction of a line from Cleckheaton to Hartshead Moor, which is included in the company's provisional order. The electrical energy for the service of the lines in the Cleckheaton district is supplied by the District Council, and in the belief that the line to Hartshead Moor would be made they put down a quarter of a mile of cable. The Liversedge Council are also protesting against the application in respect of a projected continuation of the Hightown line to Hartshead Moor, which would form a junction with the line from Cleckheaton.

**Glasgow.**—The arbitrator has given in his decision with reference to the deduction which the Corporation are entitled to under Section 37 of the Poor-Law Act of 1845. The authorities concerned had offered the Corporation a deduction of 20 per cent., while the Corporation refused to accept less than 33⅓ per cent., which they paid pending the decision of the referee. It has been decided that the Corporation are entitled to a deduction of 36 per cent. The Corporation will thus require to pay only £16,147. 3s. for poor, etc., rates, instead of the £20,044. 15s. 2d. at which they were previously assessed by the councils, a saving to the Corporation of £3,897. 12s. 2d. a year. The proposed tramway extensions have been sanctioned.

**Cardiff.**—A deputation of residents in Cathays has waited upon the Council requesting that the track to that place be paved with wood instead of granite sets. It was stated that the extra cost involved would be £1,032. A proposition to use wood paving has been defeated. It has been resolved that employés be paid "national holiday" instead of the Sunday rate of wages on Good Friday. Councillor Courtis, who protested against this increased expenditure, stated in an interview that he would raise the question again before next Easter. It will be remembered that the Corporation finances have been subjected to considerable criticism lately, and, as stated in our issue of the 29th ult., a sub-committee has been appointed to investigate the tramway expenditure.

**Aston.**—At the last meeting of the Town Council a statement was submitted of the 18 months' working. The revenue totalled £47,400, and there was a surplus of £21,345. 19s. 4d., against £16,281. 17s. 9d. in the corresponding period, being an increase of 31 per cent., notwithstanding the grant of increased wages. The total number of passengers on trams and 'buses was 8,388,230, against 7,960,479, while the number of miles covered was 655,780, against 638,765 in the corresponding 18 months. In reduction of capital account £12,000 has been transferred, and £4,152 paid for interest on loans. The balance brought down was £5,193, and out of this £2,700 had been appropriated in aid of the rates, leaving a balance carried forward of £2,496 for future use.

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**Reading.**—The financial statement submitted by the borough accountant as to the working of tramways since the conversion from horse to electric traction on July 22, 1903, shows an excess of receipts over working expenses of £8,816, notwithstanding the abnormally wet season. From July 22, 1903, to March 31, 1904, the number of car miles run by the cars was 555,540, the number of passengers carried was 4,889,270, the passenger receipts per car mile 9·08d., and the receipts per passenger carried 1·03d. The total operating expenses, amounting to £12,463. 10s. 1d., worked out at 5·34d. per car mile run, which compares favourably with the average of 6·5d. for some 40 tramway systems of the country. The cost of generation per unit averaged 0·85d. The consumption of current per car mile was one unit. The whole of the plant has been maintained in a sound and efficient condition.

**Bournemouth.**—The accounts for the last 12 months—the first complete year of working—show receipts, £53,398; working expenses, £29,277; capital charges, £16,386; amount paid in respect of local rates, £1,305; net surplus, £7,734. The manager's accompanying report states that the working expenses represent 6·88d per car mile, and the receipts from traffic 12·31d. per car mile. The gross balance as the result of the year's working amounts to £24,120. 16s. 1d. This, added to the gross balance of £9,315. 6s. 10d. brought forward from the period ended March 31, 1903, makes a gross balance since the commencement of traffic of £33,436. 2s. 11d. The capital charges from the commencement of traffic have amounted to £23,214. 3s. 9d., leaving a net balance since the commencement of traffic (21 months) of £10,221. 19s. 2d. The total number of passengers carried was 9,363 985, the average receipts per passenger being 1·34d. The total number of car miles run was 1,022,168·75.

**Baker-street and Waterloo Railway.**—Mr. Yerkes wrote to the editor of the *Times* on the question of the liability of the Baker-street and Railway Company to the Southwark Borough Council relating to the subways at the Elephant and Castle, that after this year's Bill came up for second reading he had offered without prejudice to recommend to the board of directors of the Baker-street and Waterloo road that they should (1) pay to the Council an agreed sum on account of the expense of the subways at the Elephant and Castle, they to take powers and build the subways; (2) to leave the whole matter to arbitration; (3) to have a friendly suit in court; or (4) to let the whole matter be heard before a committee of the House of Lords. The Southwark Council had at first refused all these propositions, insisting that there was only one thing to be done, and that was, notwithstanding the provisions of the Bill, that the company should build the subways, which, however, they refused to do. Afterwards, at the solicitation of some of their friends, the Council were prevailed upon to agree to the first suggestion, and Mr. Jerkes a sum, which they finally decided to accept.

**Burton-on-Trent.**—The following is a summary of the tramways accounts up to March 31: population of district served, 52,000; year of operation, first; system and gauge, overhead trolley, 3ft. 6in.; length of single track, 8·64 miles; total capital expended, £82,500; traffic revenue, £11,574; other sources, £369; advertising and sale of time-tables have brought in £336 and the parcel traffic is yielding revenue at the rate of £100 per year; operating costs, £8,919; per cent. to revenue, 74·5; gross profit before providing for interest, depreciation, or sinking fund, £3,024; percentage to average capital per annum, 3·66; interest on loan and capital, less credits, £1,534; amount provided for depreciation or sinking fund, £772; percentage to average capital per annum, ·93 — net profit, £718; number of car miles run, 282,378; number of passengers carried, 2,566,134; number of passengers per car mile, 9·05; times population carried, 75; traffic revenue per car mile, 9·84d.; traffic revenue per passenger, 1·084d.; costs per passenger ·83d.; number of units per car mile, 1·285; total revenue per car mile, 10·14d.; total power (purchase) costs per unit, 1·45d.; operating costs per car mile—power costs, 1·87d.; traffic costs, 3·54d; maintenance and renewals, ·82d.; management expenses, 1·34d.; total operating costs, 7·57d. Excluding special items, the operating costs are reduced to 6·45d. A considerable amount has been spent on tools, machinery, and other special expenditure incidental to starting up of department, and many charges which are of an annual nature are being charged in full, and all these are being wiped off in the first eight months and are included in the operating costs. There was no Sunday running for the first five weeks.

**Newcastle.**—A joint committee of the Corporation this week received a deputation from the Tyneside Tramways Company, and after the initial proposals of the latter had been rejected, the following fresh ones were submitted, which the committee agreed to consider at its meeting to-day: Wallsend traffic—(1) The Corporation to turn no cars at the Wallsend boundary, but to run on the high and low route to Park-road either by circular or shuttle service, retaining their own drivers and conductors. (2) The Corporation may increase the service to Wallsend at their option. (3) The Corporation to pay to the company ½d. per passenger for each passenger carried in Wallsend, with proportionate reduction for workmen and children. (4) Fares charged by Corporation in Wallsend to be on their standard scale, with stages so arranged as not to be prejudicial to the interests of Wallsend inhabitants. (5) Willington Quay and Shields—Corporation to allow the company to run cars with their own employés between Shields and Stanhope-street, Newcastle, and *vice versâ*, every 16 minutes, the company to hand over to the Corporation the whole of the receipts taken on account of passengers carried in Newcastle, less operating expenses only. (6) The company's employés will, in the Newcastle area, be entirely subject to the control of the Newcastle Corporation officials. (7) The punctuality of the company's cars to be to the reasonable approval of the Corporation. (8) The company's cars to be maintained to the reasonable satisfaction of the Corporation. (9) Gosforth Park—The Corporation to have entire control of the Gosforth Park line during the races, and to pay to the company half the fare charged from the Central Station to Gosforth for every passenger carried on the company's lines. Fares to be settled by agreement. The company to have the power to charge special fares during race days, and the Corporation to get half the special fare, which will more than pay their working expenses and provide a reasonable profit. (10) The Corporation to run sufficient special cars to Gosforth Park during the races as will reasonably meet the requirements of the travelling public. (11) The company to be allowed to run up to Gosforth with their own employés during the races, but on their own part of the line only, and the service to be under the control of the Corporation, and not to injuriously interfere with the Corporation service. (12) On ordinary days the Corporation to run at least an hour's service to Gosforth Park, paying to the company 1d. per passenger carried on the company's lines. The penny is half the fare from the Newcastle terminus at Gosforth to the park. As an alternative, at the option of the Corporation, the company to be allowed to run a half-hour's service from Gosforth Park to the Central Station. (13) The cost of making junctions to be borne by each party equally. (14) Each party to supply all the energy required by cars within their own area. (15) The party operating the car to be responsible for accidents caused by or to same. The company's track and overhead equipment over which Corporation cars run to be maintained to the reasonable satisfaction of the Corporation. Finally, if all other points be agreed to, the company is prepared to allow the Corporation men to take charge of their cars while in Newcastle. We understand the Corporation consider that one of the tramway authorities—we presume themselves—should have sole power to fix the schedule, and that through fares should not be granted. This would mean that any passenger travelling on the through cars would have to pay two fares—one on each side of the borough boundary. This would obviate complications in the tramway accounts, but would occasion much inconvenience to passengers. In connection with the inter-running question, the chairman and vice-chairman of the Tramways Committee have resigned office owing to a difference of opinion with their colleagues.

## LIGHTING AND GENERAL.

**Perth.**—Since the institution of the electric supply 25,894 lamps have been connected.

**Cheltenham.**—The Town Council are raising £15,954 for purposes of electric lighting and power.

**Sneinton.**—The Postmaster-General has authorised an extension of the telegraph to the post office.

**Norden.**—The District Council are about to confer with representatives of the Lancashire Electric Power Company.

**Stretford.**—The Council intend to extend the electricity station in consequence of the increased demand for current.

**Hastings.**—The proposal of the Electricity Committee to purchase new plant at a cost of £3,416. 10s. has been shelved for 12 months.

**Urban Electric Supply Co.**—Letters of allotment for the issue of £200,000 4½ per cent. first mortgage debenture stock have been posted.

**For Sale.**—Particulars of sales of a complete electrical plant, of a 51-b.h.p. electric light gas-engine, etc., will be found in another column.

**Datchet.**—The Lighting Committee have been instructed to obtain tenders for lighting by electricity, oil, and gas, and to report to the Council.

**Gainsborough.**—The Bill containing the electric lighting provisional order has passed Mr. J. W. Lowther's Committee of the House of Commons.

**Kirkby-in-Ashby.**—The Bill containing the electric lighting provisional order has passed Mr. J. W. Lowther's Committee of the House of Commons.

**Whitby.**—The Urban District Council have agreed to the provision of surface-condensing plant at their electricity works at an estimated cost of £700.

**Beckenham.**—The proposed agreement with the British Insulated and Helsby Cables, Limited, will come before the next meeting of the Urban District Council.

**Standish.**—The Town Council are favourably considering an offer from the Lancashire Electric Power Company with regard to supplying the township with electricity.

**Yorkshire Electric Power Co.**—This company have withdrawn their opposition to the Leeds Corporation (Consolidation) Bill and to the Rotherham Corporation Bill.

**North Wales Electric Power Bill.**—On Friday the chairman of the committee (Lord Clifford, of Chudleigh) intimated that the committee found the preamble of the Bill proved.

**Felixstowe.**—The Council have approved plans of the proposed extensions of the electric light works prepared by Mr. R. P. Wilson, so that they may be submitted to the Local Government Board.

**New Issue.**—The Northwich Electric Supply Company, Limited, are issuing the balance of the authorised capital, amounting to 1,371 shares of £5 each. Particulars will be found in another column.

**London County Council.**—On Tuesday it was agreed to lend the Battersea Borough Council £11,042 for electric lighting purposes and the St. Pancras Borough Council £19,000 for electric light installation.

**Walsall.**—The Walsall Electricity Committee propose to lay a 4in. main as far as the workhouse on the Pleck-road at a cost of £113, so as to afford a satisfactory supply of current to consumers in that part of the road.

**Parkside Asylum, Macclesfield.**—The Cheshire County Council have instructed Messrs. Lacey, Sillar, and Leigh, the engineers, to

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prepare the necessary specifications for electrical plant, wiring, etc., of the asylum.

**Golborne.**—The Urban District Council are considering a letter from the Lancashire Electric Power Company stating that they would be in a position to supply electrical energy in bulk to consumers in January, 1905.

**Hammersmith.**—The report with regard to proposed extensions to the generating plant (which appeared in a previous issue) was adopted at the last meeting of the Borough Council, and the work is to be put in hand at once.

**Bath.**—The Rural District Council have decided not to comply with the request made by the Bath Gas Company that the clause known as the Bermondsey clause be inserted in the proposed electric lighting provisional order.

**Dudley.**—The tramway and electric lighting department shows gross receipts for the year of £10,600, while the working expenses are given at £5,608, showing a gross profit of £4,924. The number of units generated were 470,000.

**Nottingham.**—The accounts of the electricity undertaking show that there is an estimated net profit of £12,000, as compared with an actual profit last year of £8,800. Of that sum £6,000 is to be carried to the reserve and £6,000 to the rates.

**Hampton Wick.**—The Council have received from the Board of Trade a copy of the order proposed to be issued to the Edmundson Electricity Company, which is in conformity with the agreements between the company and the Council.

**Long Eaton.**—We understand that the Urban District Council have fixed upon a flat rate of 4d. per unit for houses, shops, chapels, and manufactories. For current supplied for power and heating the price is to be continued at the existing rate.

**Nottingham Mechanical and Electrical Engineers.** — On Saturday 40 members visited the Boughton waterworks by the courtesy of Alderman Jelley, the chairman of the Water Committee. Mr. F. W. Davies, the waterworks engineer, described the works.

**Maidenhead.**—Mr. C. O. Milton in his last report says nine consumers were connected during the last month, bringing lamps connected up to 11,780. Two new applications have come in this month, bringing the total up to 188 applications received.

**Wimbledon.**—The Urban District Council are holding, under the supervision of Mr. H. Tomlinson Lee. A.M.I.E.E., their chief electrical engineer, a public electrical exhibition at the Worple Hall, Worple-road, Wimbledon, from the 18th to the 28th inst.

**Barry.**—The Bill containing a provisional order amending the Barry Electric Lighting Order, 1901, so that Section 6 of it shall be deemed to commence on the date of the passing of the 1904 order, has passed Mr. J. W. Lowther's Committee in the House of Commons.

**Rochdale.**—Mr. E. M. Lacey has been engaged as consulting engineer in connection with the extensions of plant required at the Dane-street works. The three-phase system of electrical supply to sub-stations on the Heywood and Littleborough routes has been adopted.

**Stalybridge, Hyde, Mossley, and Dukinfield** —It has been resolved to reduce the price of lighting from 4½d. to 4d. per unit, and for power a sliding scale from 2½d. down to 1d. per unit. Special case of large consumers will be dealt with individually by the committee.

**Margam.**—The Council have decided to apply to the Local Government Board for sanction to borrow £5,600 for installing a system of electric lighting to deal with the public and private lighting of the whole length of the main streets and with the public lighting only in the side streets.

**Crediton.**—The Urban District Council have rescinded the resolution previously passed—that the underground system only should be used for electric light—and have given permission for the use of overhead wires. They have also assented to the provisional order issued by the Board of Trade.

**Harrogate.**—The Lighting Committee has proposed that the tariffs for the electric light be reduced as follows: flat rate, 6d. to 5d. per unit; demand indicator system, from 6d. and 3d. to 6d. and 2d. per unit; radiators and power, from 2d. to 1½d. per unit. The proposal has been referred back.

**"National Review."**—We are requested to state that the *National Review*, beginning with the June number, will be published by the proprietor (Mr. L. J. Maxse) at his own office—viz., 23, Ryder-street, St. James's-street, London, S.W.—where henceforward all communications should be addressed.

**Parliament.**—The following Bills have been read a third time in the House of Lords: West Riding Tramways, Metropolitan District Railway, Leicester and Warwickshire Electric Power, Derbyshire and Nottinghamshire Electric Power, Clyde Valley Electric Power, Staffordshire Mines Drainage.

**Bournemouth.**—On consideration of the annual report of the borough electrical engineer, the borough engineer and electrical engineer were instructed by the Tramways and Parliamentary Committee to report further on the proposal in the report to provide additional plant at the generating station.

**Brentford.**—A committee has considered the electric lighting question, and has recommended that the statutory notices should be served so that in the event of another company applying for powers the Council would be in a position to safeguard their interests. The matter will be discussed at a special meeting.

**Mitchelstown (Cork).**—A house-to-house canvass in the town has obtained the signatures of 128 householders who agreed to become consumers of the electric light. It is estimated that the revenue from these consumers will amount to £400 a year, which will more than defray the expenditure for the proposed scheme.

**May-Oatway Fire Appliances, Limited.**—We are informed that this company are now opening branches in Liverpool, Birmingham, and Leeds. They have also appointed a manager for Scotland, who will relieve the directors of the company to develop Lancashire, Yorkshire, the Midlands, and Ireland from the three cities referred to.

**Lichfield.**—It is stated that the Board of Trade have refused the Lichfield Corporation's application for a provisional order for supplying electricity and for lighting, and other purposes, outside the city boundaries. The Corporation in 1901 secured an order permitting it to supply electricity within the city, which may not now be proceeded with.

**Newhaven.**—The Rural District Council have agreed to enter into negotiations with the Brighton Corporation in regard to the electric lighting of Rottingdean and Ovingdean, provided, firstly, the Corporation satisfied the company at present working at Rottingdean, and, secondly, if they agreed to admit of the Ovingdean sewage into their intercepting sewer.

**Macclesfield.**—At the last meeting of the Electricity Committee, the Chairman announced that he had an electric lighting scheme under his consideration which he thought was better than anything that had yet been before them, and he asked the committee to accept it in principle and he would submit it to them at their next meeting. This was agreed to.

**Stepney.**—The balance-sheet of the borough electrical installation for the year ending March 31 shows the year to have been an unusually successful one. The gross profit amounts to £12,792, which, after allowing for the payment of interest ond the repayment of capital, the writing off of small amounts of capital, enables the committee to put £4,897 to the reserve fund.

**Cullercoats** —Last week we noted that the installation of the electric light in Cullercoats parish church is being carried out under the superintendence of Mr. T. Hanning, of the firm of Robson and Coleman, Newcastle. This should read "by" the firm instead of "of," Mr. Hanning being the consulting engineer for this work, which Messrs. Robson and Coleman are carrying out to his orders.

**Electrical Railway Signalling** —The Great Western Railway Company have completed arrangements for the equipment of a section of their main line, near Didcot, with electrically-controlled signals. The necessary motive power will be derived from accumulators attached to each signal post, which will be charged from an adjoining power station. The installation is to be completed during the course of the coming summer.

**Gillingham (Kent).**—The engineer's last report shows that 282 8-c.p. lamps were connected to the mains since the previous meeting, making a total of 10,357 8 c.p. lamps connected in the district, also that applications had been received for 110 8-c.p. lamps to be connected. Notice will be given to consumers that they will not be permitted to change from one system of charging to another oftener than once a year.

**Brighton.**—An enquiry has been held into the application of the Corporation for sanction to borrow sums of £4,000 to pay the cost of changing over the standard pressure in the Corporation electricity mains in a portion of the borough and £6,000 for the purchase of electric motors to be let out on hire. An agreement has been entered into in connection with the proposed extension of the North-road generating station.

**Herts.**—The central and western electric mains at the County County asylum are to be renewed at a cost of £649, the work having become necessary owing to defects in the insulation which had developed, and which, in the opinion of the engineer, were caused by local action and could not have been foreseen. To prevent a recurrence of the trouble, the new mains will be enclosed in iron tubes along the walls, and not underneath the passages.

**Ayr.**—The monthly report by the burgh electrical engineer (Mr. Roland Marshall) states that during the past month the works have run satisfactorily. During the month the pressure of supply to consumers in the eastern half of Miller-road has been raised from 100 to 200 volts. The Glengall Asylum authorities are proposing to generate their own electricity. An agreement has been entered into with the National Telephone Company *re* underground wiring.

**Blackpool.**—The electricity department has made £1,887 clear profit, but Mr. Furness expects a surplus of £3,500 for next year. He estimates that with the new plant 120,000 more units of electricity can be generated, representing an added income of £1,700, with an increase in working cost of only £300. The total revenue last year was £31,657, and the expectation for the current year is an advance to £33,312. Working expenses were £17,013. This item is given in the new estimates as £18,215.

**Holidays.**—The Great Eastern Railway Company have issued a new illustrated "Tourist Guide to the Continent," which is cheap at the price of 6d. Among its new features are particulars of new tours in the Tyrol, in North Germany, and in Norway, Denmark, and Sweden, *via* the Royal Mail Harwich Hook of Holland route; of tours in the Luther Country, and Thuringian and Hartz Mountains; with a series of Continental maps, and a chapter, "Dull Useful Information," giving particulars of the cost of Continental travel.

**Redditch.**—The accounts for the past year of the electric supply undertaking show a nominal authorised capital of £18,911, and an actual capital expenditure of nearly £22,000. There was a profit on the year's working of £460, as compared with £214 the previous year. The increased production of 50,000 units last year for motive power only entailed an increase of £80 in the works' cost. Mr. Ferguson, works manager, states that if the 106,000 units for motive power at a low price had not been sold, the cost per unit would not have been 2½d., but 3½d.

**Watford.**—A petition has been deposited in the House of Lords by the Watford Gas and Coke Company against the Bill to confirm the

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Watford electric lighting provisional order. The chief point raised by the gas company is whether or not the local authority should be permitted to enter into what they called unfair competition with them by being authorised to have resort to the rates in order to make good any deficiency which might arise in working the undertaking. The gas company ask Parliament for the insertion of a clause which will prevent the local authority from doing this.

**St. Annes.**—Mr. J. Clothier, the electrical engineer, in his monthly report to the Electricity Committee states: "Since the last report we have received five applications for 327 lights. These figures give us the 12 months' working, and it is gratifying to note that there is an increase of nearly 45·5 per cent. in the units sold to private consumers, whilst the number of consumers connected to the mains during the year is 76, an increase of 44·5 per cent., which shows that the new consumers are well up to the size of the old ones, and that we have not exhausted the field of large and profitable consumers."

**Kirkcaldy.**—The Town Council have agreed to a revised scale of charges for electric energy and motive power from the 15th inst. as follows: For electric energy for lighting—for the first 1,000 units, per terms, at 4½d. per unit; for the next 1,000 units, per terms, at 4d. per unit; for the next 1,000 units, per terms, at 3½d. per unit; for all in excess of this amount, at 3d. per unit. For electric energy for motive power and heating purposes—for the first 10,000 units, per annum, at 2½d. per unit; for the next 90,000 units, per annum, at 1d. per unit; for all in excess of this amount, at 1½d. per unit.

**Shoreham.**—The Harbour Trustees have disapproved of a plan by the Brighton Corporation, who proposed to lay their electric cables underneath the harbour at a depth of only 2ft. below the mud at the bottom of the canal, and to fill up to the level of the harbour bed with cement. This, it was said, would create a hard backbone right across the harbour, and in addition to being a possible danger to shipping, it would prevent the deepening of the harbour if at any future time it was wished to dredge it deeper. The harbour master suggests that the cable should be lowered sufficiently to allow of there being some 3ft. or 4ft. between the level of the canal bed and the top of the covering of the cable.

**Hereford.**—The Electric Lighting Committee have presented a return showing the output of current for the quarters ended March 25, 1903, and March 25, 1904, as follows: quarter ending March 25, 1904—units sold for lighting 35,944, against 30,594 corresponding quarter last year; units sold for power 4,576, against 3,573; total units sold 40,519, against 34,167; equivalent number of 8-c.p. lamps at beginning of quarter 16,741, against 9,349; 8-c.p. lamps added 159, against 23; equivalent number of 8-c.p. lamps at end of quarter 10,900, against 9,372; number of arc lamps connected 22, against 20; number of motors connected 17, against 13; horse-power of motors connected 50½, against 42.

**Tonbridge.**—Mr. Annison has been appointed chairman of the Electric Lighting Committee. The engineer's last report shows that two additional applications for light were received during the month, bringing the total number of consumers to date to 100, equivalent to 3,399 8-c.p. lamps. The gas lamps along the line of route of the electric cable are to be replaced with electric Nernst lamps. The Electric Lighting Committee's charge for Nernst lamps will be: ½-ampere, £3. 15s. per annum; ¼-ampere, £3 per annum, as against gas company's charge of £3. 12s. 6d. (including 4s. 6d. for initial outlay) for No. 4 Kern burner and £3. 3s. (including 3s. 6d. for initial outlay) for No. 3 Kern burner.

**Newport (Mon.).**—With reference to the recent enquiry into an application to borrow £60,500 for the purpose of electric lighting and power supply, the Local Government Board have replied that the expenditure on the power station must be regarded as expenditure for tramway purposes, that the question of sanctioning a loan for that purpose was a matter for the Board of Trade, and that that department would be willing to entertain an application for such loan. The amount on this account is £45,250. With respect to the balance, the Local Government Board would sanction a loan, less the amount of debt outstanding, on works which would be superseded. The Tramways Committee has decided to apply to the Board of Trade for a loan of £45,250.

**Birkenhead.**—The Electricity Committee in their last report states that during the year ended with March 566,171 Board of Trade units were supplied to 606 consumers, an increase on the year of 113,533 units and 124 consumers, or 20·7 per cent. in consumption and 25·7 per cent. in the increase of consumers. The increase for the last quarter is about the same. The Board of Trade having approved the provisional order empowering the Corporation to extend the electricity mains so as to supply the outlying districts of Prenton and Upton, it is proposed to invite tenders for supplying and laying additional mains and feeders, and to borrow £20,000 for feeder and distributing mains, electric meters, service cables, etc., estimated to be required during the ensuing three years.

**Carnarvon.**—Dr. R. Parry has presented a report of the Electric Lighting Committee containing the following paragraph: "On the question being raised of the Council's liability for the repayment of the balance of any loans outstanding after the expiration of 20 years (the full term of the agreement), Mr. Cownie, manager of the National Construction Company, stated that his company would be quite prepared to continue to run the undertaking for the full term of the loan, if the Council so desired, when the undertaking would be handed over to the Corporation free of all liability." With regard to amended clauses as accepted by the power company, it has been resolved that the first clause, by which the power company can only supply electricity within the borough with the consent of the Corporation, and which the power company had refused to accept, be insisted upon.

**Gateshead.**—The Town Council last week received a deputation of users of electric light respecting the price of the light in the borough. It was stated that the electric light company had offered substantial reductions in price if the Council would extend the lease from 13 to 19 years. The Council had agreed to a one year extension, but had declined to grant the longer period. The deputation desired the Council to reconsider its decision, and to grant the concession. The Mayor said that the Council believed that it would be wrong to the future prospects of the town to add six years to the company's arrangement, and so prevent the arrangements with the tram and electric companies ending together. The trams and the lighting would be worked together if the town took them over, and the Council thought it was acting in the best interests of the town in arriving at the decision which it had made.

**Middlesbrough.**—The Electric Lighting Committee's financial statement for the year ended March 31 last shows a total expenditure of £3,993 and an income of £9,037, giving a gross profit of £5,044, and equal to 1·92d. per unit sold. The gross profit in the preceding year was £3 260, last year's figures showing an increase of £1 783. The charges for interest and redemption amounted to £4,509, leaving £534 transferable to reserve fund. There is thus a balance beyond interest and redemption, interest and redemption having been met in full. The profit of £534, against a loss in the preceding year of £485, amounts practically to a gain of £1,019. The revenue shows an increase of £2,213, or 34 per cent.; the cost an increase of £529, or about 15 per cent. The number of units sold was 630,407, against 446,343, or an increase of 41 per cent. The cost per unit has been reduced, after meeting all charges except interest and redemption, from 1·86d. to 1·52d., or by ·34d. per unit.

**Stock Exchange.**—The Stock Exchange Committee have appointed May 18 as a special settling days for Charing Cross and Strand Electricity Supply Corporation's further issue of 10,000 ordinary shares of £5 each fully paid, Nos. 70 001 to 80,000, and May 26 for the same company's further issue of 10,000 4½ per cent. cumulative preference shares of £5 each fully paid, Nos. 70,001 to 80,000; and have ordered both securities to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the British Electric Traction Company's £250,000 4½ per cent. second debenture stock, and to allow the Potteries Electric Traction Company's further issue of 2,500 5 per cent. cumulative preference shares of £10 each fully paid, Nos. 42,001 to 44,500, and 2,500 ordinary shares of £10 each fully paid, Nos. 52,001 to 54,500, to be quoted in the official list.

**Barnsley.**—Notice is to be given to the Barnsley Gas Company of the intention of the Corporation to discontinue using, and to remove, 140 public gas lamps, and the electrical engineer is to proceed with the work necessary to substitute 54 arc lamps. Application is to be made for sanction to borrow £6,067 for the purpose of extension of mains and other expenses incurred and sanctioned by the Council. According to the annual report of Mr. E. A. Barker, engineer, there were at the end of the financial year 449 consumers of electricity from the Corporation, as against 348 the previous year, the consumption having been 797,557 units, against 556,923. Twenty-five consumers were waiting to be connected, bringing the total consumption to the equivalent of 49,688 8-c.p. lamps. Fuel cost ·348 per unit, against ·402d., and the average price per unit, including traction, was 2·51d., against 2 81d. The gross profit, on a turnover of £8,340. 9s. 9d., was £4,684. 0s. 10d., and the net profit £737. 18s. 2d.

**Luton.**—The last report of the Electric Lighting Committee states that since March 24 last 16,169 units had been generated, an equivalent to 76 8-c.p. lamps and two motors of 3 h.p. connected, making a total of 158 consumers with 10,611 lamps and 47 motors of 163 h.p. The number of units generated shows an increase of 104 per cent. over the number generated during the corresponding period of last year, and at the present time over 330 additional lamps and six motors of 18 h.p. are being wired. Application has been received from Messrs. Hayward Tyler and Co. for a supply of energy in motors and lighting. The electrical engineer has had interviews with representatives of the Vauxhall Company and the West Hydraulic Company in reference to the supply of electrical energy, and has reported that, as their plans were not sufficiently advanced, they were unable to come to a final decision, but there appeared to be very little doubt but that they would take energy shortly. It is proposed that new cables be laid down to an estimated cost of about £850.

**Canterbury.**—The profit of the electric lighting department for the past year was £812. The profit in 1902 was £730, so that a gradual increase is shown. The Council have entered into a contract for the supply of new accumulators at a cost of £565, which will be paid for out of the current revenue. The Chairman last week referred to a statement made in the public Press with regard to the cost of their electric lamps. It was said that they were charged for at the rate of £3. 10s. per lamp, and that that did not include charges of cleaning, repairs, capital charge, etc. He wished to say that the £3. 10s. included all charges—cleaning, repairs, and the reduction of capital and interest. The gas lamps were £4, inclusive of all such charges. The reduction in the price of current which took place as from April 1 was from 6d. to 5d. for private lighting, and 7d. and 2½d. for subsequent hours in the case of the maximum demand system, which would make a considerable reduction in the cost to their consumers. A number of additional feeders are to be laid.

**Portsmouth.**—The Roads Committee have decided to recommend the Council to adopt the terms of the Electric Light Committee, who propose to supply 25 c.p. lamps at £3 a year, which is 5s. less than the gas company charge for their street lamps, and the only proviso the committee make is that a minimum of 500 lamps shall be taken. They are prepared to effect all the alterations necessary to the present standards, the removal of the lanterns, and the substitution of a semi-circular arm, and to equip and maintain the lamp without cost beyond the annual rent. The scheme for installing electricity for the lighting of Portsmouth Dockyard, and for the motive power for all the work-

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shops, is also to include the provision of the electric light for the Government establishments on the Gosport side of the harbour. Priddy's Hard, the Royal Clarence Victualling Yard, and Forton Barracks are all to be lighted with the electric light, and a large plot of land has been purchased not far from Priddy's Hard for the generating station. Plans and specifications for the lighting of the Gosport Government establishments, as well as those for the illumination of Portsmouth Dockyard, are being prepared by Sir Wm. Preece and Co. Tenders have been invited.

**Bury.**—The electrical engineer in his last report stated that for the year ending March 31 the output was 672,911 units, and the revenue about £8,010, compared with an output of 424,993 units and a revenue of £6,170 last year, an increase of 58 per cent. in the units and 30 per cent. in the revenue. He submitted the following comparative table:

| | 1903. | Per cent. | 1904. | Per cent. |
|---|---|---|---|---|
| Lighting at 6d. ... | 121,842 | 28½ | 129,892 | 19½ |
| ,, at 3d. ... | 83,269 | 19½ | 89,860 | 13½ |
| ,, at 4½d. ... | 14,891 | 3½ | 22,059 | 3 |
| Power at 3d. ..... | 39,762 | 9½ | 80,380 | 12 |
| ,, at 1d. ..... | 101,361 | 24 | 219,158 | 32½ |
| Technical school ... | 8,286 | 2 | 8,490 | 1½ |
| Public lighting ... | 55,582 | 13 | 54,664 | 8 |
| Public clock ..... | — | — | 778 | — |
| Tramways ..... | — | — | 67,630 | 10 |
| | 424,993 | 100 | 672,911 | 100 |

**Eastbourne.**—At the last Town Council meeting it was stated that last year the interest on the whole capital expenditure of £150,000 on the electricity undertaking had been paid in full. In addition, they had lowered the price of the light by 1d. per unit, yet they were able to show a net profit of £3,857. Of that it was proposed that £1,000 should be carried to the depreciation fund, that £750 should be allocated to the relief of the rates, and that the remaining £2,000 should be carried forward. The committee also proposed that the charge for public arc lamps be reduced from £25 to £22 per annum, and the private supply by ½d. per unit. It was estimated that these reductions would absorb a sum of £2,000, which was the amount it was now proposed to carry forward. It had been suggested that the committee should make a larger reduction in the price of electricity, but such an action would be fatal to the sound financial system on which the undertaking had hitherto been worked. Having anticipated that there would be a considerable increase in the consumption, the speaker remarked that a member had declared that the profits were a myth. To falsify that statement, it was only necessary to state that it was proposed to invest the £3,000 carried forward to the depreciation account and that £14,744 had already been paid off capital by annual repayments.

**Manchester.**—At the recent enquiry into the application of the City Council for increased borrowing powers in connection with municipal electrical departments, it was stated that of the £135 000 required £94,490 was to be expended on additional mains, £10,000 on the development of the motor-hiring scheme, and £21,575 on the provision of further lighting and traction purposes in the city and in several of the adjacent districts. The chairman of the Electricity Committee, Mr. Howarth, said that for the year ended March 31, 1900, the department had 3,240 consumers, using 319,245 8-c.p. lamps, and the revenue amounted to £86,297. For the year ended March 31, 1904, the consumers had numbered 5,171, the lamps 607,451, and the revenue was £261,850. Within the last two years the increase in the output of electricity, owing in a large measure to the heavy demand for traction purposes, had increased by 176 per cent., and last year was 28 950,000 units. Since the establishment of the department in 1893 the sum of £173,419 had been set apart as a sinking fund, £50,688 had been paid into a reserve fund, and £52,963 handed over to the city fund. The total of these sums, £277,070, represented the aggregate profit made by the department since its establishment. No charge had ever been made against the rates by the department, and he did not think that any charge would be made in the future.

**Chesterfield.**—Mr. R. L. Acland, electrical engineer, in his report on the second year's work of the committee, states that large extensions had been made during the year, the capacity of the station being increased by one-third, which, together with extensions of mains and connecting new consumers, had accounted for an increase in the capital expenditure of £10,051. Further extensions had also been put in hand, which would increase the capacity of the station from 600 kw. to 1,000 kw., which would probably provide for all the requirements of the town for two years. The number of consumers had increased during the year from 221 to 318. The demand for power purposes was increasing rapidly. They had now connected to the mains 43 motors of a total aggregate horse-power of 223, of which number 17 motors of a total of 73 h.p. were on hire from the department. In every case where the motor had been adopted, replacing other forms of motive power, the consumers had been more than satisfied. In Chesterfield the maximum demand system of charging was not in much favour with the majority of the consumers, and the engineer advised that the charges for private lighting supply for 12 months ending March 31, 1905, should be, for all classes of premises, under two rates, maximum demand of 6d. and 3d. (as at present in force), with a rebate of 10 per cent., and a flat rate of 4d. per unit. On this basis Chesterfield would have its private supply of electricity at the same price or lower than the rates in force in Sheffield, Leeds, and Leicester, and a large increase in the consumption consequent on the reduction might be anticipated. The net balance to be carried to the reserve fund amounted to £1,080, which, together with the sum already brought forward, amounted to £2,054 net balance as a result of the first 2½ years' working. A house is to be provided for the staff of single young men engaged at the works, at a cost of £350, including furnishing.

**Burton-upon-Trent.**—The accounts of the electricity department for the year ended March 31 contains the following figures: Total expenditure at end of year, £66,200; revenue from electricity supply £8,594, ditto from meter rents and other sources £368; total costs, £4,312; gross profit before providing for interest and sinking fund, £4,650; gross profit per cent. to capital (outlay during year averaged), 7·02; interest on loans, less credits, £1,869; amount provided for sinking fund, £1,583; per cent. to capital (outlay during year averaged), 2·39; financial result, after providing for interest and sinking fund, £1,197 surplus. Number of units sold, 678,020; costs per unit sold—coal and other fuel ·36d., oil, waste, water, and stores ·05d., wages of workmen ·47d., repairs and maintenance ·25d., works costs 1·14d., rent, rates, and taxes ·23d., management, salaries, office and legal expenses, insurance, etc. ·15d.—total costs 1·52d. Supply records—price charged for private lighting 6d. and 3d., for power and heat 3d. and 1d.; average price obtained—private supply 4·86d., traction or special 1·45d., public lighting 3d.; number of 8-c.p. lamps at end of year, 26,390; units sold per lamp, 13·3; maximum load on feeders, 370 kw.; load factor, 12·5; plant capacity at end of year, 1,110 kw.; consumers increased from 280 to 339, or 21·1 per cent.; increase in electric light and motive power units, 56,211, or 21·7 per cent.; the motors connected have increased from 64·5 h.p. to 115·5 h.p., or 79 per cent.; total increase in units, including traction, 419,038 or 162 per cent. Mr. P. J. Pringle, M.I.E.E., states that this increase in demand is sufficient to require a 500-kw. set before next winter. It may be noted that the traction supply has only been for three months. The mean price obtained for current for all purposes was 3·02d.; for lighting and motive power, 4·85d.; and for traction power, 1·45d. The gross profit has increased from £2,835 in 1902, with £163 surplus, to £4,659 and £1,197 surplus in 1904.

**Exeter.**—The official opening of the Basin electricity station, which has now been completed, but from which power has been supplied since November last, was officially opened last week. The engine-room is finished entirely with glazed brick, supplied by Messrs. Cawdy and Co., of Newton Abbot. The whole of the machinery has been supplied by the Westinghouse Company. There are at present installed four steam alternators of a total capacity of 1,300 kw., which can deal with the supply to 50,000 lamps or their equivalent. The boiler-house has a large basement, containing the gear for working the mechanical stokers and the chain of conveyor buckets. The steel bunkers have a capacity of 500 tons. There are three water-tube boilers, fitted with superheaters, each capable of supply steam for 500 h.p., to which will shortly be added the boilers from the old station, bringing the total up to 2,700 h.p. The builder is Mr. W. Brealey, of St. Thomas, and the stonework throughout has been supplied by Messrs. Collard and Son, of St. Sidwell's, while the carved panels in the main gable were executed by Mr. Rogers, of St. Sidwell's. Mr. Donald Cameron was the architect of the building, and Mr. H. W. Bulley has assisted throughout on the work. The clerk of works has been Mr. F. Smith, while Mr. Massingham has performed similar duties in regard to the machinery. The cost of the building was £14,500, while the equipment has cost about £37,000. The sub-contractors under the Westinghouse Company were: Messrs. Willey and Co., engineers, of Exeter and London; Messrs. Babcock and Wilcox, London and Glasgow; Messrs. Bellis and Morcom, Birmingham; the Worthington Pump Company, London; Messrs. E. Green and Son, Wakefield; and Messrs. C. and A. Musker, of Liverpool. Three new boilers and six sets of mechanical stokers were supplied by Messrs. Babcock and Wilcox; Messrs. Bellis and Morcom erected the engines, three of which are of 570 h.p., and the fourth 140 h.p.; the Worthington Company supplied the pumps and condensers; Messrs. Green the economisers; and Messrs. Musker the travelling crane. Messrs. Willey and Co. were among the largest sub-contractors, the supply of the coal bunkers and conveyors, the whole of the iron piping, the erection of the boilers, including those now being removed from the old station, being entrusted to them, in addition to which they had sub-contracts under the builder, Mr. Brealey, for roofing the station, the ring on the chimney stack, etc. Mr. Ch. Henderson was the resident electrical engineer for the Westinghouse Company, and associated with him has been Mr. Munro, the electrical engineer of the Corporation. The plant for the trams is to be installed within the next three months.

**London Gazette.**—Mr. J. R. Ward has been appointed trustee in the estate of Charles Aubrey Smith (trading as C. J. Smith), electrician, trading at 23, King's-street, Regent-street, and residing at 6, Granard-road, Wandsworth Common, London. A second and final dividend of 2s. 3d. in the £ has been declared in the estate of John Frederick Worthington and Gerald Nuttall, electrical engineers (trading in co-partnership under the style of J. Worthington and Co.), Foundry Works, Foundry-street, Hanley, Staffs; payable now at the office of Messrs. Poppleton and Appleby, 26, Corporation-street, Birminham. A first and final dividend of 12s. 6d. in the £ has been declared in the estate of Gerald Nuttall (separate estate), electrical engineer, trading at Foundry Works, Foundry-street, Hanley, Staffs; payable at the office of Messrs. Poppleton and Appleby, 26, Corporation-street, Birmingham. The first meeting in the estate of David Todd Cameron, mechanical and electrical engineer, Magdala-villas, Saltash, Cornwall, formerly of 13, Clifford-terrace, St. Budeaux, and 25, Barrack-street, Devonport, Devon, will be held at 11 a.m. on May 20 at the official receiver's office, 6, Athenæum-terrace, Plymouth. The partnership existing between Haydn Theis Harrison and Philip Jefferson Brewer, electrical engineers (trading as Haydn Harrison and Co.), 11, Victoria-street, Westminster, has been dissolved by mutual consent. The partnership between Eugene Morand and Arthur Walter Curtis, carrying on business as electrical engineers, 95, Station-street, Birmingham, under the style or firm of Curtis and Morand, has been dissolved by mutual consent. The partnership between James William Cutler and Walter Wardle, carrying on business as electrical engineers, 35 and 37, Dickinson-street, Manchester, under the style or firm of Cutler, Wardle, and Co.,

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has been dissolved by mutual consent. Walter Wardle will continue the business. The last day for receiving proofs in the estate of Gilbert Jackson and David Smith (trading as Jackson and Smith), electrical engineers, 6, Annetwell-street, Carlisle, is May 24; Mr. K. J. Hough, official receiver, 34, Fisher-street, Carlisle. The estates of Brown, Scott, and Co, electrical and engineers' furnishers, 195A, St. Vincent-street, Glasgow, and Robert Fyfe Barr, jun., electrical and engineers' furnisher there, the sole partner of the firm, were sequestrated on May 4 by the Sheriff of Lanarkshire at Glasgow. The meeting to elect the trustee and commissioners will be held on May 18 at the Faculty Hall, St. George's-place, Glasgow. To entitle creditors to the first dividend, their oaths and grounds of debt must be lodged on or before Sept. 5. All future advertisements relating to this sequestration will be published in the *Edinburgh Gazette* alone. Creditors of Lionel Joseph Allbright, carrying on business as Allbright and Co., 30, Regent-circus, Swindon, Wilts, electrical engineers, who have not already assented to the deed, or sent in their claims, are required to send particulars of their debts and claims to John Baker, Eldon-street, South-place, Finsbury, E.C., to-day. The final meeting of the Coventry Lighting and Engineering Company, Limited, will be held at 23, Bayley-lane Coventry, on June 8 at 11 a.m. The final meeting of the Tramway and General Appliances Company, Limited, will be held at 7, Waterloo street, Birmingham, at 3 p.m. on June 7. The Blake-Morscher Electrical Ore Separator Syndicate, Limited, is to be wound up voluntarily. Mr. David Stobie Whitelaw, 20, Copthall-avenue, London, E.C., has been appointed liquidator. The final meeting of the members of the Electrical "Lumiscriptor" Company, Limited, will be held at 10, Walbrook, London, E.C., at 11 a.m. on June 15.

## PROVISIONAL PATENTS, 1904.

MAY 2.

**10019. Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10020. Improvements in speed-limiting devices.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10021. Improvements in automatic fluid-pressure brake systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10036. Improvements in and connected with electric cables.** Allan Berlin, 6, Lord-street, Liverpool. (Complete specification.)

**10055. Improvements in supports for electric or other conductors especially suitable for use in mines.** Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London.

**10058. Improvements in electric switches.** The General Contracts Company, Limited, Edward Samuel Cook, and William Howard Chipperfield, 149, Strand, London. (Complete specification.)

**10070. Improvements in or relating to regulating sockets for electric lighting, heating, or power purposes.** Louis Francis Bogia, jun., 111, Hatton-garden, London.

**10073. Improvements relating to electric telegraphy.** Sidney George Brown, 7, Southampton-buildings, Chancery-lane, London.

**10079. An improved electrical system and means for directing the training of searchlights and the like.** Willie Dickson Kilroy, 1, Queen Victoria-street, London.

**10080. An improved system and apparatus used therein for the distribution of electrical energy over a large sub-divided area.** Albert Edgar Tanner, 1, Queen Victoria-street, London.

**10081 Improvements in electric meters.** Robert Francis Venner, 1, Queen Victoria-street, London.

MAY 3.

**10119. An improved method of and means for adapting electric candles to sconces and the like.** Charles Clare Regnart, 29, Anson-road, Cricklewood, London.

**10142. Improvements in and relating to electrical conductors.** Percy Alan McGeorge, 77, Chancery-lane, London. (Complete specification.)

**10147. An improvement in the provision of an automatic electric brake on cars operated by electricity from an outside source of current.** Josiah Sayers, The Poplars, Duffield, Derbyshire.

**10172. Improvements in dynamo-electric machines.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Bullock Electric Manufacturing Company, United States.) (Complete specification.)

**10173. A combined electric switch and plug connector.** William Hodges Warren and Charles Ernest Hunter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**10182. Improvements in or relating to means or apparatus for conveying current to electrically-propelled vehicles on railways.** Charles Hesterman Merz and Albert Henry Marshall, 46, Lincoln's-inn-fields, London.

**10183. Improvements in or relating to current-collecting apparatus and overhead frogs for use with electrically-operated tramway and railway vehicles.** Charles Hesterman Merz and Albert Henry Marshall, 46 Lincoln's-inn-fields, London.

MAY 4.

**10210. Improvements in electric traction on a shallow conduit system.** Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton.

**10242. Improvements in high-tension electric current switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10243. Improvements in vapour electric apparatus.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**10244. Improvements in vapour electric apparatus.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

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**10249. Improvements in vapour electric apparatus.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**10250. Improvements in vapour electric apparatus.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**10276. Improvements in electric block signal systems.** Tony Silvene, 53, Chancery-lane, London. (Complete specification.)

MAY 5.

**10308. Improvements in the method of and means employed for supporting and connecting the trolley wires of overhead electric systems.** James Haydock and Thomas Smith Jones, Penny Bank-chambers, Halifax.

**10341. Improvements in vapour electric apparatus.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**10356. Improved construction of mounting of trolley arms for collecting electric energy from overhead cables for electric traction.** Edwin Burbrage Phillips and Thomas Cresswell Parkin, 22, Southampton-buildings, Chancery-lane, London.

**10364. A new or improved method of and means for electrically propelling toy cars and the like.** Frederick Otto Trautmann, jun., 9, Regent-street, London.

**10370. Improvements in or relating to secondary or storage battery plates.** Alfred Julius Boult, 111, Hatton-garden, London. (Carroll Potter, United States.) (Complete specification.)

**10391. Improvements in or connected with electrical time cut-outs for controlling railway barriers and the like.** Franz Neugebauer, 40, Chancery-lane, London. (Complete specification.)

MAY 6.

**10406. Improvements in and relating to sparking plugs for electric ignition for internal-combustion engines.** Frederick Treeby Reid, 177, Sidwell-street, Exeter.

**10429. Improvements in or connected with electric incandescent lamps.** William McAuslane, 6, Lord-street, Liverpool.

**10430. Improvements in electric cables.** Alfred Whalley and Ernest Alfred Bayles, "Ashville," Helsby, Chester. (Complete specification.)

**10448. Improvements in electric ignition coils and the like.** Samuel Henry Halford, Ernest Shoula, and Samuel Bridgwater, 43, Gibson-square, London.

**10456. Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10457. Improvements in and relating to alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10458. Improvements in and relating to alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10460. Improvements in and relating to electric switches.** The British Thomson-Houston Company, 83, Cannon-street, London. (The General Electric Company, United States.)

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**10459. Improvements in electric control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10461. Improvements in multiple switch rheostats.** The British Thomson-Houston Company, 83, Cannon-street, London. (The General Electric Company, United States.)

**10488. Improvements in earthing devices applicable to lightning arresters and the like.** Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

**10492. Improvements in electrical measuring instruments.** David King Morris Keneln Edgcumbe and Edgar Isaac Everett, 151, Great Saffron-hill, London.

MAY 7.

**10502. Improvements in prepayment electricity meters.** Robert Constantine Griesbach, Holly-lane, Erdington, Birmingham.

**10503. Improvements in trolley wheel spindles for electric tramway cars.** William Austin Entwistle, Moor House, Mirfield, Yorks.

**10511. Improvements in commutator brush-holders.** William Heap and William Alfred Barnes, 55, Market-street, Manchester.

**10551. Improvements in the arrangement of electric motors in or on electrically-driven vehicles.** Franz Krizik, 46, Lincoln's-inn-fields, London.

**10559. Improvements in galvanic batteries.** Siemens Bros. and Co., Limited, and William Frederick Eichenauer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 26, 1904.*

1903.

**9604. Dynamo-electric machinery.** Mawdsley.

**9831. Device or devices for locking incandescent electric lamps to their holders.** Hill and Sir Hiram Maxim Electrical and Engineering Company, Limited.

**9998. Electric arc lamps.** Norbalie and Fulkes.

**10071. Actuating mechanism for secondary electric clocks and other intermittingly electrically-impelled apparatus.** Justice. (Morse.)

**10667. Electric conductors or cables.** Brown.

**11729. Winding forms for coils for dynamo-electric machines.** Carolan. (General Electric Company.)

**12146. Multi-carbon electric arc lamps.** Eckstein and Angold

**13674. Electric selecting, or selecting and signalling, systems for communicating between a central or main station and various other places or sub-stations, and for performing various operations at such places or sub-stations.** Sheehy and Culphey.

**13911. Automatic electric circuit breakers.** Reynders, Auel, Alexander, and Spurrier.

**14067. Automatically reversible dynamo to give a constant voltage irrespective of speed.** Imig.

**14170. Starting means for gas or vapour electric apparatus such as mercury vapour lamps for lighting or other purposes.** Le Tall. (Cooper-Hewitt Electric Company,)

**14171 Gas or vapour electric apparatus such as mercury vapour lamps for lighting or other purposes.** Le Tall. (Cooper-Hewitt Electric Company.)

**14373. Illumination of railway or like signals by electric incandescence lamps.** Siemens Bros. and Co., Limited, and Ferreira.

**14598. Electric motor-driven machine tools.** Carolan. (General Electric Company.)

**14877. Mounting electrical fittings on or in metal bases, frames, and cases.** Eckstein and White.

**14908. Electric contacts.** Prestwich and Lea.

**17431. Electric joints or connections for railway trains.** Sivelsohn.

**20128. Electric lighting.** Lamme. (Date applied for under International Convention, Sept. 29, 1902.)

**26242. Telphers.** Siemens Bros. and Co., Limited. (United Telpherage Company.)

**26242a. Controlling vehicles propelled electrically from a distance.** Siemens Bros. and Co., Limited. (United Telpherage Company.) (Date applied for under Patents Rule 9, Dec. 1, 1903.)

**26595. Electric igniting apparatus.** Schaffler *nee* Glössl and Jilek.

**26773. Arc lamp with convergent downwardly directed carbons.** Carbone.

**26848. Telephone systems.** Fairweather. (Stromberg Carlson Telephone Manufacturing Company.)

**27153. Electric signalling apparatus.** Mitscherling.

**28051. Synchronising apparatus for dynamo-electric machines.** Lincoln. (Date applied for under International Convention, Dec. 29, 1902.)

**28782. Electric sectional furnaces.** Eimer. (Date applied for under International Convention, May 28, 1903.)

1904.

**124. Apparatus for electrically transmitting, receiving, and checking signals, orders, and the like.** Barbará.

**3660. Magneto-electric ignition gear for internal-combustion engines.** Hennig.

**6333. Strut piece for electric switches.** General Contracts Company, Limited, Cook, and Chipperfield.

**6678. Electrical conductors and coils.** Anderson. (Date applied for under International Convention, April 30, 1903.)

**7702. Electric toy motors.** Broad. (Date applied for under International Convention, Oct. 5, 1903.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | 3/16-5/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5½-5⅝ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | .. | 3⅞-4⅛ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | .. | 90-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ⅛-1 |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | .. | ⅛-1⅛ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | .. | 93-98 |
| Callender's Cable, Debentures ..... | 100 | .. | 104-108 |
| —— Ordinary ..... | 5 | .. | 10⅜-11⅛ |
| —— 5 per cent. Pref. ..... | 5 | .. | 5¼-5⅜ |
| Crompton and Co. ..... | 3 | .. | 1⅞-2⅛ |
| —— 5 per cent. Debentures..... | 100 | .. | 96-99 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 3 | .. | ¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | .. | ⅛-1⅛ |
| —— 5 per cent. Debentures..... | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | .. | 2⅛-3 |
| —— 4 per cent. Perp 1st Mort. Deb. ..... | 100 | – | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9½-9⅝ |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11½-12⅛ |
| —— 4½ per cent. Preference ..... | 5 | – | 5-5⅛ |
| —— 4½ per cent. Debentures ..... | 100 | – | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 18⅛-19⅛ |
| —— 4 per cent. Debentures..... | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 14½-15½ |
| Telegraph Construction and Maintenance..... | 12 | – | 34-37 |
| —— 5 per cent. Bonds ..... | 100 | – | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | – | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | – | 115-120 |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 11½-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9½-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10½-11½ |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 100-103 |
| Brompton and Kensington, Ordinary..... | 5 | – | 10⅜-11⅛ |
| —— 7 per cent. Preference ..... | 5 | – | 10⅛-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | – | 6⅜-7⅛ |
| —— Nos. 20,001-30,000 ..... | 5 | – | 6⅜-7⅛ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12⅛-13⅛ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 107-110 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 7⅛-7⅜ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5-5⅛ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 102-104 |
| Chelsea Electricity Supply ..... | 5 | – | 6⅛-6⅜ |
| —— 4½ per cent. Debentures ..... | 100 | – | 107-110 |
| City of London, Ordinary..... | 10 | – | 10⅛-11 |
| —— 6 per cent. Cumulative Pref..... | 10 | – | 13-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 101-104 |
| County of London and Brush Provincial, Ordinary..... | 10 | – | 7-8 |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 5⅜-5⅝ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 5⅜-5⅝ |
| —— 4½ per cent. First Mort. Deb..... | 100 | – | 104-107 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1⅛-2⅛ |
| —— 5 per cent. Debenture Stock, Red ..... | 100 | .. | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5⅛-6 |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | – | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-15,000 ..... | 5 | .. | 7⅛-8⅛ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11⅛-12⅛ |
| —— per cent. Debenture Stock Red ..... | 100 | – | 102-105 |
| Kensington and Knightsbridge and Notting Hill ..... | 100 | – | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary ..... | 3 | – | 1⅛-1⅜ |
| —— 6 per cent. Pref..... | 5 | – | 4⅛-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red.. | 100 | – | 95-98 |
| Metropolitan Ordinary ..... | 10 | – | 19 20 |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 108-113 |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 95-98 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-103 |
| Notting Hill Electric Lighting ..... | 10 | – | 12⅛-13⅛ |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) .. | 100 | – | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 1,14,310..... | 5 | .. | 5⅛-5⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 | .. | 98 101 |
| Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 98-101 |
| Smithfield Markets Electric Supply, Ltd., Red., 1-12,000.. | 5 | – | 3-3½ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 85-90 |
| South London, Ordinary ..... | | – | 3⅜-4⅛ |
| St. James's and Pall Mall, Ordinary, 101-80,080 ..... | 5 | – | 14-15 |
| —— 7 per cent. Pref. ..... | 5 | – | 8-9 |
| —— 3½ per cent. Deb. ..... | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 4⅛-4¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4⅛-4¼ |
| Westminster, Ordinary ..... | 5 | – | 12½-13⅛ |
| —— 5 per cent. Cum. Pref., 110,101-138,261..... | 5 | – | 6⅛-6⅜ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 92-95 |
| —— 4 per cent. Pref. | 100 – | 98-101 |
| —— ,, ,, deferred | 100 – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 50-52 |
| —— 4 per cent. Debenture Stock | 100 – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 122-125 |
| —— ,, ,, ,, '96 | 100 – | 120-123 |
| —— ,, ,, ,, '01 | 100 – | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10-10½ |
| —— Ordinary, 1-50,000 | 10 – | 4¼-4½ |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 99-101 |
| Waterloo and City, Ordinary | 100 – | 90-93 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 4¾ 5¼ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 – | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 – | 13⅜-13¾ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1¼-2¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 97-102 |
| British Columbia Electric Railway Co., Ord. Def. | 100 – | 93-102 |
| —— Ord Pref. | 100 .. | 98-102 |
| —— Non-Cum. 5 per cent. Pref. | 10 .. | 10¼-10¾ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 – | 102-104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 . | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 9-9¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10-10¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 115-118 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅜-2¾ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 4⅜-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 104-107 |
| —— Prov. Cert., all paid | 100 – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 99-102 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 100-101 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18 19 |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 – | 108 110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8¼-8¾ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11¼-11¾ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 101-103 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,514,016 | 1 – | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 – | ¼-1 |
| New General Traction, Ordinary | 5 – | ¼ |
| —— 6 per cent. Cum. Pref. | 5 – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 – | 88-93 |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 – | 12-12¼ |
| —— 5 per cent. Cum. Pref. | 10 – | 9¾ 9¾ |
| Perth Elec. Tramways (W&A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 99-102 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £350,000 Ordinary | 1 – | 1 |
| —— £101,158 5 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 103-105 |
| —— Deferred Stock | 100 – | 88-91 |
| —— 6 per cent. Cum. First Pref. | 10 – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 – | 97-99 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 102 104 |
| Oriental Telephone and Electric Company | 1 – | 15/16 1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 20 | 1,187 | 907 | + 280 | +11,824h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 30 | 234 | 245 | – 11 | + 109 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | May 7 | 40 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 8 | 980 | 974 | + 6 | – 93 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | April 23 | 268 | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | May 6 | 876 | 724 | + 142 | + 348 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 5 | 551 | 416 | + 135 | + 302 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 7 | 320 | 262 | + 58 | — | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 8 | 1,698 | 1,611 | + 87 | – 40 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 4 | 973 | 925 | + 48 | + 369 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 7 | 5,566 | 3,196 | +2,370 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 8 | 786 | 867 | – 81 | – 48h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 6 | 4,942 | 4,517 | + 425 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 7 | 984 | 733 | + 251 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 8 | 307 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 7 | 1,920 | 1,729 | + 190 | + 431 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 30 | 178 | 186 | – 8 | + 264 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | May 7 | 6,950 | 6,962 | – 12 | – 1,040h | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 8 | 2,846 | 3,002 | – 156 | – 1,840h | 6⅝ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 5 | 483 | 550 | – 67 | – 235 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 6 | 234 | 219 | + 15 | – 96 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 7 | 188 | 206 | – 18 | – 188 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 8 | 114 | 89 | + 25 | + 110h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 6 | 4,073 | 3,971 | + 102 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 6 | 952 | 827 | + 125 | — | | | | | | | | | | |
| Dundee City Tramways | ,, 4 | 861 | 797 | + 64 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 7 | 739 | 567 | + 172 | + 542 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 7 | 14,242 | 13,287 | + 955 | +60,930h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 4 | 171 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 4 | 2,749 | 2,270 | + 479 | + 439 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | April 9 | 1,546 | 1,186 | + 360 | + 8,914 | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | May 7 | 2,037 | 1,709 | + 327 | + 1,050 | 25 | 19 | ,, 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April 30 | 446 | 317 | + 129 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | May 5 | 141 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 4 | 208 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 7 | 5,484 | 4,667 | + 817 | + 2,667 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | April 30 | 10,072 | 9,870 | + 202 | + 3,953 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | May 9 | 1,594 | 1,575 | + 19 | + 91h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | April 30 | 10,684 | 8,455 | +2,229 | + 9,759 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 16 | 143 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | May 7 | 11,602 | 10,903 | + 699 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 7 | 108 | 57 | + 51 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 7 | 3,641 | 3,119 | + 522 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 7 | 473 | 302 | + 171 | + 677 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 7 | 1,703 | 1,487 | + 216 | + 9,980 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 2 | 116 | 115 | + 1 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 5 | 440 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 9 | 3,685 | 3,029 | + 656 | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 8 | 4,279 | 3,869 | + 410 | + 539 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | April 28 | 900 | 896 | + 4 | — | 11 | 11 | ,, 31 | 33,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | May 4 | 273 | 249 | + 24 | + 145 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 6 | 523 | 245 | + 282 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 8 | 1,121 | 1,028 | + 93 | + 108 | 18·48 | 18·48 | ,, 31g | 53,930 | 13,937,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 7 | 669 | 577 | + 91 | + 126 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 5 | 741 | — | — | — | 13 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 6 | 577 | 415 | + 162 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**The Institution Presidency.**—The arrangement in regard to a president-elect, of which we gave particulars in our issue of the 6th inst., is to be a permanent one. It was formally decided last night to amend the articles of association accordingly.

**The Metric System.**—The Select Committee of the House of Lords on the Weights and Measures (Metric) Bill completed its sittings last week, and the measure with amendments having been passed by the House in committee, has been reported.

**Electric Fog Signals.**—Mr. Gerald Balfour has stated that the Board of Trade will be glad to have an opportunity of considering detailed information in reference to an electric bell substitute for the old style of fog signal. The Board of Trade have called the attention of railway companies to the question of adopting some mechanical system of fog signalling, and some of the companies are making experiments.

**Wireless Telegraphy.**—The installations of wireless telegraphy in France, which have hitherto been controlled by the Navy Department, have entered upon a commercial phase. They have been transferred to the Minister of Posts and Telegraphs, who will use them for Government purposes generally, while two of the stations will be placed at the disposal of the public for private business. Two new stations have just been completed in the environs of Paris, which will also be used for private business, besides acting as training schools for operators.

**The American Institute.**—We have received the *Transactions* of the American Institute of Electrical Engineers for March. The number contains papers on "Gas Power for Central Stations," by Mr. J. R. Bibbins, with discussion; "Conductivity of the Atmosphere at High Voltages," by Mr. H. J. Ryan, with discussion; "European Practice in the Construction and Operation of High-Pressure Transmission Lines and Insulators," by Mr. G. Semenza, with discussion; and "Notes on Flywheels," by Mr. A. S. Barnes, jun., to be read at a forthcoming meeting.

**Arc Works Engineering Society.**—The first annual meeting of this society, conducted in connection with Messrs. Crompton and Co.'s works, Chelmsford, was held on the 11th inst., Mr. S. L. Brunton presiding. It was reported that the membership had now reached 122. The average attendance at the lectures and visits to engineering and electrical works had been 42. Colonel Crompton, C.B., was re-elected president, and Mr. Brunton was appointed chairman of the committee. Mr. T. M. Mundle was elected hon. secretary in place of Mr. C Crompton, resigned; and Mr. L. O. Ilbert was appointed assistant secretary. A vote of thanks was passed to Mr. Crompton for his services during the past year.

**North-East Coast Institution of Engineers and Shipbuilders.**—We have received the April number of the *Transactions* of the institution, which contain Mr. Max Wurl's reply to the discussion on "Technical Education in Germany"; the continued discussion on Mr. J. H. Heck's paper, "The Construction of Stability Cross Curves for Balanced Paper Sections," with Mr. Heck's reply; papers on "Technical Education, with special reference to the Admiralty System," by Mr. B. C. Laws, with discussion; "Longitudinal Engine-Room Bulkheads in Merchant Vessels, in relation to Transverse Stability when Bilged," by Mr. F. H. Alexander, with discussion; and "Automatic Governing of Marine Engines," by Mr. H. M. Wilson, with discussion.

**Wireless Telegraphy Installation.**—Some particulars have been given to the German Press by Count Arco of the installation of wireless telegraphy for the course of the Gordon Bennett race which is to take place in Germany, and we see from *Der Motorwagen* that there will be three stations equipped after the field telegraph type used for military purposes, in which the current is created by means of 4-h.p. Benzin dynamos. The aerial conductor, both for receiver and transmitter, will not take the form of poles, but when there is a wind kites will be used. When there is no wind a small balloon, filled with about five cubic metres of hydrogen, will be used. The stations are only to be employed for sending news during the progress of the race. The receiving station, which is near the post office, will have a mast to carry the upward wire. The distance between the stations is 45 miles and 15 miles respectively.

**The Influence of Complex Ions on Electrolysis by an Alternating Current.**—A paper on this subject is contributed to the *Comptes Rendus* by Messrs. A. Brochet and Joseph Petit. The authors show that the presence of complex ions is not necessary to the action of an alternating current, mentioning in support many cases where an alternating current produces changes in the composition of a liquid, although the formation of complex ions is excluded. In all these instances, one or more of three phenomena are observed: (1) the evolution of electrolytic gas; (2) dissolution of electrodes; (3) oxidation or reduction. A few cases were examined where complex ions were present which are not decomposed by the ordinary continuous current. It was found that iron, cobalt, and platinum dissolve easily in aqueous potassium cyanide under the influence of an alternating current, giving potassium, ferrocyanide, cobalticyanide, and platinicyanide respectively; if, however, the metals are used as anodes, solution does not take place.

**Competitive Boiler Tests.**—In the note in our last issue on the above subject, we gave some details of some trials made at Los Angeles on boilers of the Babcock and Wilcox and Stirling types respectively. The remarks as to the percentage of moisture in the steam produced were misleading, as for this expression "dryness of steam" should have been used. The actual figures on the test were as follows:

| | | Percentage of moisture in steam. | Rate of evaporation. |
|---|---|---|---|
| Test No. 1 ... | Babcock and Wilcox ... | 0·21 ... | 3 85 |
| | Stirling ... | 0·56 ... | 3·58 |
| Test No. 2 ... | Babcock and Wilcox ... | 0·14 ... | 4·52 |
| | Stirling ... | 0 52 ... | 4·55 |
| Test No. 3 ... | Babcock and Wilcox ... | 0 16 ... | 5 86 |
| | Stirling ... | 0 58 ... | 5 68. |
| Test No. 4 ... | Babcock and Wilcox ... | 0·14 ... | 7·11 |
| | Stirling ... | 0·69 ... | 6 94 |

From the above it will be seen that the Babcock and Wilcox boiler gave drier steam on every test.

**Overhead Electric Light Wires.**—While the carrying of electric light wires overhead is much cheaper in first cost than placing them underground, the cost of maintenance is higher, and there is much more chance of interference. An example of this has recently been furnished at Wellington (New Zealand), where the introduction of electric tramways has involved extensive alterations both in the overhead electric lighting wires and also in those used for the telephone service. Both these systems of wires have needed to be raised, so as to avoid fouling the trolley wire which is now being installed for the tramways. The cost of elevating the telephones and electric light wires has been estimated at £5 000, but competent judges are stated to consider this rather low. In Auckland the cost

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was £8,000, though there the tramway system covers a larger area. The wires are to be raised by the Telegraph Department and the Electrical Syndicate, the Corporation bearing the whole of the cost. The present height of the telephone poles is 35ft., and those which are to replace them will be 40ft. high. The work is being executed with all dispatch.

**Production of Mica.**—A return issued by the United States Geological Survey indicates that the total quantity of mica produced in the country during 1902 was of the value of some £23,000, of which plate mica (167 tons) represented about £17,000. The increase in the production of plate mica during the last three years is attributable to the increasing quantity of small-sized discs and rectangular sheets that have been cut for electrical purposes. For stoves, the use of mica declined greatly during the year. There was a falling off in the production of scrap mica, the amount produced being only 1,150 short tons, valued at £2,921. The mineral is largely imported from India, and also from Canada, the increase in imports actually exceeding the total quantity of mica produced in the States. Many of the mines are owned by small producers, and when the mica in these begins to give out, or is poor, they have no means to carry on much dead work, and have no other deposit to help fill out the deficiency. Operations have been conducted in California, Nevada, Maine, Alabama, and Georgia, but in some of these States good deposits that are known to exist are not available on account of the difficulties of transportation.

**The Institution's Visit to America.**—The Institution has issued to members a circular informing them that it is proposed that the party for the forthcoming visit to America should sail on Aug. 25 from Liverpool by the White Star s.s. "Republic," this being the only steamer on which accommodation for the whole number can be found. The "Republic" is due at Boston on Sept. 2, and particulars of the programme that has been arranged were given in our issue of the 22nd ult. The programme extends to Sept. 24, when the party will disperse, some returning to England by that day's steamer, others remaining till a later date. The estimated cost, including first-class fares and ordinary hotel expenses, with a contribution towards the expenses of the Institution, will be about £80. For incidental expenses, such as gratuities, which are under the personal control of the individual, but not including wines, a further sum of at least £10 should be allowed. Special arrangements will, where possible, be made for the comfort and entertainment of ladies, who are cordially invited. As it is necessary to complete arrangements without delay, members are requested to return an immediate reply on the form accompanying the circular, stating whether they propose to participate in the visit, and the amount of accommodation they desire reserved.

**Municipal Tramways Association.**—A meeting of the Managers' Section was held at Bradford on the 12th and 13th inst. The subjects discussed on the first day consisted of "Top-Covered Cars," "Magnetic Brakes," and "Bogie *v.* Single-Truck Cars," introduced by Mr. C. R. Bellamy (the president), Mr. John Young, and Mr. J. M. McElroy respectively. A description of the Bradford tramways was given by Mr. C. J. Spencer, under whose guidance the system was inspected. The members were entertained to luncheon by Councillor James Hill, the chairman of the Bradford Corporation Tramways Committee. On the following day discussions were held on "Conduit Tramways," Sand Drying," "Track Maintenance," and "The Removal of Snow," the second and last subjects being introduced by the President, and the first and third by Messrs. A. L. C. Fell and J. B. Hamilton respectively. Subsequently, the members of the committee, which consists of Messrs. C. R. Bellamy, A. Baker, J. Young, J. Dalrymple, and J. M. McElroy, and Councillor Smithson, considered the question of the standard system of tramway accounts, which was also the subject of a joint meeting with the representatives of the Institute of Municipal Treasurers and Accountants. The proceedings terminated with a meeting of the executive.

**Canadian Patent Law.**—In a memorandum published by the Dominion Government with reference to recent amendments to the Patent Act, it is stated that patentees must, in general, commence manufacture within two years of grant, under penalty of forfeiture. By Section 7, however, an exception is made in the case of patents which, from their nature, it would be unjust to subject to such a rule. The Commissioner of Patents has issued a circular defining this class as consisting of "patents for an art or process; patents for improvements on a patented invention, when both patents are not held by the same person; patents for certain appliances or apparatus in connection with railways, telegraph, telephone, and lighting systems, and other works usually under the control of public or large private corporations, and which appliances or apparatus cannot be installed or constructed without the consent of such corporations; and patents for inventions which are manufactured or constructed only to order, and are not, according to custom, carried in stock." It is reported, rather significantly, that the Patent Office is inundated with applications seeking the benefit of this saving clause. The principle is quite in accordance with equity; the danger lies in laxity of interpretation, which it is reassuring to see the authorities appear to be conscious of.

**Honorary Members, Inst.E.E.**—At the last meeting of the Council of the Institution of Electrical Engineers Major-General C. E. Webber, R.E. (retired), C.B., was elected an honorary member of the Institution. We have to congratulate Major-General Webber on his being added to the distinguished list of honorary members of the Institution, and we are exceedingly pleased to see that the Council have fittingly recognised the services rendered by him to the profession at large. Major-General Webber was one of the original members of the Institute of Telegraph Engineers, and he has taken a most active part in the subsequent development of electrical engineering. His work has been of a much more general character than that of any other member we know. Commencing as a telegraph engineer, he did a great deal of pioneering work in electric lighting, being responsible for the early stations laid down by the Chelsea Electric Lighting Company, and also for the first work carried out by the City of London Electric Lighting Company. He has been interested in telephone engineering, and throughout his career has always placed his expert knowledge at the service of his fellow-members of the Institution. It is most appropriate, therefore, that he should be added to the list of honorary members, which now includes five other distinguished engineers—namely, Dr. Henry Wilde, Lord Kelvin, Dr. J. Wilson Swan, Mr. E. Mascart (Membre de l'Institut de France), and Prof. Antonio Pacinotti, of Pisa.

**Edison Storage Battery.**—At the end of last month Mr. R. A. Fliess, who is the head of the testing department of the Edison Storage Battery Company, delivered a lecture on this subject before the New York Electrical Society. He gave some information as to the more recent types of these cells, which emphasises the conclusions independently arrived at by English experts. He showed that the "E" type of cell could be discharged at five times the normal rate without the ampere-hour capacity being reduced. This

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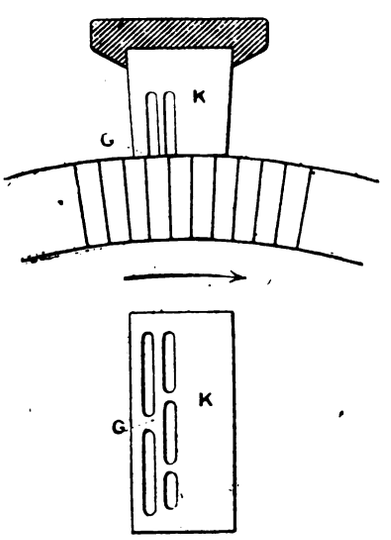
type of cell contains 18 plates—six being of iron and 12 of nickel. With a 30 ampere discharge rate this is equal to 15·56 watt-hours per pound. The Edison accumulators are now being manufactured in three sizes—*i. e.*, with outputs of 110, 165, and 275 ampere-hours. The first cost of the battery is still high, being almost twice that of a lead accumulator of equal capacity. On a four-hour discharge rate Mr. Fliess claimed for the Edison cell from 55 to 60 per cent. energy efficiency, as against 75 per cent. for a good lead battery. At the higher discharge rates, however, the position is reversed, as with five times the normal rate of discharge the energy efficiency of the Edison cell only falls to 44 per cent. In the case of a lead cell it would fall to 38 per cent. The advantages of the high rates of discharge were fully dealt with in the lecture. In conclusion, Mr. Fliess gave information as to a trial on the roads of a battery of accumulators covering 5,000 miles, after which the cell gave over 13 per cent. greater capacity than it had done before it went into the vehicle.

**Electrical Development in Mexico.**—The commercial advancement of Mexico under President Diaz has been indeed remarkable but hitherto, electricity has not been one of its features, and numerous manufacturing and mining undertakings have gone to the wall because of the great cost of fuel. It was manifest, however, that in a progressive community, contiguous to the great industrial republic, the introduction of electricity would only be a matter of time, especially when Mexico's abundant water power is remembered. The consequenee is that the country is now undergoing an industrial transition, and applications to the Government for powers are of daily occurrence. The State and the municipalities are encouraging such enterprise, and several electric lighting plants are in course of construction. The Mexican Railway Company contemplates electrifying a heavy-grade section of its system; a broad-gauge electric railroad between the cities of Guadaljara and Morelia, 120 miles in length, has practically been decided upon; a service of electric street cars will shortly commence running between Saltillo and Villa de Ortega; and an American company meditates purchasing at the price of £400,000 the concession for the street cars of Hermosillo, with a view to electrification and extension. The inhabitants are also alive to the advantages of electrical power for other purposes, and some of the mining concerns have contracted for the installation of plants to operate the machinery. It is scarcely necessary to state that in many instances Americans are responsible for the present state of things, but the Mexicans themselves fully appreciate the situation, so that the revolution is proceeding by rapid strides.

**E.E.V.R.E.**—The volunteer corps of the Electrical Engineers pass their Saturday evenings in a most sociable and most enjoyable way if last Saturday's Bohemian concert is to be regarded as an average specimen. Major Erskine presided, and there was a fairly complete attendance of officers, non-coms., and men. Owing to the presence of ladies, smoking was deferred until after the interval, when everybody seemed to thaw a little more in consequence. The Entertainment Committee, of which Captain J. J. F. O'Shaughnessy is the president, and Second-Lieutenant E. J. Sheppard the hon. secretary, are to be congratulated upon the excellence of the arrangements, the presence of Quartermaster-Sergeant G. Applebee no doubt accounting for much as far as the staging was concerned. The programme contained items instrumental, vocal, and comical, each of which was preceded by a roll of the drum. The artistes, many of which thoroughly earned an encore, were Mesdames Carrie Tubb and Elizabeth Davis, and Messrs. Ramsey, Warren, Marmaduke Stone, Miller, Norris; Sergeant Arundel, Corporal Hume, Sappers Gervers and Costello. During the evening Major Erskine presented a handsome silver cup to Second-Corporal Bennett. This was a prize given by Captain Leys for the best score in a three months' shooting competition. Major Erskine said that out of a possible 50 points per month Corporal Bennett had scored 49, 46, and 48. He had been run very close by Second-Lieut. Sheppard and Second-Sergt. Bowker, who tied for second place. Next year there will be two cups to compete for, another having been given by Major Hopkinson. On Wednesday evening the corps made an attack on Hampstead Heath, during which the two searchlights came into extensive play.

**New Carbon Brush.**—Mr. Gisbert Kapp has just patented a new type of carbon brush, the details of which can be seen in the following illustration, which we take from the *Elektrotechnische Zeitschrift*. The brush is to assist in a sparkless commutation in direct-current machines. The reversal of current in the conductors, which are connected to the commutator's sections, is influenced largely by the resistance of the brush contact. With an ordinary brush this resistance increases rapidly, starting from a very low




value, and becoming infinite at the moment when the section of the commutator leaves the brush. Mr. Kapp gives a special form to the brush, which increases the time during which the variation of this resistance is produced. By this means he is able either to avoid the use of a reversing field, or to employ a much more feeble one. The brush consists of a solid part, K, which serves to collect current, and a second part, G, which is honeycombed in the manner shown. The diminution of the surface of contact thus obtained serves to augment the contact resistance at this point, which effect is required.

**Aluminium Electrolytic Condensers.**—On April 8 last Mr. C. J. Zimmerman read an interesting paper before the American Electro-Chemical Society on the above subject. In it he described a number of experiments on aluminium electrolytic condensers, and some deductions made as to the film which is formed on the aluminium plate. By means of interference colour phenomena, he has estimated that the thickness of these films ranges from 0·000005cm. in exceptional cases to 0·00005cm. The disruptive strength of this film when the metal is positive to the electrolyte is apparently greater than that of mica. Its specific inductive capacity is not unity, as has been assumed, and if calculated from the above thickness, it would seem to be abnormally high for a solid. The author proceeds to give a number of curves, taken by means of the oscillograph, to show the use of such condensers for rectifying alternate currents

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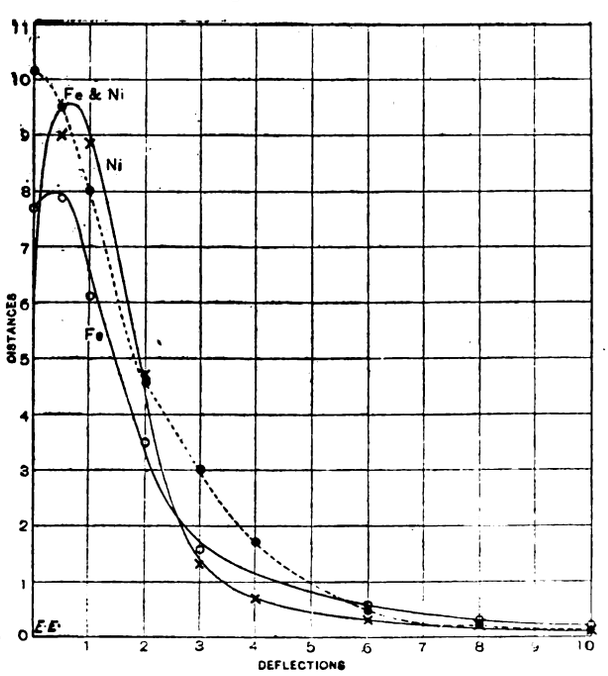
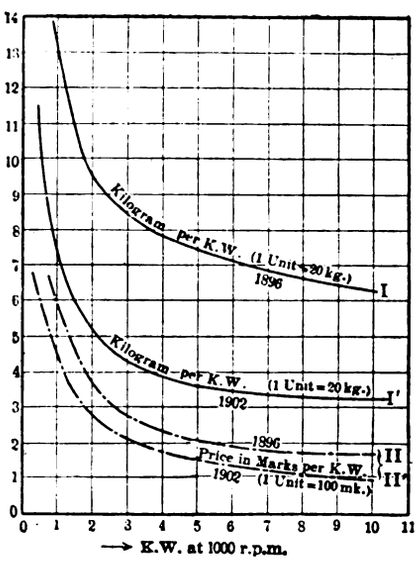
and also for ascertaining the losses in the same. His conclusions are that, in general, the voltage limit for single cells is not much above 150 volts where high efficiencies are desired. The efficiencies may range from less than 93 per cent. to as high as 97 per cent., according to the operating conditions. It is possible to operate condensers continuously at efficiencies above 95 per cent. with pressures at 110 volts. The weight, volume, and cost per microfarad of single-cell electrolytic condensers are considerably smaller than for equivalent tinfoil condensers operating at the same voltages. This great difference is not so marked where the voltages rise much beyond those at which single condensers can operate efficiently, since the energy-storing value of a condenser varies as the square of the pressure upon its terminals. The electrostatic capacity for 110-volt aluminium condensers may be said to be roughly one-quarter to one-half microfarad per square inch of aluminium plate in the cell.

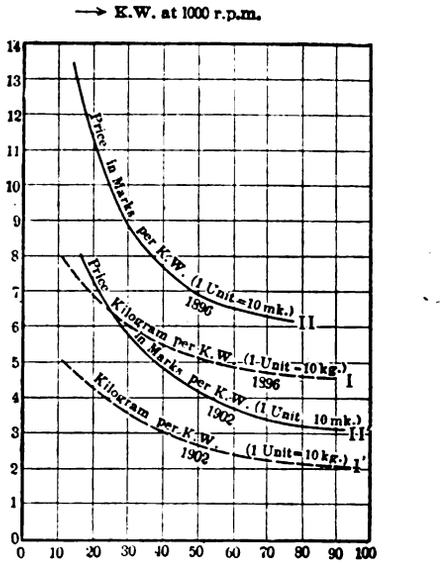
**Nickel in Magnetic Detectors.**—Mr. A. L. Foley contributes to the *Physical Review* particulars of an interesting research on the use of nickel in the core of the Marconi magnetic detector. He used in his experiments a ballistic galvanometer instead of a telephone, in order that accurate measurements could be obtained of the effect for the varying positions of the magnet and core in the electric wave detector. His experiments show that the sensitiveness




of the detector with a nickel core was not very different from that when an iron core was used. The results were given in the accompanying curves, in which the distances in centimetres is plotted against the deflections of the galvanometer. A curve is also given for a mixed core of iron and nickel wires. When this was used, the deflections of the galvanometer increased as the magnet approached the core, even up to the point of contact. It will also be seen that the mixed core was more sensitive than an iron one. The author concludes with the observation that since these electric oscillations appear to "have the power of reducing the effects of magnetic hysteresis," he is testing their effect on the hysteresis loss in transformers, armatures, etc. Although some experimental work has been done in this direction, it is too early to announce their results yet.

**Dynamo Costs.**—In connection with the opening ceremony of the St. Louis Exhibition, our contemporary, the *Electrical World* of New York, comments on the remarkable changes in the construction of electrical machinery since the Paris Exhibition. There is a great decrease both in weight and price of dynamos and motors, while at the same time their quality and durability has not been impaired. To illustrate this, our contemporary reproduces the two following sets of curves, taken from the data of one of the most successful German electrical firms. These curves are plotted to show in two cases the weight in kilogrammes per kilowatt, while the others give the cost in marks per kilowatt. In reading these curves the error will not be appreciable if the cost be considered in shillings. In order to make the comparison correct, the kilowatts are reduced for all machines to 1,000 revolutions per minute.




The curves show that, as compared with the year 1896, the same output is obtained with about half the material then used.

**London Traffic Commission.**—The sittings of the Commission are approaching a close. One more remains to be held, on June 2, when the evidence will be completed. At last week's sitting evidence was tendered by Mr. E. J. Harper, statistical officer to the London County Council, who gave a quantity of figures relating to the progress of London tramways. In 1881 the mileage run by cars was 9,722,678, and the number of passengers carried was 71,509,859; for 1903 the corresponding figures were 34,771,382 miles and 336,800,596 passengers. The increase of passengers per car mile illustrates the traffic created by new services, the figures for 1881 and 1901 being 7·35 and 10·46 respectively. In 1902 the number for the County Council's trams was 11·56, the fall in the following year being due to the temporary dislocation caused by the electrification scheme. Witness favoured the extension and electrification of tramways. He had come to

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the conclusion that, on the whole, the receipts from workmen's tickets in London, even where issued at the lowest fares, not only paid all working expenses, but left a margin. Mr. C. A. Brereton, partner with Sir John Wolfe Barry, submitted a scheme for a street 140ft. wide, with electric tramways and railways underneath, from Bayswater-road to Whitechapel-road. The tramways would run in subways, and a continuous footway would be constructed along the side of each line, to which access would be obtained at intervals from the roadway. The electric railway would be under one side of the roadway and the tramway under the other side. The railway would connect the main lines at east and west ends of the route. The north and south route would be from the Elephant and Castle to the Holloway-road, and would cross the river by means of a new bridge west of Blackfriars. The total cost of the east-to-west route would be £6,125,000, and that of the north-to-south route £2,550,000, exclusive of land, which for the former would cost about £11,293,550 and for the latter £7,000,000. The widening of Waterloo Bridge was recommended by Sir John Whittaker Ellis. Colonel Crompton stated that the Kensington and Knightsbridge Electric Lighting Company, of which he is chairman, had constructed small subways underneath the footways close to the kerbstone, with openings closed by covers, thereby obviating the breaking up of the streets. He considered most of the provisions of the City of London Street Bill of 1902 reasonable and workable.

**General Electric Company (of America).**—The report of this company for the year ending Jan. 31, 1904, shows that the gross receipts totalled over £8,500,000, or some £900,000 above those of last year, though the net earnings were not so high, the profits amounting to £1,560,000, against £2,048,000 in the previous year. The output included about 900,000 h.p. of generators, rotaries, and turbines; more than 7,000 railway motors, aggregating over 300,000 h.p. capacity; transformers of over 650,000 h.p. capacity; more than 15,000 alternating and direct current motors, aggregating over 200,000 h.p.; more than 75,000 arc lamps, and 110,000 meters. Attention is directed to the large order from the New York Central system for apparatus to operate as far out as Croton, 34 miles from New York City, and the economy in operating costs effected by American railway companies that have adopted electric traction is shown. The company's employés number 17,000, as compared with 8,000 in 1899, but are 1,000 fewer than in 1902-3, a fact largely attributable to increased use of automatic machinery. The new turbine shop at Schenectady is 237,000 square feet, and one for the same work at Lynn has 137,000 square feet. The company had five large plants under construction with line pressures of 60,000 volts. There was an order for 5,000 h.p. of generators for the Cauvery-Kolar plant. At Niagara power plant the company now has 11 generators of a total of 55,000 h.p. capacity; it has shipped the first 10,000-h.p. machine for the Canadian side of Niagara, and has two more coming along for delivery. Reference is made to the big order for locomotives for the New York Central Railway, "the forerunner of many others," the introduction of single-phase railway motors, and the Curtis turbine, the future of the last-named being spoken of in very optimistic terms. Working in co-operation, the inventor and the company have developed a type of prime mover specially adapted to driving electrical generators. A large line of turbo-generators, varying in size from 1½ h.p. to 7,500 h.p., has been developed. The company has sold about 350,000 h.p., of which 35,000 h.p. have been installed and are in successful operation. The company appears to be doing some 25 per cent. of the entire electrical manufacturing of the States, and a much larger proportion of that which falls within its special fields. The net profits of the year before writing off depreciation are equivalent to over 22 per cent. on the stock, and 18 per cent. after charging off depreciation. The gross receipts of the company have expanded by nearly 50 per cent. during the last three years.

**Side-Door Cars.**—The *Street Railway Journal* of New York gives a description of the new side-door steel cars now in use on the suburban lines of the Illinois Central Railway. These cars have an aisle along each side, and there are sliding side doors opposite each section of seats. These doors are carried on ball-bearing rollers and work between the walls of the car. They are connected by a mechanism within the wall, which is so arranged that all of the doors on one side may be opened, closed, locked, or unlocked simultaneously. This mechanism has duplicate control, one for air, with a cylinder 2½in. in diameter, and the other with a hand-wheel about 30in. in diameter. In practice the doors are unlocked from either end as the train stops, leaving the opening of such doors as are needed to the passengers who desire to use them. They are then closed and locked simultaneously by the trainman before starting. To obviate delay in restarting, a series circuit is being wired from the cab down one side of the train and up the other side, including every door in the train in series and back to the cab. This circuit is so arranged as to ring a bell in the cab when any door in the train is not locked, thus breaking the main circuit; hence the bell in the cab will ring during the five or six seconds of stop, and its cessation notifies the engineman that all is in condition for him to proceed. The hand-signal apparatus will still be maintained as a reserve system. In order to provide against any serious trouble from catching of fingers or clothing in the sliding doors as they are closed by the employé at one end of the car, flexible connection between the door and the operating rod is employed, which will allow the door to yield sufficiently when it strikes such an obstruction, so that no damage is likely to be done. The advantages claimed for the new type of car include steel construction throughout of the under frame and upper frame, giving greater protection to the passengers against accidents and from fire; a floor plan combining with transverse seats an aisle on both sides of the car, affording access to every part of the car from either side; slide doors which slide within the walls of the car, and end doors, with vestibules connecting all the cars, affording access from within to every part of the train; electric connection between the side doors of the entire train and the locomotive, giving signal automatically to the engineman of the opening and closing of the door; distribution of passengers evenly on station platforms, with assurance that the train can be entered at any point; and short stops at stations, with consequent improved train schedules. Mr. Sullivan, who is responsible for many of the new features, further calls attention to the fact that while the seating capacity is 100 passengers, there is standing room for 200 more. The cars first built weighed 84,600lb, but this will be reduced on those under construction. The net weight of car per passenger is less than can be obtained with any form of wooden construction. One new car takes the place of two old cars. He reports that as many as 46 passengers have been discharged from one car at an intermediate station in two seconds. So successful has the design been, that none of the objections urged against it at its inception have been realised; but in the new equipment, which includes eight additional cars, all provision for expansion at the ends of the frame has been omitted, as this has been found unnecessary.

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## SCARBOROUGH TRAMWAYS.

The electric tramways at Scarborough were officially opened on Friday, May 6, when the Mayoress switched the current on to the car-sheds, and afterwards drove the first car round the various routes which are completed. The opening function was witnessed by a very large number of invited guests, and the route taken by the decorated cars conveying these guests was lined by numbers of enthusiastic spectators. From what we saw at Scarborough at the opening ceremony, there should be a very great future for the tramway system both in conveying inhabitants from one part of the town to another, and also from the large number of visitors in the Scarborough season. The routes which have now been equipped total about 4½ miles in length, and provide communication between the North and South Shores and in the principal streets. Grades and curves which have to be negotiated on some of the lines approaching the South Shore are severe, and preclude the use of any other system of traction. Some few years ago electric omnibuses were tried, but the hills proved too severe. The electric cars on Friday last experienced no difficulty in this respect, and the very steepness of the grades will tend to an increase of traffic even from the inhabitants of Scarborough. The following details of the tramway construction will be of interest as showing the excellent character of the work done. The rails are of the girder type, 6in. deep; the 1⅛in. groove rails weighing 90lb. per yard, and the 1¼in. groove, 91lb. per yard. These were supplied by the North-Eastern Steel Company, Middlesbrough. The fish-plates weigh 38lb. per pair. The bolts are 1in. diameter and of Ibbotson's make, and there are six to a pair of fish-plates. The points and crossings and special work were supplied by Messrs. Hadfield's steelfoundry, who constructed seven special lay-outs at their works and supplied them

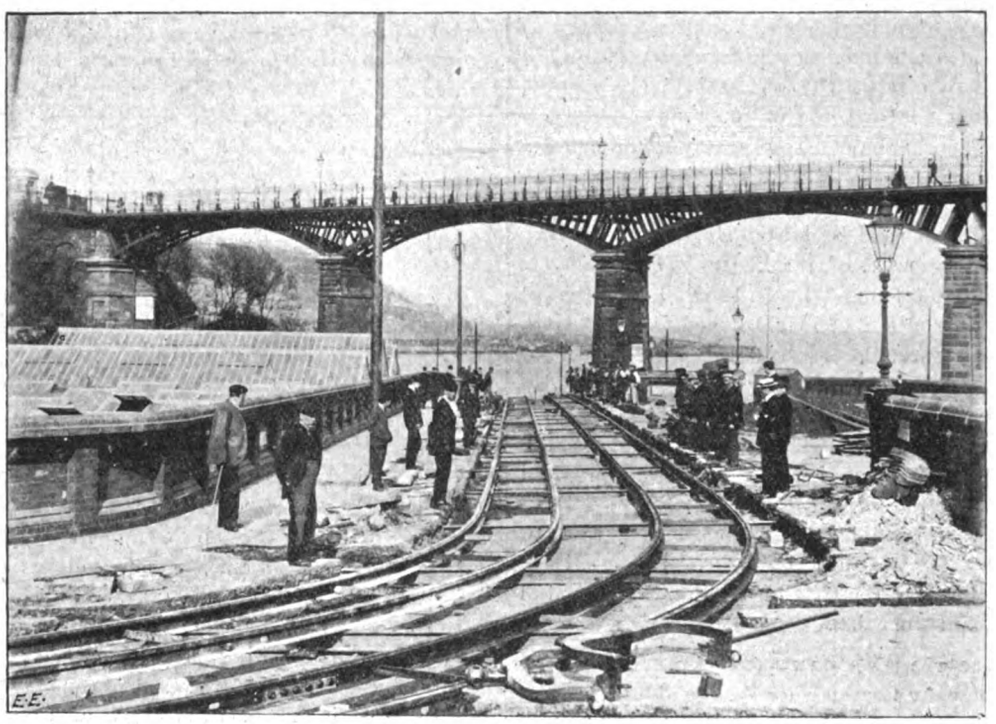

FIG. 1.—The Tramway over the top of the Aquarium. The line does not end in the sea, as appears from this view.

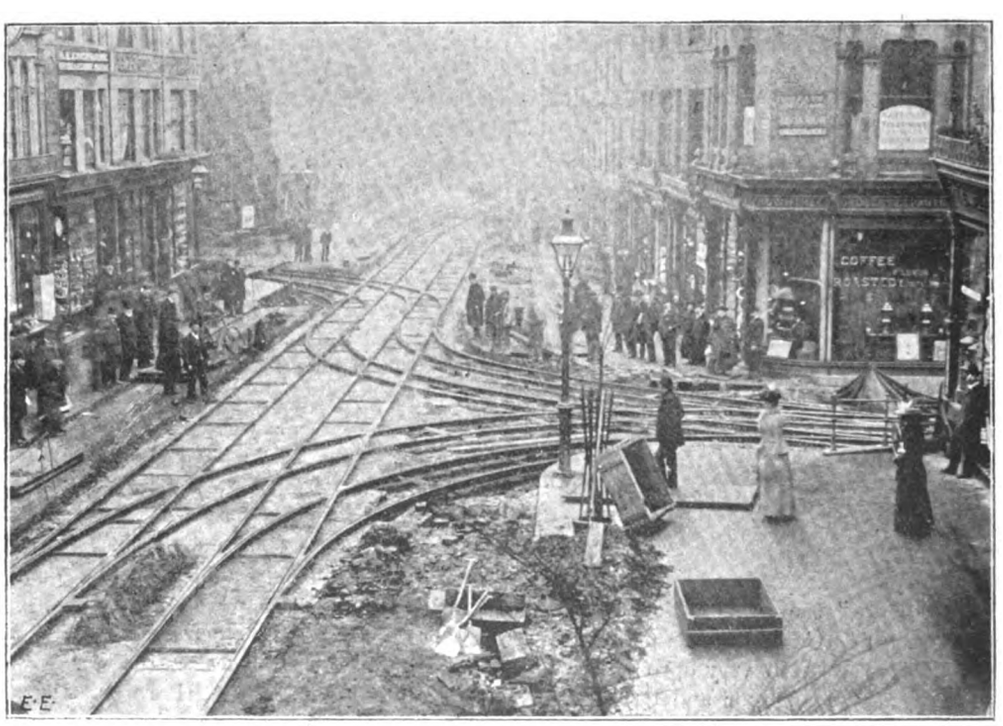

FIG. 2.—The Crossing at Vernon Place and Aberdeen Walk, Scarborough.

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ready for putting together on the job. The gauge is 3ft. 6in., and there are 21 standard passing places in the town. The rails are drained where necessary with Hadfield's patent drain boxes, and on the steepest gradients with Crosta's patent drain boxes and sump. There are an unusually large number of sharp radius curves, and one or two of these occur at the foot of steep gradients. The sharpest radius is 32ft. 6in., and there are 37 curves under 50ft. Blackwell's Neptune bonds are used of 4/0 section, and every joint is double bonded. The concrete is composed of one part of Portland cement, one part of sharp sand, and five parts of clean broken stone or shingle. The cement was supplied by the Associated Portland Cement Manufacturers, Limited. There are four different kinds of paving used: (1) Tar macadam between rails, with a granite margin to the rails. The tar macadam was done by the Corporation of Scarborough as a sub contract. (2) Basalt lava between rails, with an 8in. basalt margin, and tar macadam outside this. (3) Wood paving between rails, with 15in. wood outside, and a 3in. granite border. (4) Wood paving right across the street,

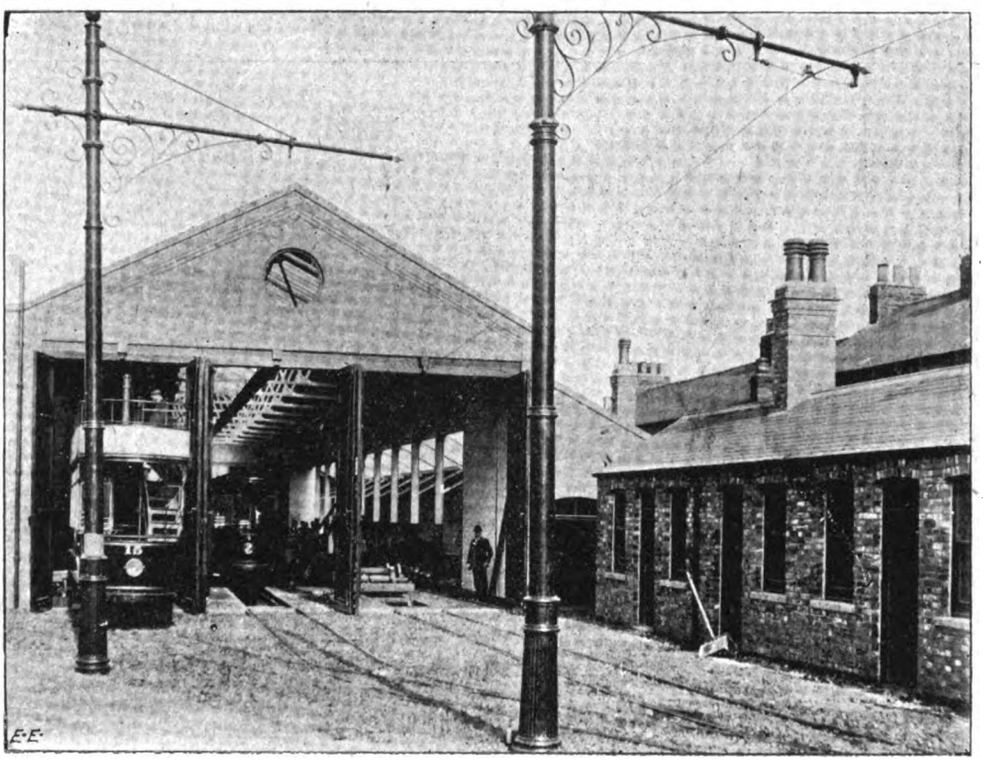

FIG. 3.—The Car Shed.

let as a sub-contract to Mr. James Brunton, Hull. There have been several necessary alterations to road levels and street corners, which have been carried out at the tramway company's expense by Mr. Harry W. Smith, A.M.I.C.E., the borough engineer. Every piece of double line is in sight of double line, so that the chances of two cars getting on to one section are reduced to a minimum. Special construction was necessary where the tramrails go over the Aquarium (Fig. 1), and in this instance the tramway company put in transverse steel girders so that they rested over the main piers of the Aquarium, and longitudinal creosoted pitch-pine

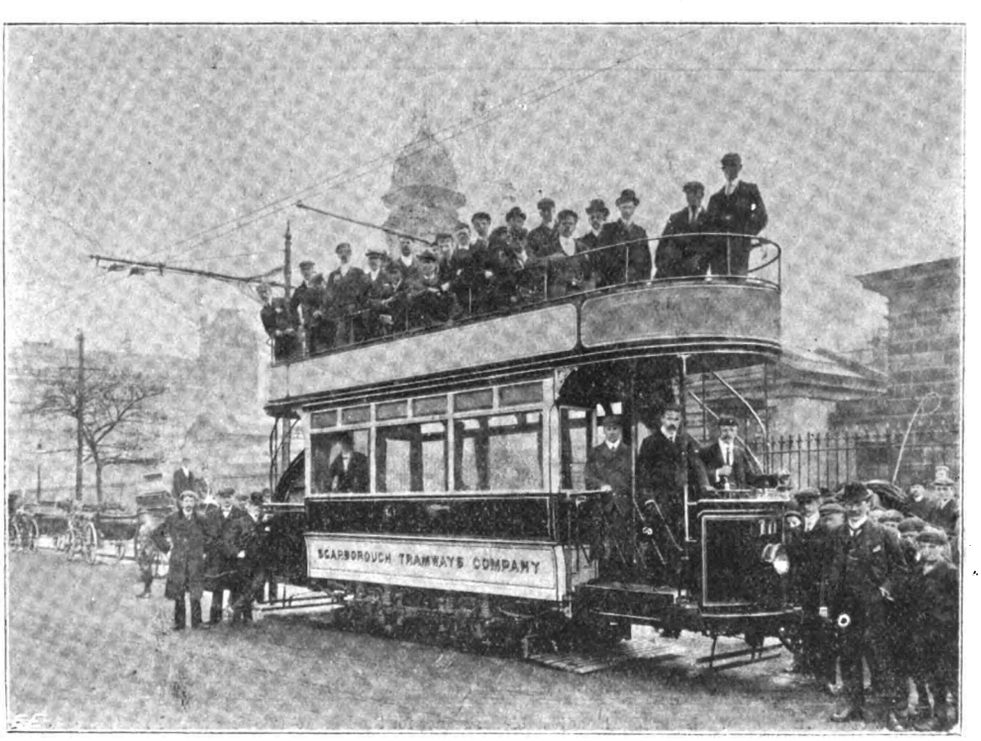


FIG. 4.—A Scarborough Tramcar outside the Station.

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sleepers resting on these, to which the rails were fixed by coach screws. The Aquarium Company also, under a mutual arrangement, considerably strengthened their underworks, which was done by pulling down the original brick piers, and rebuilding them with cast-iron columns in the centre.

There are three types of overhead construction employed—viz., the side bracket, span, and centre pole.

The feeders are of Callender's vulcanised bitumen, and are of ·4 and ·3 section, laid solid in a wood troughing with tiles on it. The negative return cable from Falsgrave-road to the supply works is 1 25 section. The feeder pillars are of Callender's latest design, and contain main feeder switches, switch fuses, pilot connections, twin telephone connections, and lightning arresters. At half-mile sections,

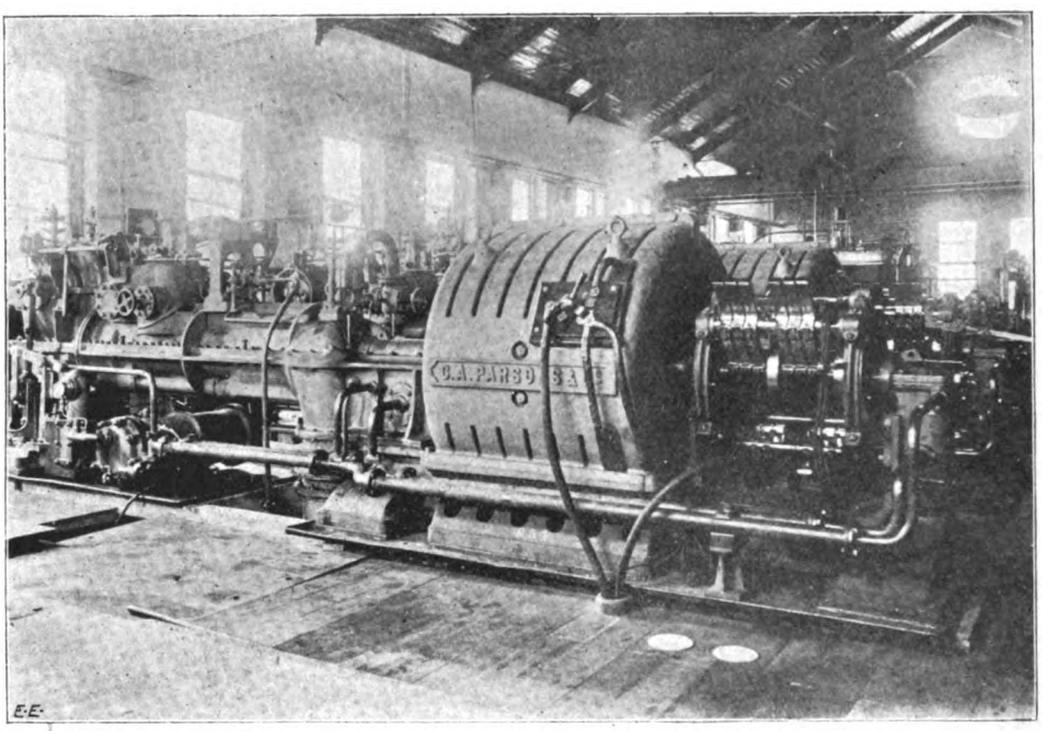

FIG. 5.—View of the Scarborough Electricity Works, with the Direct-Current Steam Turbines in the foreground.

The poles are 31ft. long, let into the ground for 6ft., and are made up of three parallel sections of solid-drawn steel tube. The concrete used for fixing the poles is of the same proportions as in the permanent way. The overhead work was carried out by Messrs. Edmundson's, and the materials were supplied by Dick-Kerr. The automatic and trailer frogs were supplied by J. and G. McLoughlin, of Dublin. On the Aquarium top-heavy cast-iron bases were used, and these were cast locally. In streets where no cables are laid the telephone and test wires are carried overhead on brackets on the poles. There is about 10 miles of 2/0 trolley wire run and about eight miles of guard wire. The guard and span wires are of bimetallic bronze.

and at each end of special overhead work, there are section boxes on the poles which contain two main switches for separating any portion of the overhead in case of break-downs. These switches are simply arranged to short-circuit the section insulators. There are eight miles of cables laid altogether.

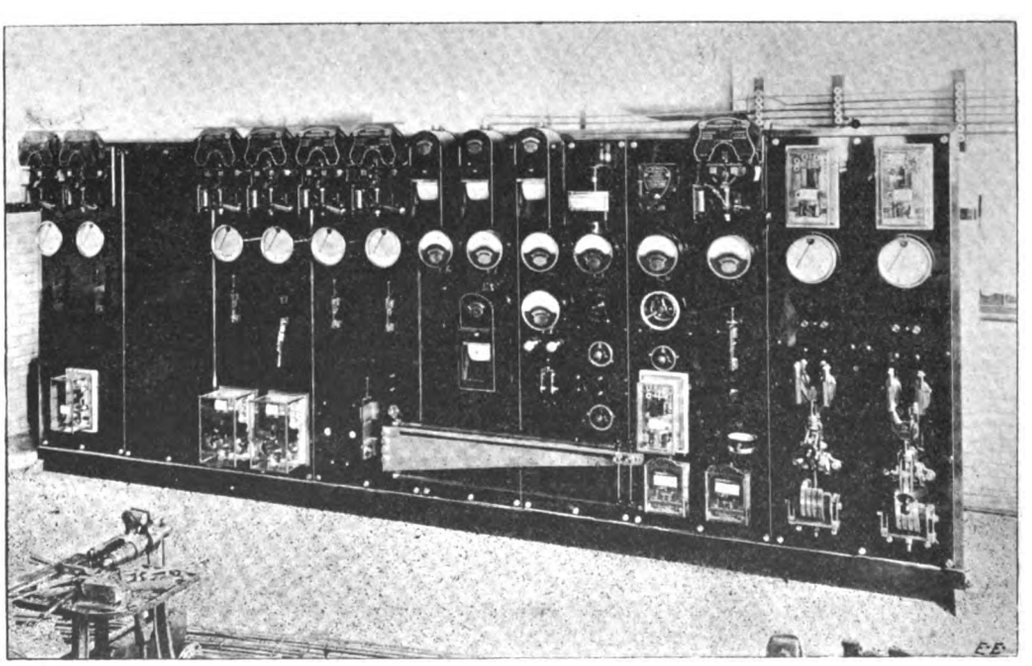

FIG. 6.—View of the Traction Switchboard. The adjustable resistance for the Highfield Booster is at the bottom of the board.

The car-sheds (Fig. 3) were built by Messrs. J. and J. W. Bland, of Scarborough, to the specifications and plans of Mr. J. E. Waller and Mr. A. A. C. Swinton, and were part of Messrs. Edmundson's contract. They contain ample room for 15 cars, and are built with a view to extensions. They also contain a fitting shop, joiners' shop, and smithy, and in an adjoining block there are lavatories, men's

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mess-room, foreman's room, stores, etc. They are lighted from the 500-volt circuit, in series of three and five lamps. The wiring was done by C. L. Sanderson, Scarborough, to Mr. Edmundson's instructions. There are 15 cars at present in the sheds, and these were supplied by the British Thomson-Houston Company, Rugby, and consist of Brush Company trucks and car bodies and of the B.T.H. electrical equipment. Each car has two motors of G E.-58 type of about 35 h.p. each. The controllers are of the B.-18 type. Each car has a track brake, wheel brake, B.T.H. electric brake, and Tidswell's patent lifeguards. The cars are constructed to carry 20 inside and 24 outside, and are 26ft. 6in. long and 6ft. 3in. wide. One of the special features of the car is the patent folding step, which is a great safeguard against accidents. This can be seen in the illustration (Fig. 4). The step is so arranged as to fold up on to the platform. It is operated by means of a lever, which is so interlocked with the folding gate that the step cannot be lifted up until the gate is closed, and the gate cannot be opened again until the step is altered. In this way, there is no step to the front of the platform when the driver has closed and locked the gate, and hence passengers are not so likely to try to board the front of the car. Another advantage is that by raising the step, a much clearer space is left under the car in front of the lifeguard. This is a distinct advantage should anyone fall in front of the cars, as they are less likely to be struck.

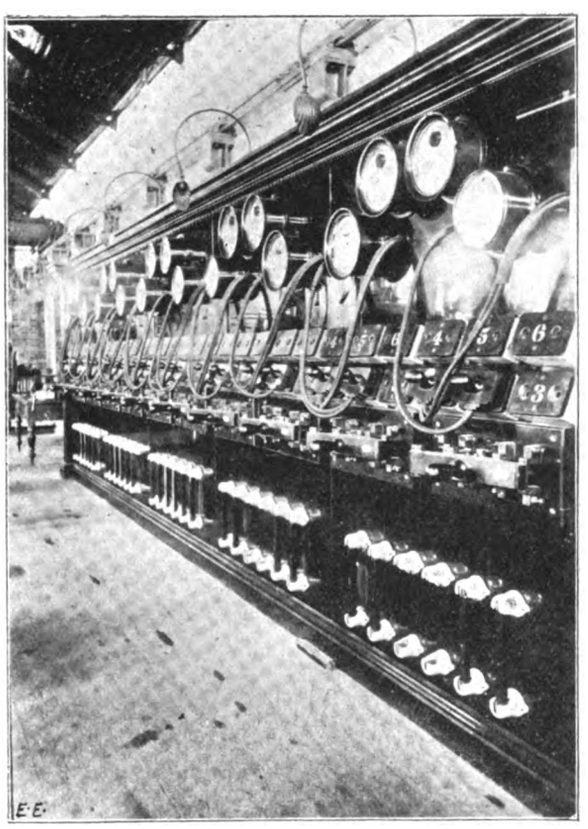

FIG. 7.—The H.T. Lighting Switchboard, showing the Plug and Flexible Connections for Circuit Running.

Work on the construction of the above tramways was commenced on Oct. 12, 1903, and has been continued since without intermission. During the first six months the contractors completed seven miles of single track, which is considered a very fair record, as they only started with one gang at work and never had more than two gangs at work in the town. Edmundson's Electricity Corporation, Westminster, were the contractors for the permanent way and overhead work, which was constructed to specifications and plans prepared by Mr. J. E. Waller and Mr. A. A. C. Swinton, of Westminster. Messrs. Edmundson's have also supplied and connected up the switchboard for the Scarborough Supply Company, who previously had only an alternating single-phase supply. Mr. J. E. Edmundson, A.I.E.E., has acted as resident engineer for Edmundson's, with Mr. W. E. Nicoll and Mr. A. L. Fisher as assistants. Mr. H. C. Bemrose represented Mr. J. E. Waller, and Mr. F. Mildred Messrs. Callender's Cable Company, who have laid all the tramway cables.

As will be gathered from the above, the whole of the current required for the tramways is taken from the Scarborough Electric Supply Company. For this purpose the company have installed two new steam-turbines of the Parsons type, each coupled to a 300-kw. compound-wound direct-current dynamo. A view of the station with these turbines to the foreground is to be seen in Fig. 5. They have also added a Tudor battery of accumulators and a 200-ampere Highfield booster. The traction switchboard (Fig. 6) was made by Edmund Charrington, of London. On the switchboard are three Vulcan wattmeters in series, and the mean of the readings of the three is taken as the basis for payment, which is made on a graduated scale which was mutually agreed upon. This work has been done to Mr. A. A. C. Swinton's specifications, and under the personal supervision of Mr. F. G. Holden, resident engineer.

The Scarborough electricity supply works are interesting from the fact that they are essentially a turbine station. Thus, when we looked at the same on the morning of the opening, we found a turbine running which was installed when the station was opened some 11 years ago. This turbine is of 75 kw. capacity, and runs at 5,000 revolutions per minute. As it has been in regular work during that time, and has been responsible for the continuity of supply at light loads, it is a good proof of the durability of the Parsons turbine. We had thoughts of ascertaining the total number of revolutions made by this turbine, but the figures would crowd our limited space. The other alternate-current machinery comprises one turbine of 126 kw. output, one of 150 kw., and two of 500 kw. These last turbines run at 2,400 revolutions per minute. The alternate-current plant in the station is worked on the circuit principle, and the machines are not connected in parallel. The switchboard which enables the circuits to be thrown from one machine to another is illustrated in Fig. 7. The introduction of the traction plant will greatly improve the load factor of the station, and hence tend to economy in running.

At the luncheon which followed the opening ceremony, the chair was taken by Mr. W. S. Rowntree, the chairman of the tramway company, who had on his right the Mayor of Scarborough. After the usual loyal toasts, Mr. A. A. Campbell Swinton proposed "The Corporation of Scarborough," and expressed his opinion that the prosperity of the town and the prosperity of the tramways were closely interconnected. The Mayor, in reply, referred to the fact that in 1881 he had had to do with the first electric tramway in the United Kingdom. This was a short length laid in the Blackpool Winter Gardens. Councillor J. W. Rowntree proposed "Success to the Scarborough Electric Tramways," and commended to the study of the tramway engineers the time-tables of the North-Eastern Railway Company, which gave connections with certain villages in the neighbourhood. He thought that a perusal of these time-tables might lead to an extension of the tramway system. Mr. W. S. Rowntree, in reply, said he had great hopes of the success of the Scarborough tramways. He had recently seen the tramways at Santa Cruz, which paid extremely well in spite of much worse grades and curves than were found necessary at Scarborough. The Corporation of Scarborough were favourably situated, in that they took no risk over the tramway undertaking, but were still entitled to a share in the profits. Councillor Whittaker proposed the "Health of the Consulting and Tramway Engineers," and referred to the fact that Mr. J. E. Waller had first advised the town on tramway matters, and subsequently acted as consulting engineer to the company. As adviser to the Corporation he had made excellent terms with the company. Mr. J. E. Waller, in reply, said that in this respect he had made a rod for his own back. He thought that Mr. J. E. Edmundson had made a record for carrying out tramway work promptly. He was quite sure that the tramways would need to be extended, and that a line to Scalby might provide a little more rapid intercommunication than the trains of the North-Eastern Railway Company. Mr. F. E. Gripper also replied.

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## LEICESTER CORPORATION ELECTRIC TRAMWAYS.

### Mainly Historical.

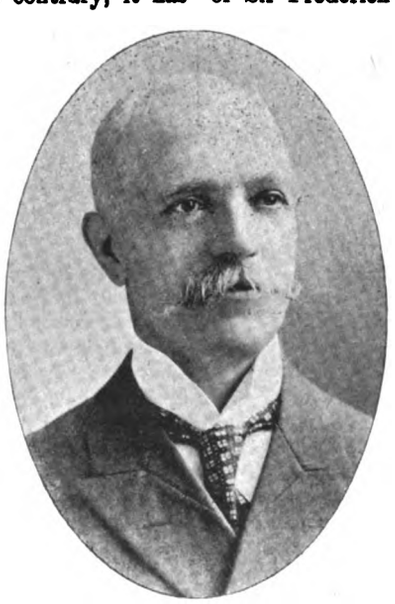
It seems but yesterday that the question of a site for a new electric power station was engaging the attention of the Leicester Corporation, and now we have to record the formal inauguration of the supply from that station for traction purposes. The ceremony took place on Wednesday last, when the first instalment of a boldly-conceived and splendidly up-to-date system of electric tramways was handed over to the public. Leicester has lagged somewhat in the matter of electric traction, but, on the other hand, has profited from the experience gained in other large towns by adopting a system which is assured of success. Having regard to its numerous undertakings, Leicester, in other respects, cannot be said to have been behind in municipal enterprise; on the contrary, it has made phenomenal progress in those things which add to the comfort and well-being of its citizens. In recent years the growth of the town has been very rapid, the population having more than trebled itself during the last 40 years, being now over 220,000. The rateable value exceeds £1,000,000, and the area of the borough, which was extended in 1891, is 8,586 acres, measuring, roughly speaking, five miles from north to south and four miles from east to west. The system of electric tramways now constructed supersedes the old horse tramways originally owned by the Leicester Tramways Company, Limited. It was in 1874 that this company opened for traffic the first of three lines authorised by their provisional order. Further powers conferred upon the company in 1877 enabled them to equip two additional routes. The question of acquiring the undertaking for the town was first considered in 1893, but without definite result, and three years later the Council decided to promote an omnibus Bill in Parliament empowering the Corporation when they acquired or constructed any tramways to work the same, and take tolls and provide the requisite buildings, plant, etc. These powers were conferred by the Leicester Corporation Act, 1897. In the following year the advisability of purchasing the tramways undertaking, either by agreement or compulsorily, was again brought forward, the special committee appointed to consider the matter even going so far as to obtain expert advice and a report from Mr. H. Graham Harris, M.I.C.E., of the firm of Sir Frederick Bramwell and Harris, besides a valuation of the freehold land and buildings of the company by Sir John Rolleston, F.S.I. This committee in their report recommended the Council to purchase by agreement on certain terms, but the advice was not then adopted. The question, however, was not destined to rest long, the Tramways Committee being reappointed by the Council towards the latter end of 1899, with Mr. Councillor S. Flint as chairman and Mr. Alderman Thomas Smith vice-chairman. A sub-committee, technically assisted by Mr. E. George Mawbey, M.I.C.E., the borough engineer, and Mr. James Bell, the late town clerk, then considered the position of

COUNCILLOR SAMUEL FLINT, CHAIRMAN OF THE TRAMWAYS COMMITTEE.

THE BOROUGH ARMS.

ALDERMAN THOMAS SMITH, VICE-CHAIRMAN OF THE TRAMWAYS COMMITTEE.

MR. E. MANVILLE, M.I.E.E., CONSULTING ENGINEER.



MR. E. GEORGE MAWBEY, M.I.C.E., BOROUGH AND ELECTRIC TRAMWAYS ENGINEER.

MR. T. ROBERT SMITH, A.M.I.E.E., RESIDENT ELECTRICAL ENGINEER.

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the Corporation with respect to the purchase of the tramways, and made most exhaustive investigations as to the municipalisation of tramways generally, and as to the construction and working of the different systems of tramway traction then in vogue, visiting the chief installations at home and on the Continent for the purpose. The report which was issued as a result of these investigations, and obtained wide publicity due to its excellence, dealt incidentally with the various advantages and disadvantages of the surface-contact, accumulator, conduit, and overhead trolley systems of electric traction, and embraced the complete scheme now being carried out at Leicester, including the purchase and working of the tramways undertaking by the Corporation, and the adoption of the overhead system of electric traction with direct-current generating plant.

In this connection it may be mentioned that while the claims of the conduit system were fully recognised, it was deemed too costly for a provincial town like Leicester. The opposition which was offered to certain of the recommendations embodied in the report evoked lively interest at the time, and it will be remembered that Mr. E. Manville, M.I.E.E. (of the firm of Messrs. Kincaid, Waller, Manville, and Dawson), was appointed to report on the scheme, chiefly with regard to the two main questions—viz. (1) the adoption of the underground conduit, surface-contact, or overhead trolley system; and (2) as to an independent central power station or a combined power station. That gentleman having carefully gone into the matter, recommended the adoption of the whole scheme as previously submitted to the Council, including the overhead system of electric traction, and the provision of a separate power station for tramway purposes, which advice was finally acted upon in July, 1901, but not before the wisdom of the recommendations had been established by convincing arguments. At the same time, the Council adopted the provisional agreement which had been arrived at with the Leicester Tramways Company, Limited, for the purchase of the undertaking for the sum of £134,000. It need hardly be said that this result was extremely gratifying to the committee and their engineer, Mr. Mawbey, who had devoted so much of their time and energies to a scheme which they fully believed was the best that could be produced in the interests of the town. Mr. Manville, whose arguments had served to convince the Council, was appointed consulting engineer to advise and assist as might be required from time to time in respect of any matters in connection with the preparation of the details of the adopted scheme, and to support the scheme in Parliament as might become necessary, his services being subsequently retained as consulting engineer during the progress of the works.

The Corporation themselves commenced working the horse tramways in January, 1902, and Mr. A. F. Lucas, who was the manager and secretary for the tramways

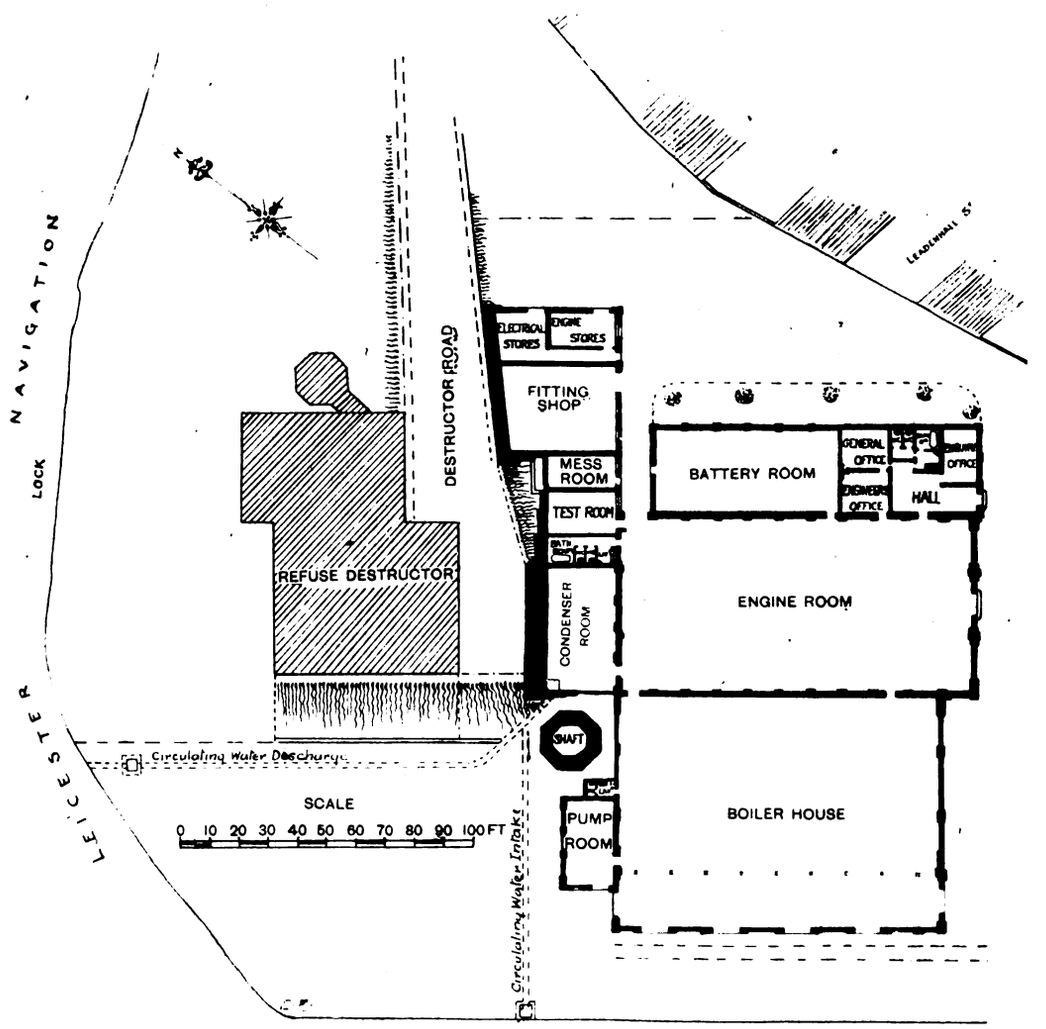


FIG. 1.—Block Plan of the Tramway Generating Station at Leicester.

company, continued to fill this position for the Corporation. Mr. Lucas has now been appointed permanently as the manager for the electric tramways. It is interesting to note that the horse tramways have been worked with marked success since they was taken over by the Corporation. The receipts have increased from £42,000 to £47,000 a year, and the passengers carried last year exceeded all previous records by over a million All this has been achieved notwithstanding the fact that these old lines have been nearly all torn up and replaced by the new permanent way, temporary tracks having been very largely used during the reconstruction.

The parliamentary plans and estimates for the new scheme were prepared by Mr. Mawbey, and deposited in December, 1901, receiving the Royal assent in July of the following year. The estimate for the whole scheme, including track, power station buildings, machinery and equipment, main and district car depôts and equipment, feeders, ducts,

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tramcars, land, etc., was £537,000, a further item of £113,000, set down for street improvement, bridge widening, and side paving, bringing the total to £650,000. As is well known, Mr. Mawbey has been the chief engineer for all the branches of this scheme, both in connection with its design and execution, having the direct dealing with the various contractors and the general detailed supervision of the work, and this, coupled with the fact that Mr. Manville and his partners have from time to time advised Mr. Mawbey on all the points on which he required advice, is a sufficient guarantee that the town has been well served from an engineering point of view. Mr. Mawbey speaks

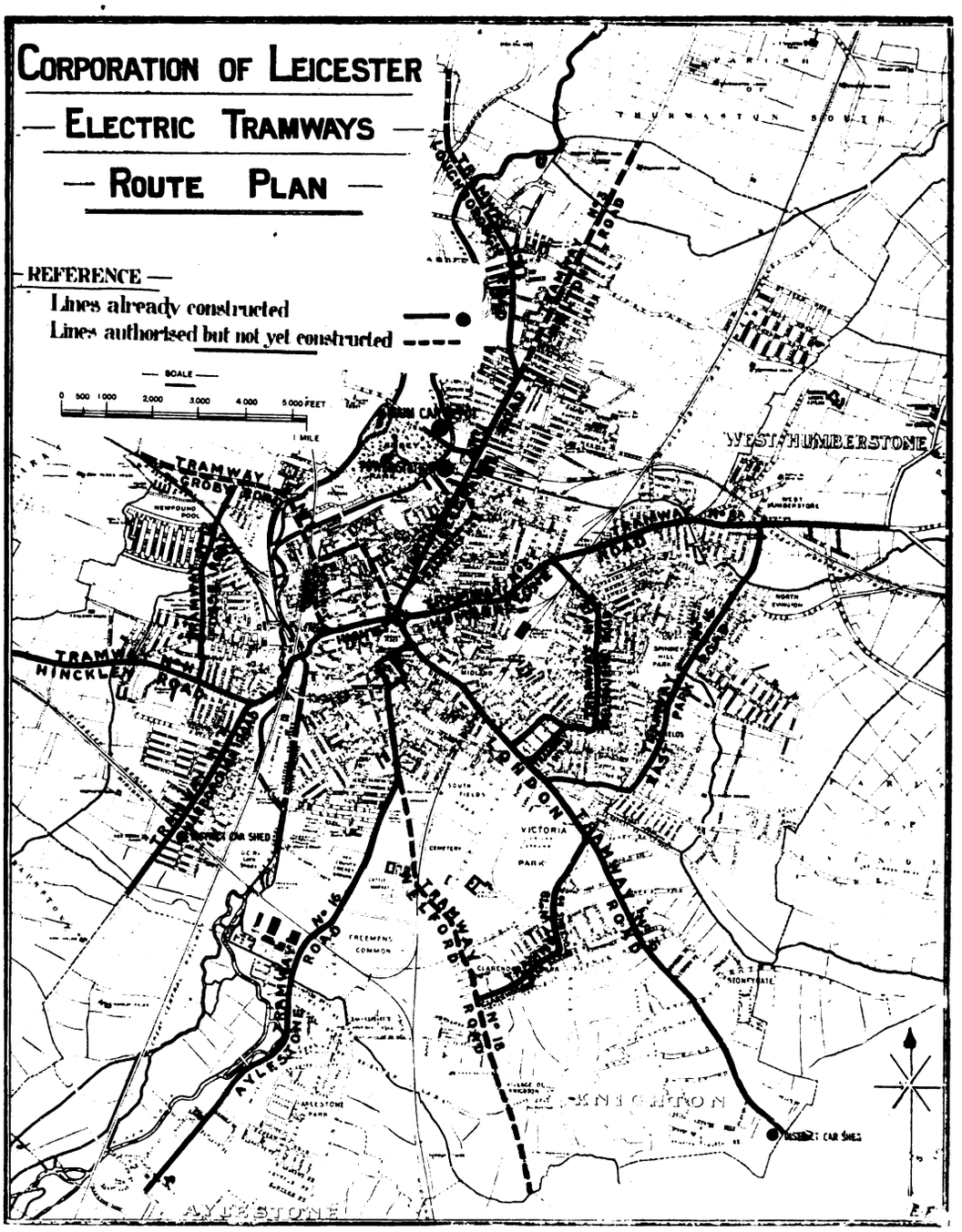


Fig. 2.

in high terms of the very able and loyal assistance he has had from his staff in connection with the designing and carrying out of this extensive scheme. The appointment of the staff was very wisely entrusted largely to Mr. Mawbey, who commenced by selecting and promoting to the chief positions men already in his own office. During the preparation of the parliamentary plans, he entrusted the position of chief civil engineering assistant to Mr. H. C. Leadbeater, who had been in the service of the Corporation for several years, and who subsequently secured an appointment under the London County Council about the time that the Bill was deposited. Mr Mawbey then promoted to this position Mr. W. Plant, P.A.S.I., another member of his staff who had been with him for several years, and who has acted as chief assistant for all the permanent-way work, buildings, bridge work, etc. To the position of chief electrical and mechanical assistant, Mr. T. Robert Smith, A.M.I.E.E, who had also been some time previously in Mr. Mawbey's office, was promoted, and so satisfactory have been his services that he has now received the permanent appointment of resident electrical and mechanical engineer. Tribute must also be paid to the untiring energy and ability with which the chairman (Mr. Councillor S. Flint) and the vice-chairman (Mr. Alderman Thomas Smith) of the Tramways Committee have devoted themselves to the scheme. It is not too much to say that by the active interest and assistance of these gentlemen Mr. Mawbey's task of organising and carrying his scheme through to completion has been greatly facilitated. That the committee have been wise in allowing Mr. Mawbey an unfettered hand is proved by results to date, and, if we mistake not, time will convince even the most obstinate opponent of the scheme of the soundness of their engineer's judgment. Valuable services have also been rendered to the Tramways Committee in various ways, particularly in connection with street improvement and paving works, by Mr. Alderman J. S. Vorley, the chairman of the Highway

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and Sewerage Committee. Such services are apt to be overlooked, hence it gives us extra pleasure to record them, especially as they reveal a whole-hearted endeavour among members of the local authority to serve the true interests of their town.

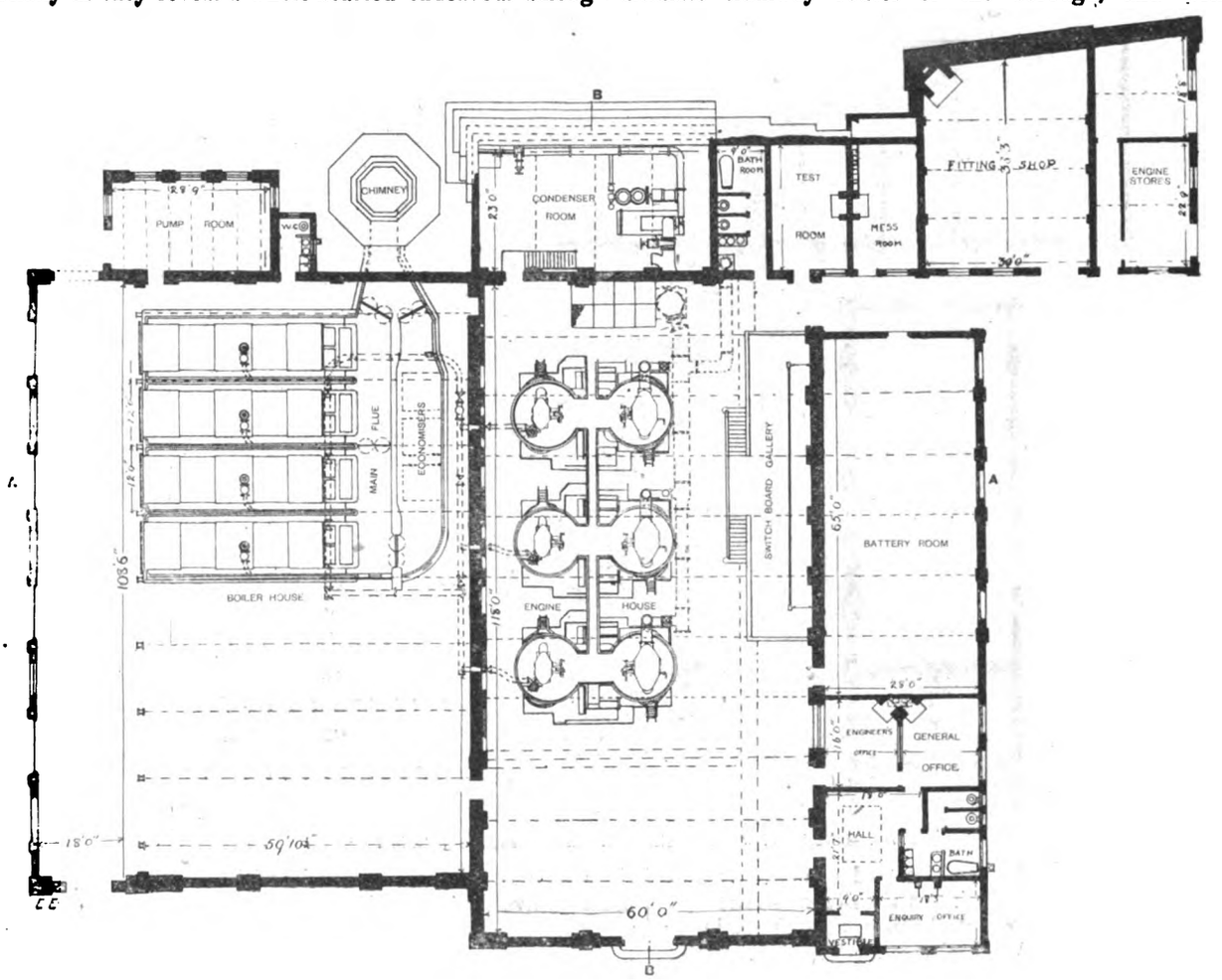


FIG. 3.—Plan of the Generating Station.

ration refuse destructors. The position (Fig. 2) commands within a radius of three miles the whole of the possible ultimate tramway routes of the borough, and within four miles the whole of the populated districts immediately surrounding the borough. It is also conveniently

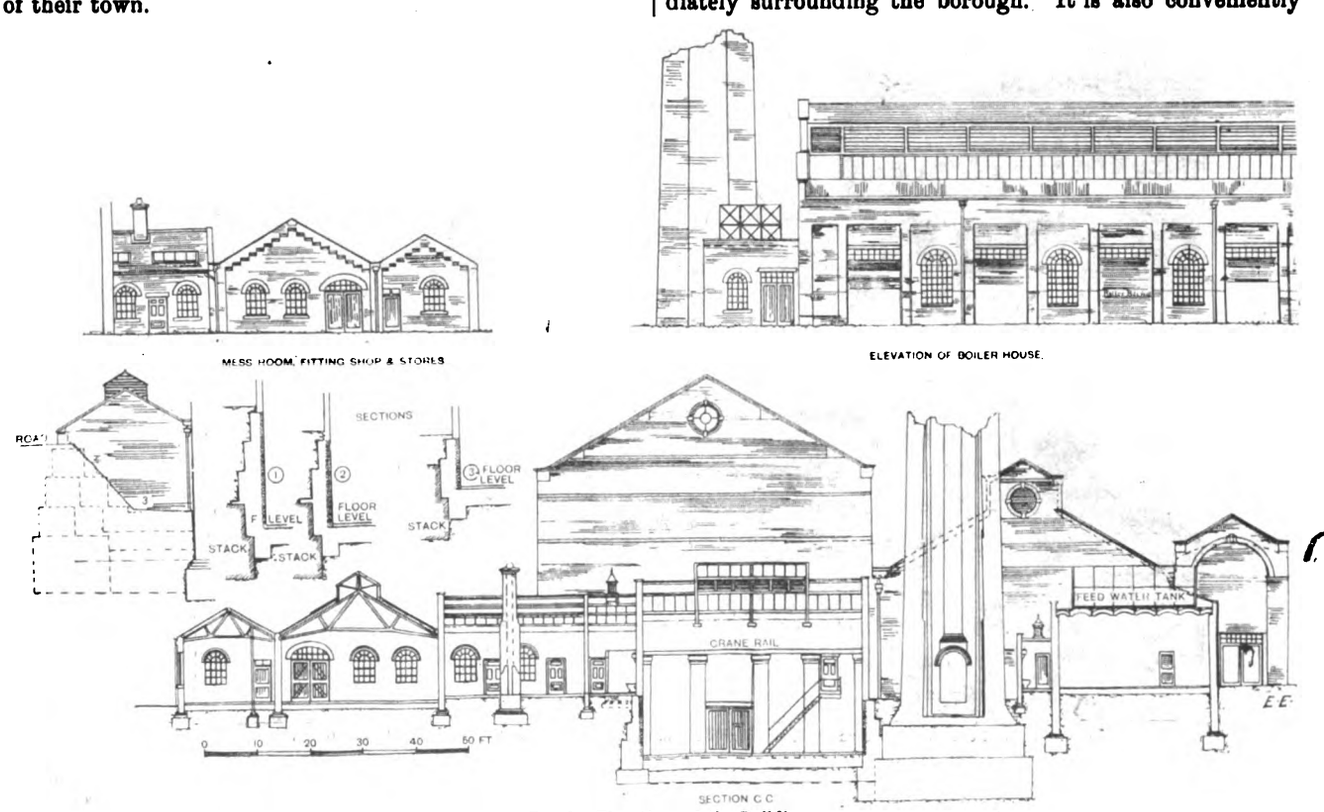


FIG. 4.—Elevations of the Buildings.

## Site of Generating Station.

The generating station (Fig. 1) is situated close to the Leicestershire Canal, on a site adjoining one of the Corpo- near to the most densely populated and busiest part of the town. The central position thus secured has enabled economies to be effected in several directions, not

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the least important being in respect of expensive sub-stations. The canal affords an ample supply of water for condensing purposes, and coal can be delivered direct from the Derbyshire and Nottinghamshire coalfields by its means.

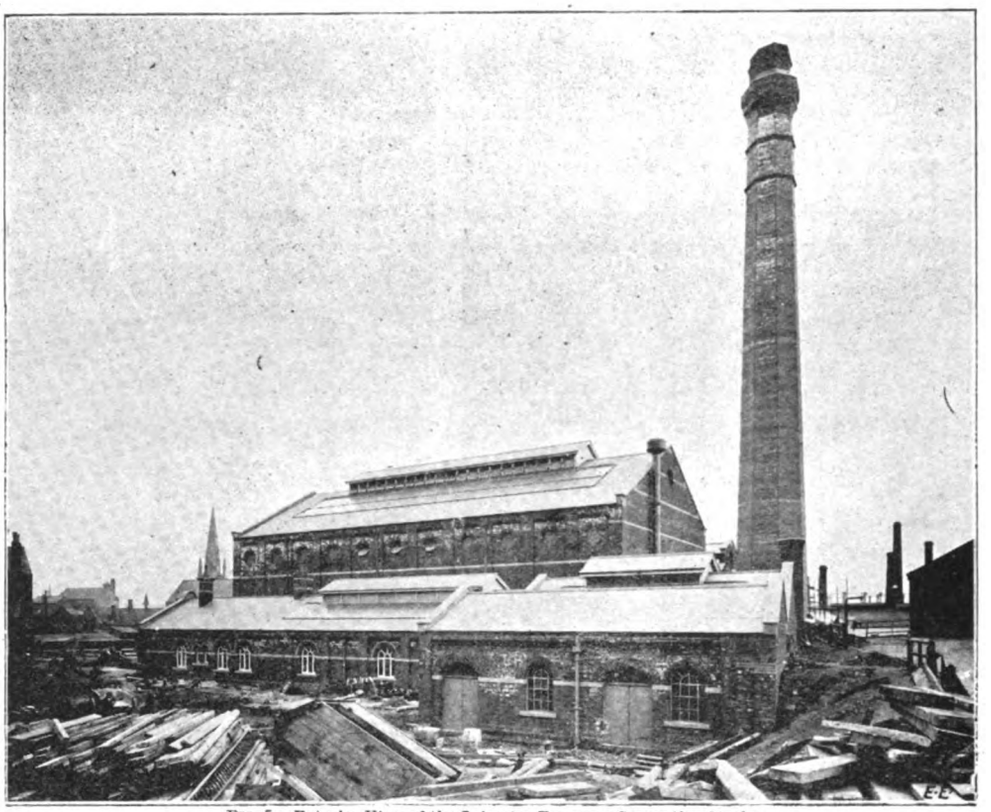

FIG. 5.—Exterior View of the Leicester Tramway Generating Station.

It is also found that Leicestershire coal can be shot into barges from the railway trucks at Soar-lane Wharf and delivered to the site by canal cheaper than it could be arted across the town. We understand that it is intended at some future time to utilise the waste heat from the adjoining refuse destructor to augment the volume of steam supplied from the coal-fed boilers.

## Generating Station Building.

The station (Figs. 3 and 4) comprises engine-room, boiler-house, pump-room, condenser-room, battery-room, test-room, engineer's office, general office, enquiry office, mess-room, fitting shop, stores, lavatories, with bath-rooms, etc., the relative positions of these several divisions having been arranged with a view to maximum convenience. The buildings (Fig. 5) are faced externally with red sand stock bricks from Sileby, near Leicester, with Derbyshire stone dressings, copings, etc.

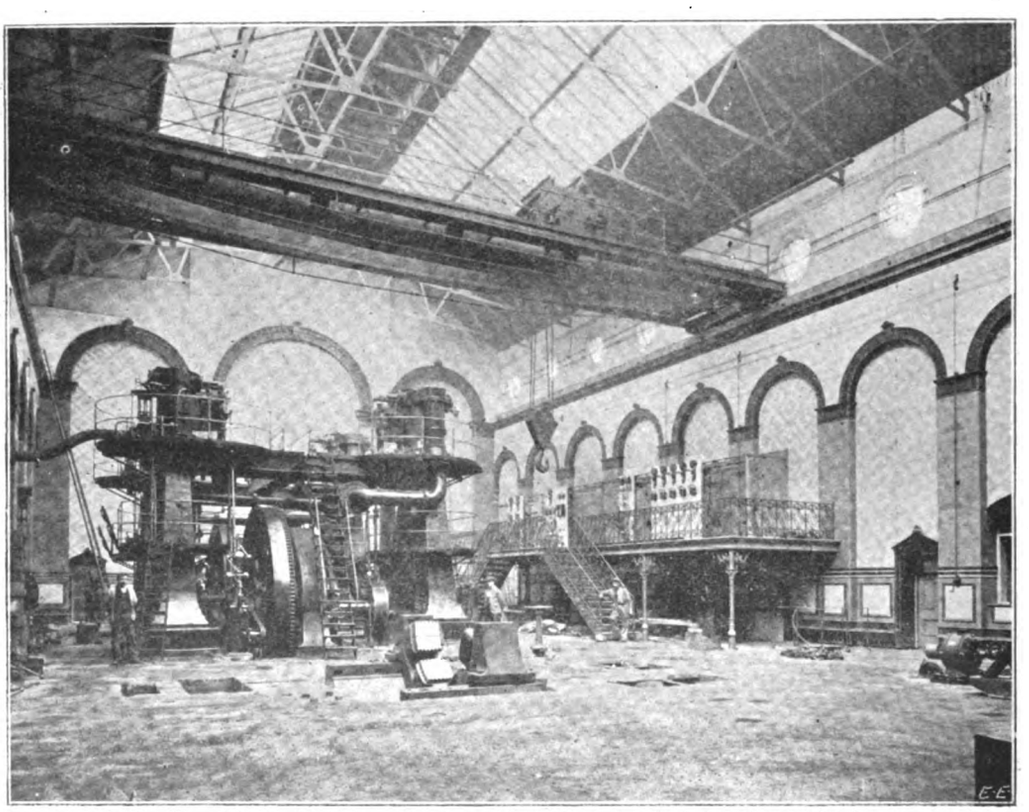

FIG. 6.—View of the Engine Room, with Yates and Thom Engine coupled to Dick-Kerr 500-kw. Dynamo

Upon entering the buildings one is immediately impressed by the liberal proportions of the engine-room (Fig. 6) and its pleasing design generally. This room is 118ft. long, 60ft. wide, and 40ft. high to the eaves. It is lighted mainly from the top by means of Rendle's patent glazing, which has also been used in the fitting shop and battery-

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room. The only side-lights in the engine-house are bullseye windows above the traveller rail. Good ventilation is effected by means of centre-hung casements in the lantern light. The room provides accommodation for the three 500-kw. sets now installed, besides extra space for an additional 1,000-kw. set. It is lined internally up to the height of the traveller rail with glazed tiles having patent keyed backs, moulded tiles being carried up to a height of 6ft. to form a dado. Moulded tiles are also carried round all the arches, with moulded faïence blocks under the traveller rail. This tiling, which was supplied and fixed by Messrs. Maw and Co, of Jackfield, Shropshire, gives the engine-room a very fine appearance. The tiles have not been carried round the south-east gable, as it will be necessary to take down this wall when the building is extended. The entrance hall and

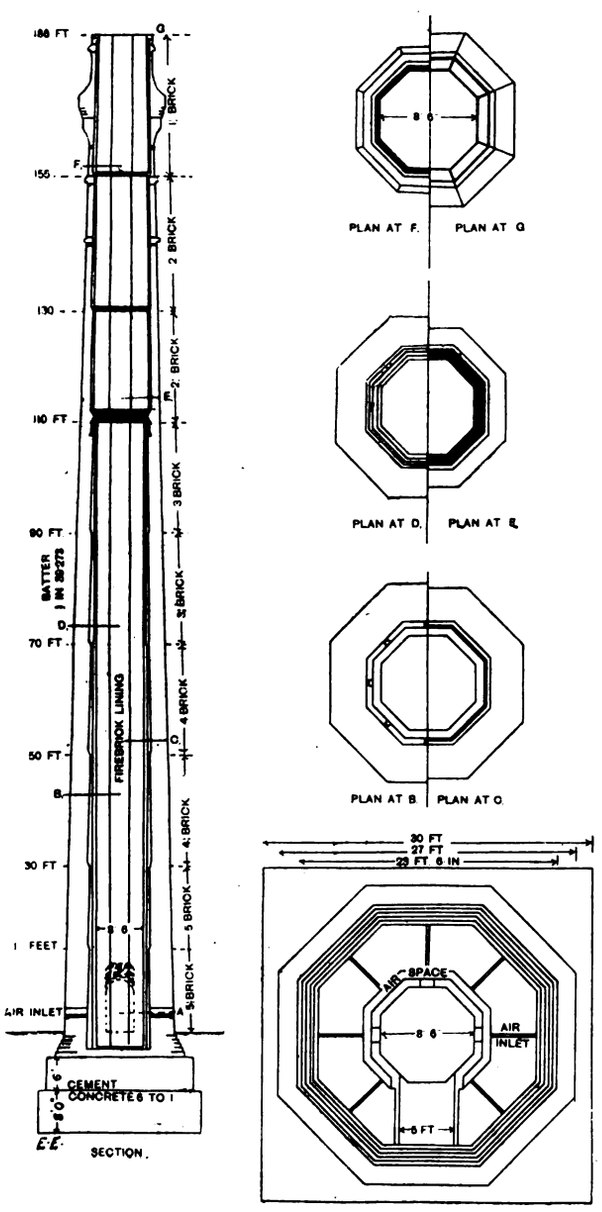


FIG 7.—Details of Chimney Stack.

the floor in the engine-room, except the space reserved for the extra set, have been laid in mosaic by Messrs. Diespeker, Limited, of London. A roomy basement is provided below the room, except under the portion reserved for extensions.

The boiler-house is 108ft. long and 77ft. wide, providing accommodation for eight boilers, four of which have already been installed. A stoking floor 18ft. wide extends the full length of the house, with an ash tunnel below. Provision has been made in designing the stanchions supporting the roof of the boiler-house for installing coal bunkers and conveyors over the stoking floor when the number of boilers justifies the expenditure. At present the stoking floor is covered with a temporary corrugated iron roof. The question of the coal supply to the boilers when a larger number has been installed has also been very carefully considered, and the boiler-house has been so arranged that when the coal is delivered by barge alongside the boiler-house it will be lifted by a crane fixed at the north-western end of the house into a conveyor, and conveyed into the coal bunkers. This conveyor will be continued round and through the ash tunnel for the removal of the ashes. The boiler-house is lighted principally from the roof by means of Mellowes's patent glazing. Windows have also been inserted in the south-western elevation, and metal louvres fixed in the lantern which runs the full length of the house. Kinnear rolling shutters have been inserted in the doorways opposite the fronts of the boilers.

The condenser-room measures 42ft. by 23ft, the floor being 11ft. below the level of the engine-room. It is lighted entirely from the roof, and is provided with a five-ton overhead travelling crane. The battery-room is 65ft. long, 28ft. wide, and 12ft. high to the eaves. The whole of the trusses for the roofs, except those for the battery-room and offices, are constructed of flat steel bars and plates throughout, except the rafters, which are of T section.

The chimney stack (Fig. 7) is octagonal in shape, faced with Whitwick pressed bricks. The foundations were carried down to a depth of 17ft. into the solid red marl. The stack is 186ft. high, the external diameters being 20ft. at ground level and 11ft. at the top. The internal flue is 8ft. 6in. in diameter throughout. It has an independent firebrick lining 9in. thick for a height of 70ft., the remainder being 4½in. thick. For a height of 110ft. to the top the cavity is omitted. The cast-iron cove is constructed in eight sections, each section weighing about one ton.

The contractors for the main building were Messrs. Richardson and Son, of Leicester, the steel roofs being let in a separate contract to the same firm. The contractors for the chimney stack were the Leicester Builders, Limited. A considerable area has been reserved for extending the building occasion requires.

*To be continued.)*

## The Opening Ceremony.

The proceedings on Wednesday were an unqualified success. At 2 30 p.m. the invited guests assembled at the town hall, whence they were conveyed by horse cars to the power station. A brief description of the station and its equipment having been given, the Mayor (Alderman Sawday) called upon Councillor Flint and Alderman Smith, chairman and vice-chairman respectively of the Tramways Committee, to start the first and second engines, which done, the ceremony of switching the current on to the 'bus bars was performed by Mrs. Flint and Mrs. Smith, the company being then conveyed by electric cars to inspect the main car depôt. More electric cars—this time gaily decorated—were in waiting outside, and these having been boarded, a tour was made over the principal routes equipped. The atmospheric conditions being good, this proved very enjoyable, the cars running smoothly at a speed which exhilarated in the fresh air. It should be mentioned that to the Mayor and Alderman Smith was assigned the duty of starting the first cars.

After the run the guests were entertained at tea in the mayor's rooms. Speeches followed, not to mention the presentation of a silver tea and coffee service to Councillor and Mrs. Flint as a mark of esteem from present and past members of the Tramways Committee. For lack of space we cannot refer to the speeches in detail Suffice it to say, they were of the usual complimentary order, but with the difference that there was unusual justification for the praise meted out. All the evidence serves to show that Leicester has come into the possession of a system of tramways which will bear comparison with any. Each detail has been carefully considered, and the whole is as near perfection as ability in design and care in execution could make it. The remarkable excellence of the track work was especially dwelt upon, also the high collective and individual reputation of the contractors responsible for the plant installed. It was suggested that those concerned had been imbued with a common desire to make the Leicester tramways undertaking a standard for future comparison. Be that as it may, the result is

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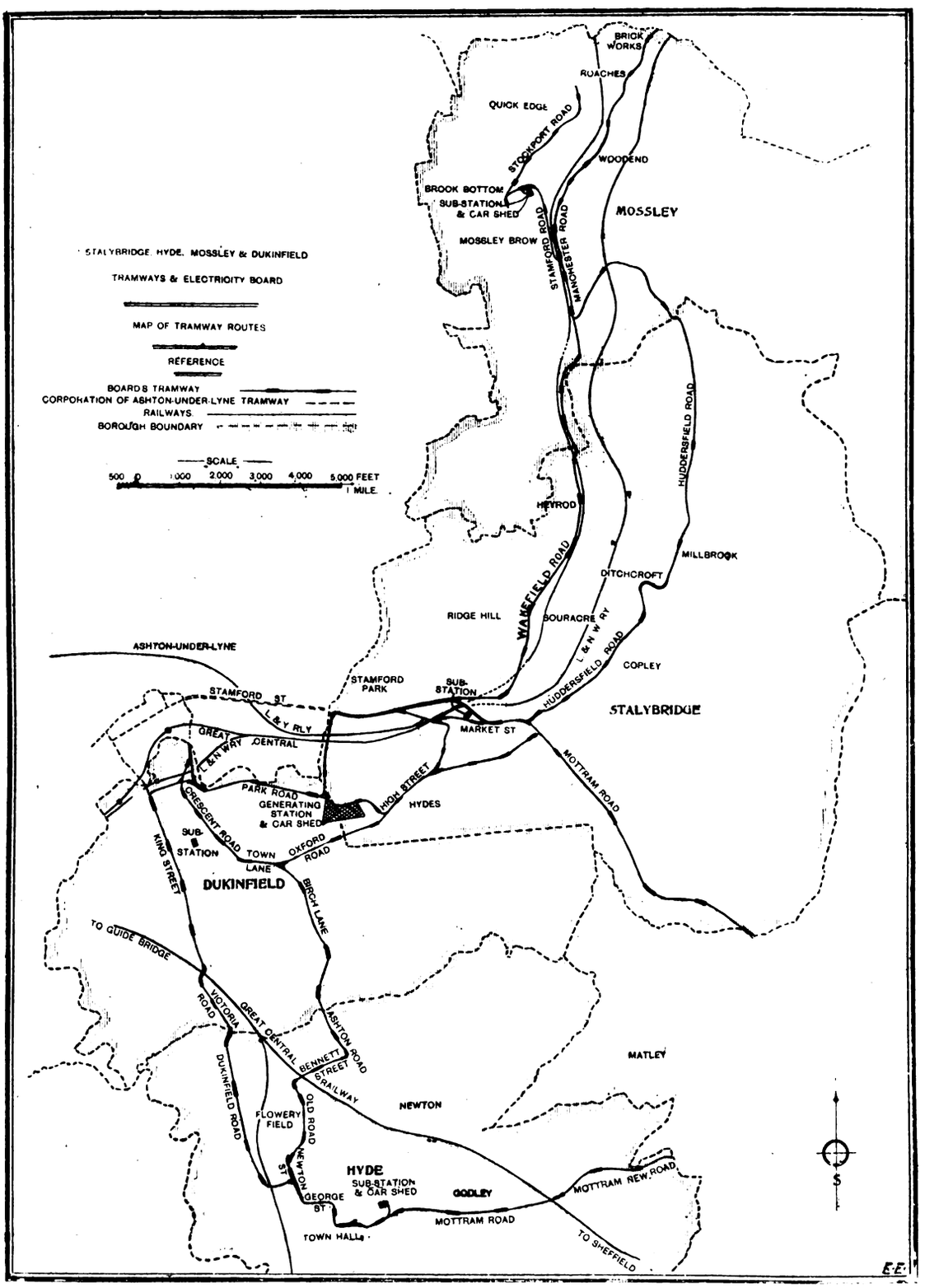
gratifying, and reflects great credit upon the engineers—Mr. E. George Mawbey in particular.

## THE STALYBRIDGE, HYDE, MOSSLEY, AND DUKINFIELD TRAMWAYS AND ELECTRICITY BOARD.

The preliminary runs of the generating plant in the station of the above Board have been successfully carried out, and the first of the four sub-stations has also been started up. The motor-generators in the Dukinfield sub-station were used to supply current to the tramway network surrounding it, and the public service on the routes in question is to be started on Saturday. The formal opening of the system is likely to take place in about three months. We shall then be able to give a more complete and detailed description of the scheme, together with illustrations and plans, which it is impossible to obtain at present, owing to the incomplete conditions of the buildings and machinery. The following description will, however, give an indication of the nature and extent of the undertaking.

The possibility of a joint municipal arrangement for the control and operation of the electric lighting and tramway interests of these four boroughs was first suggested in 1897 by Alderman J. R. Norman, J.P., of Stalybridge, during his mayoralty. A joint committee was afterwards formed, and an inspection was made of various electric lighting and tramway systems in the country. Among the places visited was Bradford, where the first joint municipal electric lighting and tramway station was in operation, and which had been designed and managed by Mr. A. H. Gibbings Mr. Gibbings had just commenced a consulting practice, and he was selected by the joint committee to make a full and detailed report on the proposed scheme.

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The report was submitted on April 11, 1900, and supplemented on June 8, 1900, when it was unanimously adopted, the joint committee deciding to go forward for a special Act. Mr. Gibbings was retained as consulting engineer, and the four borough surveyors prepared the parliamentary plans in their respective districts. The Act, known as the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board Act, 1901, was duly obtained in August, 1901, constituting a Board of six representatives from the councils of each of the boroughs, or 24 members in all Councillor T. C. Beeley, J.P., of Hyde, is acting as chairman of the Board, and Alderman J. Ridyard, J.P., of Stalybridge, is the deputy-chairman.

On Jan. 1, 1902, Mr. A. H. Gibbings, who had been appointed engineer-in-chief, commenced to design the scheme which is about to be formally inaugurated. A reference to the plan of the area will show that the boundaries of the several boroughs are contiguous the one to the other for a considerable length. The total area contains 11,399 acres, and a population of about 100,000 inhabitants. It is situated east of Manchester, and is bounded by the following towns and urban districts—viz, Ashton-under-Lyne, Guide Bridge, Audenshaw, Denton, Stockport, Woodley, Mottram, Hollingworth, Greenfield, Saddleworth, Lees, and Hurst—having a population over 180,000. Stalybridge is distant from Manchester about seven miles, and the tramways will be in direct communication with the Manchester Corporation tramways, through Ashton-under-Lyne, to which town the Manchester trams now run. The Board's system is also in immediate touch, though no physical connection is made, with the Oldham, Ashton, and Hyde tramways, the Ashton-under-Lyne Corporation tramways, the Stockport Corporation tramways, and the Glossop tramways. It will thus be apparent that the area is an important one, including one of the principal districts of the cotton trade, and it is a practical tribute to the public spirit and municipal enterprise of the corporations that such a scheme should have become an accomplished fact in a comparatively short time.

The system of generation comprises a main generating station and four sub-stations. Electricity is generated at 6,000 volts three-phase alternating current at 40 periods. This is transmitted to each sub station, at which it is transformed and then distributed as direct current to lighting and tramway feeders. Each of the four towns has a complete lighting network of mains. The tramway track consists almost entirely of single line with turnouts, the exception being three-quarters of a mile of double track in Stalybridge. The route length of track is 21 miles 390 yards, of which 6 miles 667 yards is double line. The gauge is the standard 4ft. 8½in, uniform with the gauge of the adjoining tramway systems.

In order to encourage and make popular the use of electric energy, the Board has adopted a reasonable scale of charges and offered other inducements to the public. The charge per unit for lighting purposes will be 4d. The charge for motive power purposes and electric heating, etc., will be at the maximum rate of 2d. per unit, with a sliding scale of rebates down to 1d. per unit. No doubt these prices will be further reduced as soon as a demand has arisen. The tramways department will be charged 1½d. per unit for all electric energy supplied for that purpose. As a further encouragement it has been decided not to make any charge either as a rental or otherwise for meters, cut-outs, and switches on service connections. No charge for service cables will be made up to a distance of 60ft. from the nearest main, whether a part of such service cables are on private property or not. Thus the consumer will find his liability defined and limited by the charge per unit. The Board has also adopted a scheme for hiring-out motors, on similar lines to that which was so successfully inaugurated by Mr. A. H. Gibbings at Bradford in 1897. The sizes to be obtained will range from ½ h.p. to 20 h.p., and a large demand is anticipated. Here again the charges usually made for fixing and periodical inspection are merged in the rental.

With such facilities thus placed before the public, and with good business management, the undertaking should speedily take rank with similar successful enterprises in this country.

## THE FARADAY SOCIETY.

An ordinary meeting of the Faraday Society was held on Monday, May 9, at the Institution of Electrical Engineers, Mr. Bertram Blount in the chair.

Dr. CHARLES E. FAWSITT read a paper entitled "Studies in Viscosity." The viscosity of a mixture of two or more substances in aqueous solution is equal to the product of the viscosities which the solutions of the substances separately have. If, however, the substances act chemically on one another, then the viscosity of the mixture is different from the calculated value. By numerical illustrations from cases where a strong acid is neutralised by a strong base, this difference is shown to have a constant value for equimolecular quantities. This value corresponds to the formation of undissociated water from the hydrogen and hydroxylions. The difference between the calculated and observed values in the case where a weak base is mixed with a strong acid has a value which varies with the base in the case of urea and its derivatives appears to vanish. A comparison of the viscosity constants of some urea derivatives and aurides of the fatty series shows that for a difference in the composition of $CH_2$ there is a corresponding difference in the viscosity constant. There is, however, a pronounced "constitutional" effect, as shown by the different values obtained for isomeric substances.

Mr. B. BLOUNT referred to the difficulties in making accurate and reliable viscosity measurements on which important deductions are based.

Dr. T. M. LOWRY discussed the relationship between viscosity and conductivity and conductivity and temperature, and he showed how in the case of very dilute solutions the conductivity-temperature curves converge to zero conductivity at −39deg. C.; just as the viscosity curve for pure water does.

Dr. FAWSITT, in reply, said that his results were all obtained with one apparatus, and that they were strictly comparable. Referring to Dr. Lowry's remarks, he added that viscosity is inversely proportional to migration velocity.

Dr. F. M. PERKIN then read a paper by A. Fontana and himself on "The Electrolytic Oxidation of Anthracine." The authors have taken up the study of the oxidation of anthracine primarily to ascertain whether it was possible to obtain a good laboratory method for the preparation of anthraquinone. The first attempts were made with solutions in acetone, platinum electrodes being employed. Although oxidation took place in solutions of anthracine in acetone, it was not found possible to oxidise more than about 55 per cent. of the anthracine. Attempts were then made to electrolyse anthracine suspended in 20 per cent. sulphuric acid or in caustic alkali to which an oxygen carrier had been added. Various carriers were employed, the most satisfactory being chromium, cerium, or manganese salts. The anode consisted of a lead vessel; the cathodes, four in number, were also of lead, and were placed in four small porous cells. There was also a lead paddle which was connected with the positive pole; the total anode surface was about six square decimetres, current density one ampere per square decimetre, temperature 70 deg. to 80deg. C., and E.M.F. from 2·5 to 3·5 volts. The yield of anthraquinone was about 80 per cent., and it was not found possible to increase the yield more than 1 or 2 per cent. above this. It was afterwards found that almost equally good results were obtained without a diaphragm. In this case the stirrer one-half square decimetre in area was made the cathode. In discussing the results of their experiments, the authors consider that owing to its volatility and the comparatively poor yield a solution in acetone cannot be recommended. On a large scale no method in which a diaphragm is employed would be satisfactory, owing to the migration of the $SO_4$ ions from the cathode to the anode side. They then briefly review the patents of the Höchst Farben Fabrik, Darmstädter, and Martin Moest. Le Blanc criticised Darmstädter's patent, and doubted whether it would be possible to obtain any appreciable quantity of anthraquinone owing to the reduction of the chromate by the cathodic hydrogen. The authors are of the opinion that to a certain extent the chromium, manganese, and cerium salts act as chromium does when employed in the electrolytic bleach industry—viz., by prevention of reduction. Moest claims, in his patent, to obtain 100 per cent. yields of anthraquinone—the authors have been unable to obtain much more than 80 per cent. They are, however, of the opinion that very likely better results would be obtained on a manufacturing scale.

Mr. BLOUNT suggested the use of thallium salts. He thought the energy bill in this instance might not necessarily be an all-important item.

Dr. STEINHART thought better results would be obtained if the anode solution were removed from the cathode.

Mr. INGLIS discussed the effect of the potential difference between the anode and solution.

Mr. GASTER thought the cost of energy was of prime importance. He suggested the use of petroleum as a base for colours instead of tar.

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THE

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### TO CORRESPONDENTS.

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## THE LONDON TELEPHONE SERVICE.

On Wednesday last a large conference was held in the Guildhall, at which there were present delegates from the Corporation of London, the London County Council, two county boroughs, six municipal corporations, the Council of the city of Westminster, twenty-five borough councils, and forty urban district councils. The outcome of the conference was to pass resolutions which, after amendment, read as follows: "(1) That this conference is of opinion that it would be inexpedient for the Government to acquire the undertaking of the National Telephone Company on any other terms than those set out in the agreement between the Postmaster-General and the company, dated Nov. 18, 1901." "(2) That this conference is of opinion that before any agreement is entered into with the National Telephone Company for the purchase of their system within the London telephone area, the terms of the proposed arrangement should be submitted for the consideration of the local authorities within the London telephone area; and that in the event of Parliament appointing a committee to consider purchase negotiations between the Postmaster-General and the National Telephone Company, that the local authorities within the London telephone area should be enabled to submit their views before such committee, and steps be taken to secure accordingly." "(3) That this conference again protests against the Post Office telephone tariff, being of opinion that the charge for the use of a telephone in the London area should be materially reduced." "(4) That, in the opinion of this conference, the trunk line service is inadequate and unsatisfactory, and requires considerable improvement."

From the general tone of the resolutions, one would gather that the inhabitants of London were entirely dependent on the members of the various local authorities for the supervision of the telephone service, and hence that these local authorities individually should have either the power of the House of Lords, or perhaps the Royal veto, which would enable them to vary at will any agreement entered into between the National Telephone Company and the Postmaster-General. The facts are quite otherwise, as the London people return members to Parliament, the large majority of whom are in agreement with the present Government as far as politics are concerned. This being so, the Postmaster-General is quite as representative of the inhabitants of London as are the members of the local authorities. To look into the resolutions in detail, we note that the conference condemned as inexpedient the immediate acquisition of the undertaking of the National Telephone Company. In so doing it condemned any possible agreement for the unification of the London telephone system, although such a reversion from the present dual control is much to be desired. Having by the first resolution condemned every possible agreement for purchase at the present time, the conference proceeded to suggest that any agreement before it is entered into with the National Telephone Company should be submitted to the local authorities. As has been stated in Parliament, no such agreement will or can be concluded until it has been discussed in the House of Commons. In addition to this, the conference suggested that at least the seventy-six local authorities represented at the conference should have the agreement laid before them for consideration. These authorities are not parties to the agreement, they are not experts in telephony, and we fail to see what useful purpose would be served by the course suggested. We are quite sure that if the whole of the local authorities tried to make an agreement with the National Telephone Company no conclusions would be arrived at, owing to the very large number of members who would have a voice in the matter. It is quite likely that

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certain of these authorities would adopt the very course which the Postmaster-General seems to be contemplating, in spite of the resolutions of the conference to the contrary. For instance, the electric lighting the St. Marylebone Council has bought out, or, to be more correct, is now bound to buy out the undertaking of the Metropolitan Electric Supply Company at its present value as a going concern, and with allowance for future profits up to the period of the electric lighting order. The Postmaster-General is in a much better position to negotiate with the National Telephone Company than was the above Council with the electric lighting company. Presuming, therefore, that a reasonable agreement for the immediate unification of the telephone system of London can be come to, we see more hope for a reduction of the telephone charges and for the improvement of the telephone service, which is more important, than can be possibly entertained if the purchase is deferred until 1911.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### LIGHTNING.

SIR,—Could some of your readers enlighten me on the probable cause of globular lightning and St. Elmo's fire.—Yours, etc.,

May 18, 1904. INQUISITIVE.

## FORTHCOMING EVENTS.

FRIDAY, MAY 20.

**Royal Institution.**—At 9 p.m., "Radiation and Emanation of Radium."

**Association of Municipal Engineers.**—At Buxton, opening of bacterial filter beds.

SATURDAY, MAY 21.

**Association of Municipal Engineers.**—Buxton meeting (continued).

**Institution of Electrical Engineers.**—Students' Section: At 2 p.m., visit to Great Northern and City Railway.

TUESDAY, MAY 24.

**Royal Institution.**—At 5 p.m., "The Solar Corona," by Mr. H. F. Newall (Lecture I.).

WEDNESDAY, MAY 25.

**Electro-Harmonic Society.**—At 4.30 p.m., annual general meeting.

THURSDAY, MAY 26.

**Institution of Electrical Engineers.**—At the Society of Arts, Adelphi, W.C., at 8 p.m., "High-Speed Electric Railway Experiments on the Marienfelde-Zossen Line," by Mr. Alexander Siemens (president-elect).

FRIDAY, MAY 27.

**Physical Society.**—At 5 p.m., Royal College of Science, "The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers," by Dr. C. Chree, F.R.S.

**Institution of Electrical Engineers.**—Benevolent Fund: At 5 p.m., annual general meeting.

**Wimbledon District Council.**—(To 28th inst.) public electrical exhibition at Worple Hall, Wimbledon.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

**Institution of Mechanical Engineers.**—Chicago Meeting, May 31 to June 3.

**British Association of Waterworks Engineers.**—Annual meeting, June 9 and 10. June 11-18, visit to Belgium.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on May 12 the following were the candidates balloted for:

*Member.*—R. A. Hadfield Parkhead House, Sheffield.

*Associate Members.*—J. P. Clark, 19, Hessle-view, Leeds; H. L. Davis, care of Messrs. R. Blackwell and Co., Limited, Corridor-chambers, Market-place, Leicester; A. P. Rutherford, burgh electrical engineer, Leith Corporation, Leith; W. A. Wales, Corporation Electricity Works, Ashton-under-Lyne.

## THE "CHEAP AND NASTY" MOTOR.

They test me as a dynamo—with brushes off the com.—
They dress me in a handsome suit of grey;
My temperature they take upon a Centigrade thermom,
And they pack me up and put me on a dray.

They send a bogus warranty, a tin of "motor grease,"
And instructions as to how I *ought* to run;
They provide for me a starter with an overload release,
Though at half of half full load I'm overdone.

While they bolt me to foundations I'm as docile as can be,
And I let them fix the cables and the belt.
On my shining commutator a seraphic smile they see—
Not a hint that smiles (and copper) sometimes melt.

My owner comes to see me—brings, perhaps, his daughter fair
And his sons to see me started with all state.
I am put on "no-load" duty, started up with every care,
And pronounced by all and sundry "just first rate."

But soon I get a load on—settle down to serious work.
Then superfluous is the incandescents' light,
For around my commutator, as my brushes jump and jerk,
An encircling glory shines—a halo bright.

Next day, ere noon, six telegrams to "Cheapannasty" rush;
An "expert" comes, who lifts my carcase lid,
Then swears because the man in charge did not adjust each brush,
And, when corrected, swears because he did.

Anon, three commutators "melt"; two armatures burn out;
My owner says, "Electric power's an ass.
Throw the blamed thing on the scrap heap—Now then, look alive, you lout—
Steam's good enough for me—or may be gas."

PABLO.

## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

*(Continued from page 748.)*

*General Lay-out of Large Power Station.*—For a comparatively large power station, of say an initial capacity of 10,000 kw. capable of extension to three or four times this size, and especially for one utilising steam-turbines, the general arrangement shown by Figs. 6 and 7 is convenient, as it fulfils the several requirements we have laid down—namely (1) simplicity of design; (2) sub-division of plant; (3) saving of labour; (4) ease of extension. A turbine occupies so little floor space in comparison with its output that it is impossible to adopt what had almost become a standard arrangement—*i.e.*, having one or two lines of boilers parallel with the engine-room, as by so doing sufficient boiler-house capacity could not be obtained without wasting an excessive amount of floor space in the engine-room through spacing the turbines very far apart. In fact, with turbines there are only two alternatives possible, either to have a two-storey boiler-house or to arrange groups of boilers at right angles to the axis of the engine-room, providing each turbine with its own group of boilers.†

*Other Arrangements of Main Buildings.*—The designs shown in Figs. 7, 8, and 9 are typical of the three possible arrangements so far as relative position of engines and boilers are concerned. Fig. 8 may be considered most suitable for power stations up to 5,000 kw. The arrangement shown in Fig. 9 with the double row of boilers has been extensively adopted both in this and other countries. It has, however, many objections—it is difficult to allow for unlimited extension, and the steam and feed piping are considerably longer than in other arrangements. For all power stations of over 5,000 kw. capacity, especially stations for power supply (which must be designed for large extensions) the authors consider the arrangement shown by Figs. 5, 6, and 7 the best and most flexible. It may be specially noted how this design facilitates an alteration in the size of units without upsetting the general arrangement of the station, as the extension boiler-houses may be longer.

* Paper read before the Institution of Electrical Engineers.

† A similar arrangement has been adopted by Messrs. Sargent and Lundy for the new stations at Boston and Chicago (see Fig. 5), where Curtis turbines are being installed. The authors have independently adopted it at Carville, where Parsons turbines are in use (see Figs. 6 and 7).

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*Arrangement of Auxiliary Apparatus.*—The arrangement of the auxiliary plant, including in this term all piping and cable connections, is a most important factor in the design of the engine-room. A design which probably originated on the Continent, and which is carried out there extensively, has also been largely adopted in this country—*i.e.*, the provision of a basement to contain all pipes and auxiliary machinery. Experience has shown this to be an extravagant method, affecting adversely both capital and running costs. It is, in short, directly antagonistic to the requirements which we have laid down as essential to an efficient design. It is also expensive in running wages, as unless the plant be allowed to run with practically no attention, more men are required, and it is expensive in repairs on account of the difficulty of providing lifting tackle and the necessity of working entirely with localised artificial light. Against these objections the only advantage is a clean engine-room floor. Various arrangements have been adopted by engineers to avoid the inherent defect of installing the auxiliary apparatus in the basement. The provision of wells or pits instead of a basement in the main engine-room has been frequently adopted, and though this arrangement hardly gets over the difficulty with regard to piping, it certainly reduces the supervision and attention required. The turbine, on account of the small floor space which it occupies, has simplified matters immensely, as with it all apparatus can easily be put on the one floor, or (as is desirable on account of increased efficiency), the condenser may be placed directly *below* the turbine;* in the latter case the turbine, as it requires little or no attention, can be left to run by itself at a higher level with merely a gallery round it. The auxiliary apparatus, requiring as it does much more attention, can then be put on what may be regarded as the main floor. Both arrangements allow of all apparatus being conveniently handled by the main crane—though neither provides that perfect-looking engine-room which is a feature of many Continental stations.

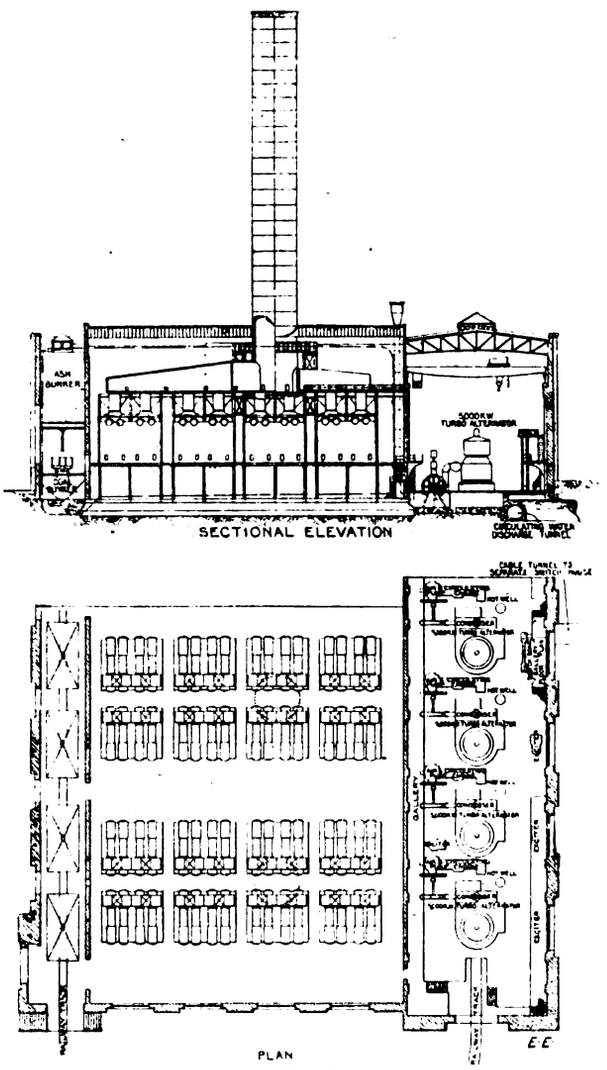


FIG. 5A.

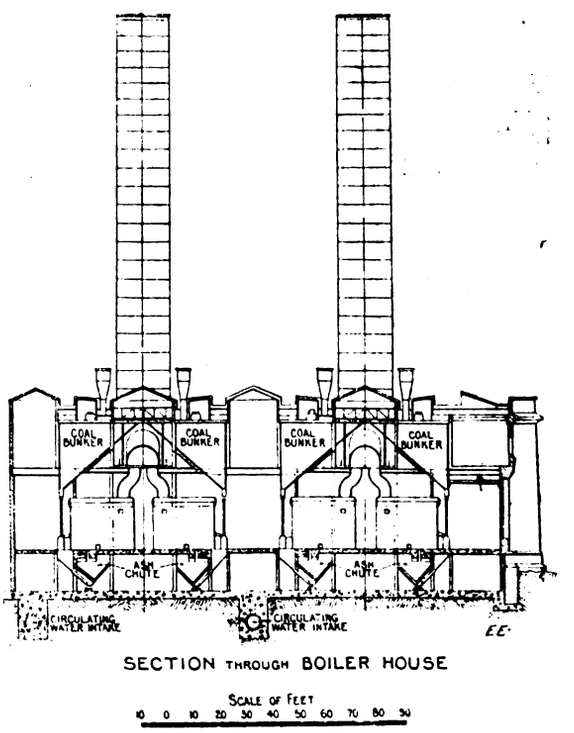


FIG. 5B.

*(To be continued.)*

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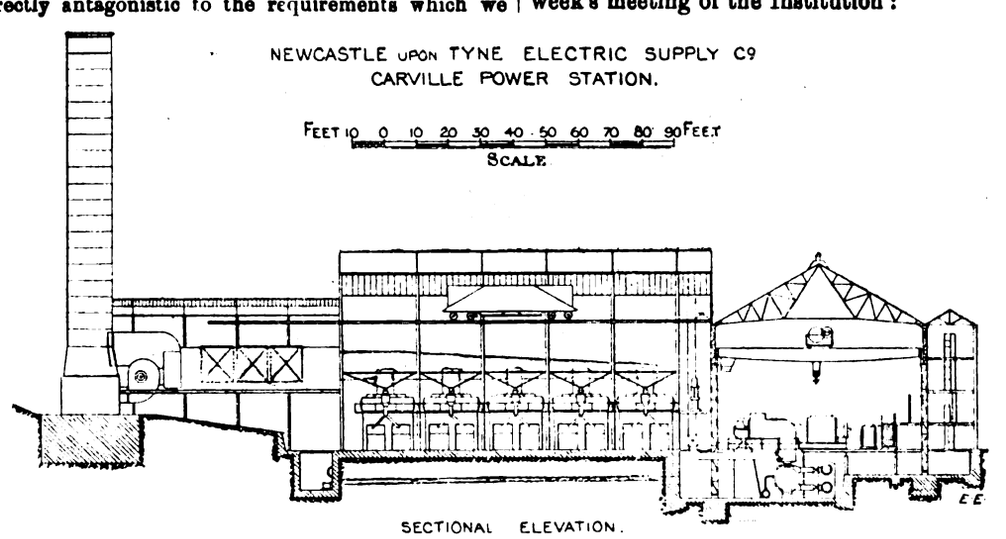
The following is a summary of the discussion on Messrs. Merz and MacLellan's paper, which was concluded at last week's meeting of the Institution:


NEWCASTLE UPON TYNE ELECTRIC SUPPLY CO
CARVILLE POWER STATION.
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SCALE
SECTIONAL ELEVATION.
E E

FIG. 6.

**Mr. Venning** dissented from the authors' views on many points. They commented upon the great attention paid to central-station

* The General Electric Company of America are developing their Curtis turbine with a condenser in the base of the turbine itself, which at once secures this advantage. In the case of small units it is an advantage to provide a condenser for each pair of sets, as in this way at light loads the advantage of a high vacuum is obtained.

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design compared with distribution. This state of things was quite justified by the fact that the former was the centre of the system. The authors put the total cost of station and plant at £40 per kilowatt. In small stations it might exceed £50, but in large stations the plant would not cost more than £18, with £5 or £6 for buildings. Stations for turbines could now be built for £14 or £15 per kilowatt, which would be about the minimum cost at which they could be constructed, and the buildings cost only £2. In dealing with economy of production and reliability of supply, the authors had lost sight of organisation, which was indispensable to good results. In the illustration

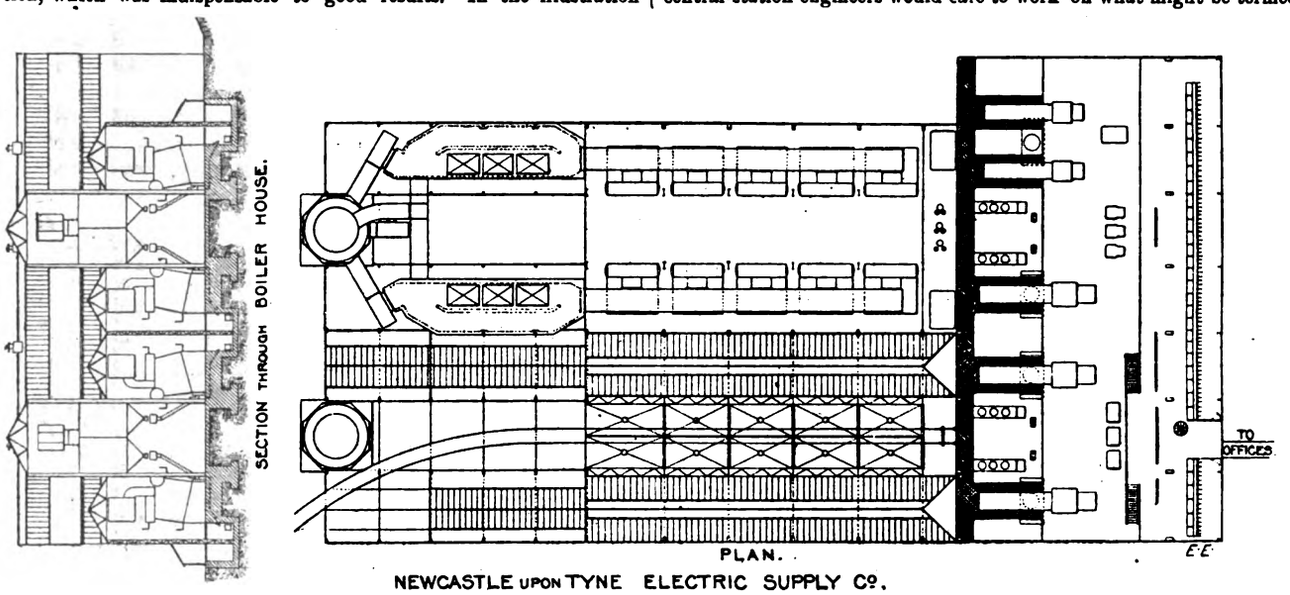
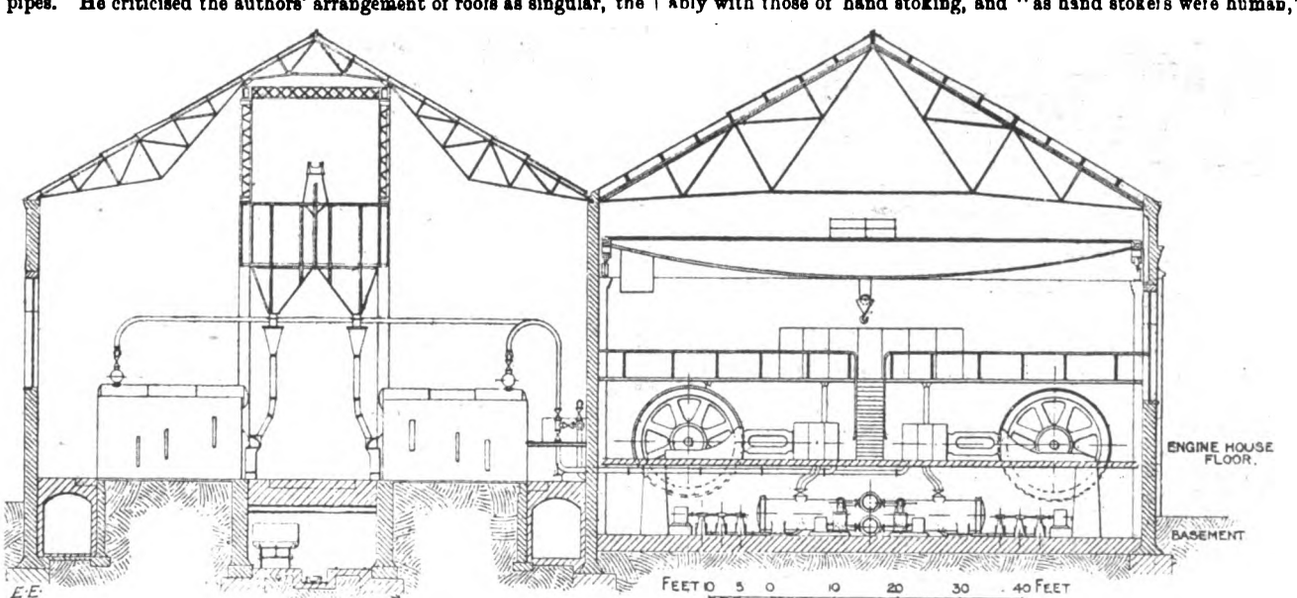



FIG. 7.

of the Carville station chimneys were placed at each end with economisers, which was what the authors themselves deprecated. Corrugated iron buildings would not be tolerated, except in rural districts. Uralite might be used in cheap stations. It was non-conducting and durable. The right-angle design of station was nothing new. In 1890 a 20,000-kw. station had been constructed on the same principle at Boston, U.S.A. Basements did not originate on the Continent, as stated by the authors. Watt put his engines below ground, and in America it had been found cheaper to excavate a basement, which facilitated the examination of pipes. He criticised the authors' arrangement of roofs as singular, the numerous spans entailing great expense. The question in regard to economisers was, Do they economise or not? With coal at 4s. 6d. to 6s per ton they did not pay, but they were justifiable when coal cost 15s. per ton.

**Mr. W. H. Patchell** remarked that the authors spoke of the low cost per kilowatt of the Carville station, but there was an absence of information on this point—in fact, the subjunctive mood predominated in their references to this question. For coal, 6s. per ton was put down in the turbine test; in London this had to be trebled, which exactly doubled the cost of production. In regard to buildings, he quoted a case from his own experience in which the County Council had refused to sanction a steel structure, on the ground that it was not a permanent building. He related, amid some amusement, that, the Tower Bridge having been opened just previously, he enquired of the authorities whether that was a permanent structure. Concerning basements, he disagreed with the authors' views, as it was often necessary to excavate so as to obtain the proper strata for setting the machinery.

**Mr. Leach**, like Mr. Patchell, would like more figures in regard to cost. Again, the author's table did not state whether it referred to units generated or units sold—he presumed the latter were meant. Regarding steam-piping intercommunication, he thought that very few central-station engineers would care to work on what might be termed the "watertight protection" system—*i.e.*, a range of boilers for one set of plant The authors had scarcely given adequate consideration to reciprocating engines. The Newcastle-on-Tyne Company were working partly with turbines and partly with engines, and found the utility of the latter practically equal to that of turbines. At the same time, he concurred with the authors as to the advantages of turbines, which in regard to superheating offered some way out of the difficulty of lubrication. The authors were not favourably disposed towards the use of automatic stokers, in regard to which his own experience was that with first-class stoking apparatus the results compared very favourably with those of hand stoking, and "as hand stokers were human,"




GENERATING STATION WITH DOUBLE ROW OF BOILERS

FIG. 9.

the average results obtained were by no means adverse to mechanical stokers, besides which they obviated the smoke nuisance.

**Mr. Merz**, replying, stated that some speakers had not dealt with such large stations as those contemplated by the authors. Further, many speakers had only dealt with their individual branches, and it was difficult for an engineer who had not had to consider the design of power stations as a whole to realise the relative importance of the various machinery. It was not the authors' object to discuss the merits of the different apparatus: they desired to emphasise the advantage of the complete unit system. He also pointed out that some of the speakers, notably Mr. Venning, appeared to be under a misapprehension when they stated that the

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authors' power station design was not new. The authors did not make any claim to originality. Referring to Colonel Crompton's observation that credit had scarcely been given to the pioneers in central-station design, Mr. Merz stated that the authors fully appreciated the services they had rendered; the only reason they were not alluded to in the paper was on account of space. Dealing with the various points raised, Mr. Merz said that the fact of boiler-houses having been placed at right angles to the engine-house 20 or 30 years was quite a side issue. There was no merit in such an arrangement unless it secured certain advantages; in many cases great disadvantages might result. It was these disadvantages which had been avoided in the cases of Carville and Messrs. Sargent and Lundy's Chicago station. In regard to the authors' curves, these were constructed on an approximate basis, and he quite agreed that a load factor and the price of coal in the South would represent appreciable variations. Major-General Webber and others had asked for figures in regard to the estimate of £20 per kilowatt which Mr. Merz had given before a parliamentary committee, but the authors scarcely felt justified in disclosing the cost of the Carville station at the present time, though he might mention that the cost was greatly below £20 per kilowatt. Regarding the relative merits of steam and gas, the authors did not suggest that the former was the better under all conditions, though they naturally favoured it in designing a power station on the Tyne. The essential difference between the designs of Dr. Kennedy and others and the authors was that, whereas in the former there were several generating units supplied from one steam-main or one group of boilers, with either single pipe

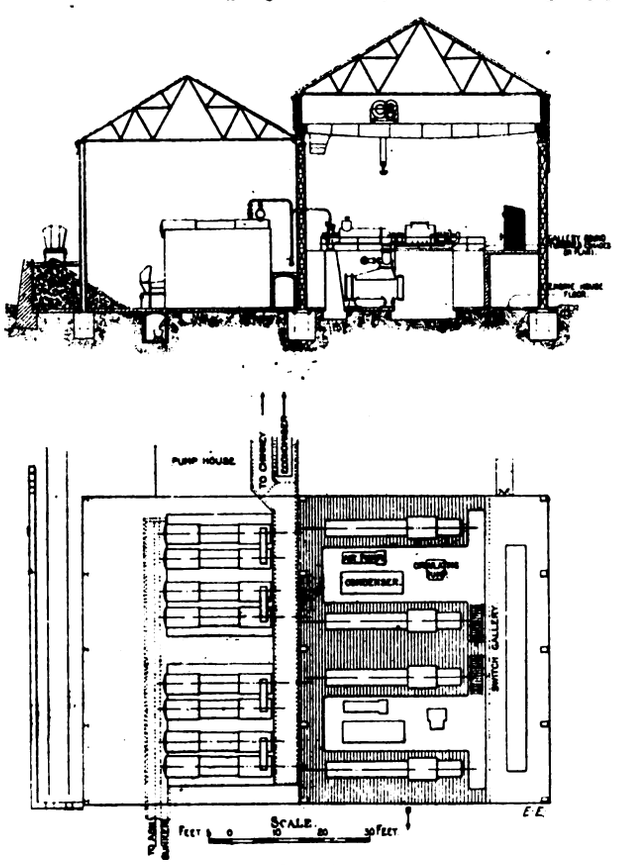


FIG. 8.

or duplicate pipes, in the latter one large unit was adopted, which was coupled to its own boilers, and a group of boilers fed a group of engines. In small boiler-houses the advantages of the right-angle arrangement were considerably reduced. The authors agreed with Mr. Steinitz and Mr. Patchell that basements sometimes came naturally, but when such was the case, the authors considered that the basement, unless a very deep one, and built up from a natural foundation, should be left open and only a gallery put round the turbines or engines, and all the pipes and auxiliary plant left open to view. In regard to buildings, Mr. Merz pointed out that the authors were speaking of stations outside towns when they advocated corrugated iron, which was not only economical, but lent itself readily to alteration. Referring to Mr. Dykes's comparison of the relative cost of gas and steam engines, he pointed out that if a steam generator could give a 50 per cent. overload for two hours at very little increase of capital cost, that must be a very important consideration under any conditions, and especially in the case of wide areas. The authors scarcely considered it necessary to have two spare sets, as recommended by Mr. Jenkin, under ordinary conditions (which meant that a station only had to operate up to its peak load two hours a day for not exceeding three months in the year), especially as it might be assumed that the plant would be put into thorough working order for the heavy season; and even where it was desirable, under special circumstances, to have two spare sets, the author did not think it necessary to reduce the size of the units as much as was often done, in support of which view Mr. Merz adduced several figures. In regard to switchgear, the authors were sensible of the work done by Mr. Andrews, and sympathised with his appeal on behalf of British manufacturers, but thought that a little more enterprise on their part was desirable. Regarding the suggestions that the switchgear should be operated mechanically instead of electrically, Mr. Merz pointed out that in all cases of automatic overload it was necessary to drop the switches electrically, and consequently there could not be much objection to putting them in electrically.

The proceedings concluded with a hearty vote of thanks to the authors.

## STEPNEY ELECTRICITY ACCOUNTS.

**The accounts of the electricity department of the Stepney Borough Council for the year ended March 31, 1904, show a total expenditure on capital account to that date of £199,129, of which £3,871 has been written off. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity, generated, sold, etc.**

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Coal or other fuel | 3,779 | 15 | 7 |
| Steam from dust destructor | 2,945 | 3 | 5 |
| Oil, waste, water, and engine-room stores | 404 | 9 | 0 |
| Wages at generating station | 1,484 | 15 | 1 |
| Repairs and maintenance of buildings | 185 | 2 | 9 |
| Engines and boilers | 377 | 15 | 2 |
| Dynamos, exciters, etc. | 33 | 1 | 11 |
| Other machinery, instruments, and tools | 61 | 10 | 5 |
| Accumulators and accessories | 62 | 13 | 6 |
| Distribution of electricity—Wages | 47 | 16 | 10 |
| Repairs, maintenance, and renewals of mains | 147 | 18 | 1 |
| Repairs of transformers, meters, etc. | 302 | 7 | 2 |
| Repairs, maintenance, and renewals of other apparatus | 10 | 16 | 0 |
| Attending and repairs to public arc lamps | 1,406 | 11 | 8 |
| Ditto incandescents | 43 | 17 | 5 |
| Rates and taxes | 537 | 2 | 9 |
| Management expenses—Engineer's department (salaries) | 427 | 6 | 9 |
| Accountant and staff (salaries), including storekeepers | 1,080 | 1 | 4 |
| Wages, meter readers | 62 | 17 | 4 |
| Stationery and printing | 172 | 14 | 2 |
| General establishment charges | 161 | 10 | 0 |
| Law costs and parliamentary charges | 21 | 17 | 3 |
| Insurance | 55 | 9 | 9 |
| Interest on consumers' deposits | 11 | 3 | 7 |
| | 13 823 | 16 | 11 |
| Balance carried to net revenue account | 12,792 | 17 | 3 |
| | £26,616 | 14 | 2 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current to private consumers | 19,934 | 12 | 8 |
| Public lamps | 4,918 | 15 | 8 |
| Rental of meters and other apparatus | 226 | 10 | 7 |
| Work done for customers | 19 | 12 | 6 |
| Attending and repairs to public lamps | 1,450 | 9 | 1 |
| Rent receivable | 66 | 13 | 8 |
| | £26,616 | 14 | 2 |

BALANCE SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Balance of loans borrowed from London County Council | 189,141 | 2 | 10 |
| Sundry creditors | 9,769 | 2 | 5 |
| Surplus of assets at March 31, 1904 | 8,057 | 13 | 5 |
| | £206,967 | 18 | 8 |

| Cr. Assets and Capital Outlay. | £ | s. | d. |
|---|---|---|---|
| Amount expended for works | 195,257 | 10 | 10 |
| Stores on hand | 3,739 | 11 | 2 |
| Sundry debtors for current supplied, etc. | 6,478 | 8 | 7 |
| Cash account in hands of treasurer, etc. | 1,493 | 8 | 1 |
| | £206,967 | 18 | 8 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | |
|---|---|---|
| Quantity generated in B.T.U. | | 2,745,805 |
| Quantity sold { Public lamps 731,066 / Private consumers by meter 1,802,445 } | | 2,533,511 |
| Quantity used on works | | 73 358 |
| Total quantity accounted for | | 2,606 869 |
| Quantity not accounted for | | 138,936 |
| Total maximum supply demanded (kilowatts) | | 1,268 |

Number of public lamps: incandescents, 24; arcs, 331.

## NEW COMMITTEES.

BREDBURY AND ROMILEY.—*Tramways and Electric Lighting*: H. R. Pratt, chairman.

BRIERFIELD.—*Tramways, Electricity, and Lighting*: Councillor Walmsley, chairman.

CAMBORNE.—*Lighting*: Messrs. Caldwell, W. H. Dunkin, and Cock.

STROUD.—*Streets and Lighting*: Councillors J. Bowe, T. J. Clarke, W. Coward, J. S. Dudbridge, P. H. R. Ford, F. E. Gardiner, G. R. Harper, E. H. Hawkins, G. J. Holloway, W. Knee, C. Lambert, and J. H. Tratt.

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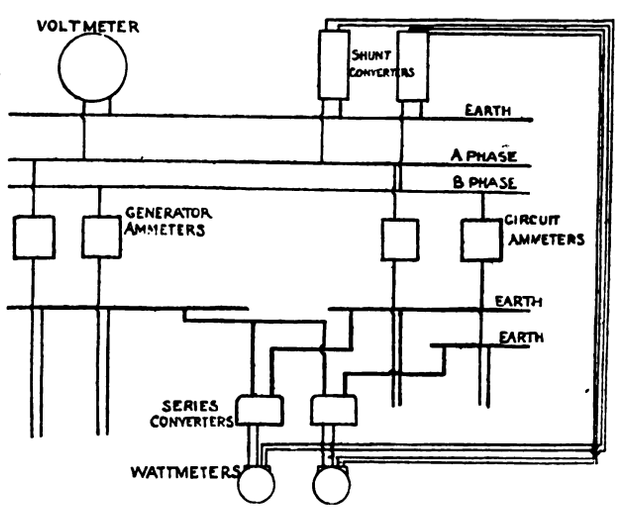
## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

689. On a central-station two phase switchboard of the Ferranti type two Westinghouse wattmeters, with series and shunt converters, were placed between the earth bar of the generators and the circuits, the bar being cut between generators and circuits for one phase, and an additional bar being added for the other as per




sketch; but the reading obtained on the wattmeters varied considerably at times in comparison with the output as compared with switchboard ammeters, and the maximum reading only amounted to about one-half the total output for each phase. How is this?—S. F. R.

690. What are the relative advantages and disadvantages of lap and wave wound armatures for continuous-current machines?—F. G. W.

### ANSWERS.

*Question No.* 682. Explain the relative advantages and disadvantages of reverse-current cut-outs and minimum cut-outs when used on continuous currents.

*Best Answer to No.* 682 (*awarded* 10*s.*).—The usual function of automatic cut-outs is the safeguarding of individual generators against damage from heavy reverse currents which may be sent through them from other generators connected to the same 'bus-bars. If, when several

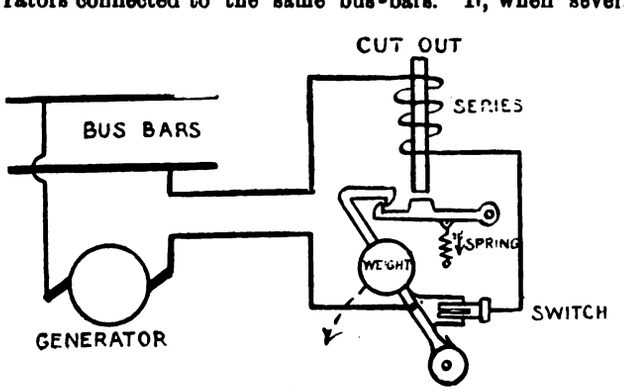



FIG. 1.

generators are running in parallel, one of them should have a short-circuit in its armature or have its exciting circuit interrupted its voltage will fall, and, if not automatically prevented, an excessive motoring current will be sent through the faulty machine, probably resulting in serious damage. An ordinary minimum cut-out (Fig. 1) cannot be relied on to prevent this occurrence, for the change from a generated current to a motoring current may be too sudden to allow the switch to open—a reverse current of a certain amount being just as effective in such a cut-out in keeping the switch on, as an equal current in the original direction.

With a reverse-current cut-out (Fig. 2), on the other hand, the action of the magnet depends on the differential effect of a shunt winding, whose excitation depends on the 'bus-bar voltage and a series winding carrying the generator current. The shunt excitation alone is made just too small to allow the switch to open, but as soon as the shunt is aided by a small amount of reverse current the magnet acts and the switch is opened. The greater the reverse current becomes in this case, the greater is the certainty of the switch being opened. The number of ampere-turns for which the shunt is wound is decided by the construction of the apparatus, and is usually made 90 or 95 per cent. of that excitation, which would cause the switch to open. The amount of series winding is decided by the maximum overload which the generator is intended to give (for such a cut-out acts as a maximum current as well as a reverse-current cut-out). At this maximum overload the series winding must overpower the shunt just sufficiently to open the switch—*i.e.*, the series winding at this maximum current will have rather more than twice as many ampere-turns as the shunt. Suppose 500 ampere-turns are sufficient to cause the switch to open against a reasonable spring power, and that the maximum allowable current of the generator is 500 amperes, then the shunt would be wound to give about 450 ampere-turns and the series winding to give 950 ampere-turns in opposition to the shunt when the current generated in the normal direction is 500 amperes. Then should a reverse current of about 26 amperes flow (50 ampere turns in the series winding) the total effective ampere-turns would be increased to 500, and the switch would be opened.

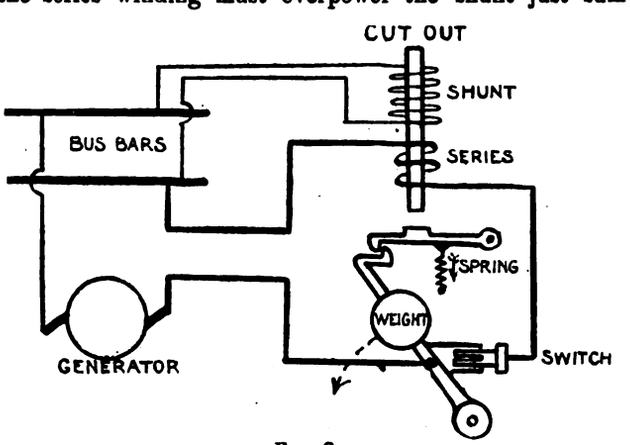



FIG. 2.

Only minor disadvantages can be urged against the reverse-current cut-out. The presence of a fine-wire shunt winding on the magnet, and the fact that each cut-out has connections to both poles of the generator, necessitate more care with the insulation. In the case of the higher-voltage installations, external resistances have often to be used in series with the shunt winding to keep the wire of a reasonable size. These points necessarily somewhat increase the price, but the greater safety obtained, as compared with the ordinary minimum cut-out, quite out-balances any such considerations.—Q.

*Answer to No.* 682 (*awarded* 5*s.*).—In summing up the advantages and disadvantages of reverse-current cut-outs and minimum-current cut-outs, the main points to be borne in mind are: the reliability of the apparatus under consideration to properly perform its work when required to; the liability of it to work at the wrong time, and thus endanger the continuity of the supply. Secondary considerations are prime cost and cost of upkeep, ease of adjustment, and ease of manipulation. One advantage of the minimum-current cut-out is that it absolutely prevents a reversal of current taking place, and can be depended on

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to drop the machine out at the right time. The reverse-current cut-out allows the reversal to take place, but comes into play before the reverse current has attained a dangerous degree; thus the principle on which the minimum-current cut-out works is far superior to that of the reverse-current cut-out. There is no chance of the minimum-current cut-out being brought into play by vibration, as it has no moving parts; it can, in consequence, be set much finer than the reverse-current cut-out, which, if set too fine, is very apt to be brought into play at any time by vibration, and this mishap is more likely than not to happen when the machine is on full load. In prime cost and cost of upkeep, the minimum-current cut-out has a great advantage over the reverse-current cut-out, costing about 50 per cent. less to buy, and having no charge for upkeep. The reverse-current cut-out has working part to manufacture and maintain and keep in adjustment, which adjustment may easily be upset by the presence of dirt or corrosion at the working parts or contacts, it being generally very awkward to get at the parts of a reverse-current cut-out to clean them. A reverse-current cut-out may be slightly easier to manipulate than a minimum-current cut-out, but the advantage is so slight as to be negligble. The writer has experienced the troubles alluded to above with reverse-current cut-outs, and an entire absence of any trouble with minimum-current cut-outs. In conclusion, the minimum-current cut-out is more reliable, less expensive, and less likely to go wrong than the reverse-current cut-out.—W. T. W.

*Answer to No.* 682 (*awarded* 5*s.*).—In order to be able to discuss the advantages and disadvantages of reverse-current and minimum cut-outs, it is better first to examine the construction of each. Minimum cut-outs vary only in detail, and are all erected on the following principle. The current passing through the switch flows as well round a series coil, which it causes to become a magnet. This magnet sucks in a lever, which in turn keeps the switch in position. As soon as the current ceases to flow through the switch the coil is no longer a magnet, and a small spring, regulated to overcome the residual magnetism, pulls back the lever and releases the switch. The reverse-current type is practically the same, with the exception that the lever is a permanent magnet, usually excited by a shunt coil, so that when the current is passing through the series coil it attracts the opposite pole of the lever, and so keeps the switch in, while as soon as reverse current flows through the series coil it forms the same pole as that of the lever, and repulsion takes place, forcing the switch out.

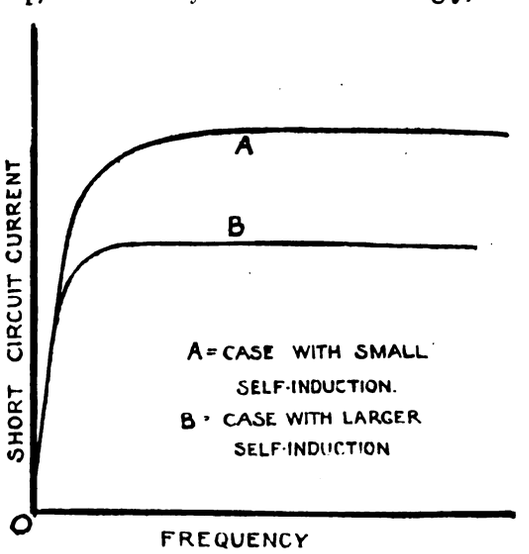
Could the minimum cut-out be guaranteed to act, it would be preferable to the reverse type, because the latter does not break until after the reverse has taken place, but usually the zero is passed so quickly that it does not allow the mechanism of the minimum style to work before the reverse current flowing through the series coil holds the lever in. Take, for instance, cut-out used on a dynamo circuit, and suppose for some reason or other the machine voltage suddenly drops, it is highly doubtful if the minimum would have time to act, while the reverse must do so. Or again, imagine the switch put in with the machine voltage lower that of the 'bus bars, what happens? The current flowing through to motor, the machine would keep the minimum in, while the reverse-current switch must break.

To sum up the advantage of the reverse is that it cannot fail to act, and the disadvantage is that it does not act until after the zero has passed. The advantage of the minimum is that it cuts out at zero, while the great disadvantage is that the zero does not last long enough in the majority of cases to allow it to break. The minimum cut-out = theoretical; the reverse cut-out = practical.—H. S. P.

*Question No.* 683.—When drying out a three-phase generator of the Oerlikon type the following connections were made: The three open ends of the generator stator windings were all shorted together. The generator was then run up to 400 revolutions per minute. A current of 10 amperes 100 volts from one of the exciters was passed through the rotor field, which showed 16 amperes on ampere-meter in one of the stator windings, just enough to warm up the windings of stator. The following happened: the exciting current was kept quite constant, and if the speed of the generator increased or decreased it would show no difference on the ampere-meter in stator coils—the current kept constant at 16 amperes; and if the generator was only just moving, the current would still remain the same, but the moment the generator came to a standstill no current would be shown on ammeter. I should like to know the reason of this.

*Answer to No.* 683 (*awarded* 7*s.* 6*d.*).—The phenomenon noted in this question is fairly well known, as in some text-books when giving instructions for carrying out the short-circuit test, we are told that to correct for incidental variations in the observed speed the observed open-circuit volts must be altered in the ratio of the standard speed to the observed speed, but the short-circuit current may be taken as *independent of the speed* over fairly large ranges of speed variation.

The following is an explanation: The short-circuit current per phase is given by the usual expression $\frac{E}{\sqrt{R^2+(2\pi f L)^2}}$, where E is the voltage generated per phase in the armature coils under short-circuited conditions; R is the resistance per phase of the armature; $f$ is the frequency corresponding to the speed of rotation, and L is the coefficient of self-induction of the armature per phase. Now, at the working frequency, the term $2\pi f L$ is much bigger than R, and therefore $R^2$ is still more insignificant compared with $(2\pi f L)^2$, so that the current is given by $\frac{E}{2\pi f L}$. As the machine slows up, the term $2\pi f L$ decreases accordingly, but it will




be some time before it is comparable with R in magnitude, and so long as this is so the current will still be given by $\frac{E}{2\pi f L}$. Now, E is proportional to the speed, as also is the frequency, so that $\frac{E}{2\pi f L}$ is constant. When, however, very low frequencies are reached, the whole term $\sqrt{R^2+(2\pi f L)^2}$ cannot be written as $2\pi f L$ simply—that is, the denominator of the fraction is more than proportional to the frequency, and if the E.M.F. generated continued to be proportional to the frequency, the current $\left(\frac{E}{\sqrt{R^2+(2\pi f L)^2}}\right)$ would decrease. But another action occurs which tends to keep the short-circuit current up to its previously constant value. As the term $2\pi f L$ becomes nearer to R, the power factor $\left(\cos\phi = \frac{R}{\sqrt{R^2+(2\pi f L)^2}}\right)$ increases, and as the demagnetising action of the armature current is proportional to $\sin\phi$, this action becomes less than before, with the result that the excitation on the magnets produces more flux, and consequently more volts are generated. Therefore in the expression for the current both the numerator and denominator are more than proportional to the frequency, so that the current *tends* to keep the same. In the figure specimen curves are plotted connecting short-circuit current at different frequencies for the same excitation. The curve, of course, finally bends over, and passes through the origin, because at very low frequencies the term $2\pi f L$ becomes small compared with R. Two curves

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are given to show the effect of increased self-induction in the same type of machine (which may be brought about, for instance, by the use of closed slots). With the higher value of self-induction the current is smaller than in the other case, but its value is kept constant down to lower frequencies. The question states that the machine was of the Oerlikon type, but as the Oerlikon Company build machines of many different types, most of which are not essentially different from those made by other firms, this does not enable us to investigate the matter further in this direction. The present writer is, however, surprised that a machine running normally at 400 revolutions per minute should have the short-circuit current still the same when it is just turning, but would suggest that the excitation used (10 amperes) was so much below the normal value, and the short-circuit current was so low, that none of the iron parts were at all saturated, thus making the coefficient of self-induction much larger than it would be under normal running conditions at full load.—P.

*Answer to No.* 683 (*awarded 7s. 6d.*).—The fact put forward in this question, although peculiar at first sight, is one commonly observed in all classes of alternators, and its explanation is very simple. Briefly, the explanation is as follows: The excitation being maintained constant, the E.M.F. developed in the armature windings is directly proportional to the speed of rotation of the machine, but the current is the quotient of the E.M.F. divided by the impedance, and, generally speaking, the difference between the impedance and the reactance in an armature winding is quite inappreciable, and the reactance is also directly proportional to the speed; therefore, the current is independent of the speed. The sudden change from normal short-circuit current to zero as the machine slows down and stops, is not quite so sharply marked as would appear to be indicated in the question. Such sudden transitions seldom or never occur in nature. If such were the case, it would indeed be a puzzle to explain it. The fact is, at a sufficiently low speed the resistance of the winding ceases to be inappreciable, and

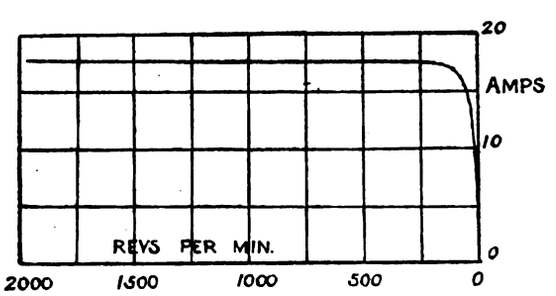



FIG. 1.

plays an increasingly important part in deciding the value of the current during the last few seconds that the machine is turning. Nevertheless, to see the falling of the current to zero needs very careful watching.

Let us take an example. Let 100 be the normal voltage of an alternator when running at a speed of 1,800 revolutions per minute, and let the frequency at this speed be 90. Let L, the inductance of the winding, be ·01 henry, and R, the resistance, be ·1 ohm. Now, the current $= \frac{E}{\text{impedance}}$ and $(\text{impedance})^2 = (\text{resistance})^2 + (\text{reactance})^2$, and the reactance $= 2\pi n$ L. It will be seen from this that, even when the frequency has fallen down to eight alternations per second—*i.e.*, less than 10 per cent. of the normal—that $R^2$ is still only one-fifth of $(2\pi n \text{ L})^2$, or the impedance is only 10 per cent. in excess the value that would be obtained if the resistance were neglected.

Appended is a column showing the connection between short-circuit current and revolutions per minute, and Fig 1 shows the same thing graphically.

| Revolutions per minute. | Current. |
|---|---|
| 1,800 | 17·7 |
| 400 | 17·6 |
| 200 | 17·5 |
| 100 | 16·9 |
| 60 | 15·5 |
| 20 | 9·7 |

SUPERHEAT.

*Answer to No.* 683 (*awarded* 5*s.*).—In dealing with problems concerning the strength of the current in any circuit in which a known alternating E.M.F. is acting, we have always to bear in mind that we cannot apply the law for direct currents—viz, $C = \frac{E}{R}$—unless we take R as representing the "impedance" of the circuit—a quantity which is not a constant, but depends partly on the periodicity of the applied alternating E.M.F. and partly on the resistance of the circuit. In short, the equation for the R.M.S. value of the current in such a circuit is

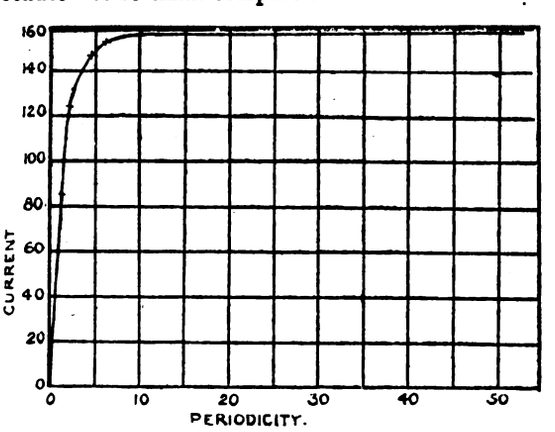
$$C = \frac{E}{\sqrt{r^2 + 4\pi^2 n^2 L^2}};$$

where E = R.M.S. value of applied E.M.F.;
$r$ = resistance of the circuit;
$n$ = periodicity of the applied E.M.F.;
and L = the inductance of the circuit.

Now, the E.M.F. acting in the stator winding of the machine under consideration depends on the rate of change of magnetic flux through it—that is, if the exciting current is kept constant—is K $n$, where K is a constant, depending on the number of turns in the stator winding and the strength of the magnetic field; and $n$ is the periodicity, or the revolutions per second × the number of pairs of poles. And since the stator windings are short-circuited at the machine, the value of $r$ compared with $2 . \pi n$ L is very small, even when $n$ is comparatively low. Therefore, we may almost neglect $r^2$ in the above equation, and we then have

$$C = \frac{K n}{2 . \pi n L} = \frac{K}{2 . \pi . L} \text{ (nearly).}$$

Thus we see that the current simply depends on the constants, and is independent of the speed of the machine, because $r$ is so small compared with the reactance term.




To show in a diagram how soon the current in the stator windings will reach a steady value as the periodicity is increased, I have assumed a circuit of resistance 0·01 of an ohm, inductance 0 001 henry, and plotted a curve connecting current and periodicity, K being taken as unity for ease of calculation. The following is the table from which the curve is plotted:

| Periodicity, $n$. | Current calculated from formula, $C = \frac{n}{\sqrt{(\cdot01)^2 + 4\pi^2 (\cdot001)^2 n^2}}$ |
|---|---|
| 0 | 0 |
| 1 | 85 |
| 2 | 124 |
| 4 | 147 |
| 6 | 153 |
| 8 | 156 |
| 10 | 157 |
| 50 | 158 |

From the curve we see that for the circuit we have assumed the current reaches more than half its final value when the engine is running so slowly as to only give a periodicity of 1, and that when the speed is such as to give a periodicity of 10 the current has almost reached its maximum constant value.—W. S. P.

ERRATA.—In our last issue there are the following corrections needed in the answers published:

On p. 754, the paragraph marked (*d*) at the bottom of the left-hand column should read: (*d*) Have the electrolyte

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analysed for traces of nitric acid. Diphenylamine or bruceine give the best tests.

On p. 756, the contributor of the answer signed "W. B." asks us to note "that the heat is proportional to the current square," and not to the current, as stated.—ED. *E. E.*

# LEGAL INTELLIGENCE.

## THE MANCHESTER CARRIAGE AND TRAMWAY COMPANY v. THE SWINTON AND PENDLEBURY URBAN DISTRICT COUNCIL.

This case came before Mr. Justice Channell on Friday last.

**Mr. Fletcher Moulton, K.C.**, for the plaintiffs, explained that the Swinton and Pendlebury authority purchased the system running through their district from the Manchester Carriage and Tramway Company, and the whole point at issue was whether the local authority had to purchase the whole of the undertaking, including two depôts, one in Ford-lane and the other in Church-street. The point had been taken before Sir F. Bramwell, sitting as arbitrator, who held that the Ford-lane depôt, though in a limited sense used for the purposes of the tram undertaking, yet was not suitable to such undertaking, but that the Church-street depôt was used by and was suitable to the undertaking. He assessed the total value of the tramlines and the depôt, etc., at £49,006, but said that if the Court should be of opinion that the Council were not compelled to purchase the Church-street depôt, then that sum must be reduced to £24,689.

**Mr. Balfour Browne**, for the Council, said that all that the Act could compel the Council to buy was "such part of the undertaking as is within their district," and it was clearly outside the Act to make them buy more.

**Mr. Justice Channell** said he thought he was bound to support the findings of the award. If Sir F. Bramwell had been alive he thought he should have sent it back to him, as there were facts set out in the evidence which showed the depôt was only partly used for the purposes of the tram undertaking. He had great difficulty in understanding exactly how the arbitrator came to his conclusion, but the point was clearly submitted to the Court—assuming as a matter of fact that the building, which was outside the Council district, was at the time the undertaking was taken over suitable to and used for the purpose of the undertaking—were the purchasers bound to purchase it? He thought it was quite clear that they were. He was compelled, therefore, to come to the conclusion that the award must be supported.

Judgment for plaintiffs accordingly.

## SOUTH LANCS. ELECTRIC TRACTION AND POWER COMPANY.

At Liverpool last week the case of Grenfell and others *v.* Willox and others was tried by Mr. Justice Jelf and a special jury. The plaintiffs were debenture holders, and the defendants, consisting of Sir John A. Willox, M.P., Hon. Arthur Stanley, M.P., Messrs. E. K. Muspratt, James Basnett Atherton, and Jacob Atherton, were directors of the company.

Mr. Sutton and Mr. Byrne appeared for the plaintiffs; Sir Edward Clarke, K.C., for Sir John Willox, the Hon. A. Stanley, and Mr. Muspratt, and Mr. Rufus Isaacs, K.C., for Messrs. Atherton.

The defendants were alleged to have stated in the prospectus that in 1900 the company possessed statutory power to supply the local public authorities of South Lancashire with electricity in bulk for lighting as well as power purposes, whereas it was not till three years later that the company obtained such powers. Plaintiffs subscribed on these representations, but fresh capital had to be created to obtain powers three years later, and plaintiffs alleged their debentures had become worthless and the shares of the company unsaleable. Accusations against the defendants of *mala fides* were withdrawn in court. The defence was that the directors acted in good faith, and on the opinion of their general adviser, Mr. Balfour Browne, K.C., that on the whole the company possessed in 1900 the powers set forth in the prospectus.

Evidence on both sides was given by several witnesses, including **Sir John Willox**, who stated that he fully believed that the statement in the prospectus was true, as, after enquiry, he had no doubt whatever that the company had power to supply electricity in bulk to local authorities.

At one stage of the proceedings the jury retired to consult, as a majority were in favour of dismissing the case. Subsequently, they intimated that they did not desire to hear further evidence.

**Mr. Sutton** then addressed the jury on behalf of the plaintiffs.

**His Lordship**, in summing up, said his impression was that Mr. Balfour Browne was perfectly correct in his opinion that the Act of Parliament did give the company the power which the prospectus said it possessed. The defendants were alleged to have made a statement which was untrue as true in accordance with the interpretation of the Act. That was a matter of opinion, and his Lordship had grave doubts whether the Act was not intended to apply to mere expressions of opinion. It was curious plaintiffs did not say the prospectus was untrue until three years later, when fresh capital was to be raised which would rank before their debentures for interest. Then they made the charge of fraud against the directors, which they afterwards withdrew, but practically repeated in another form when they asked the jury to decide that defendants had issued the prospectus, which was not only untrue, but untrue to their knowledge. His Lordship put it to the jury whether defendants had reasonable ground to believe the prospectus was true.

The jury ultimately found that defendants had reasonable ground to believe that the prospectus was true, and returned a verdict for defendants. Judgment accordingly, with costs.

## TRAMCAR LICENSES.

A test case was heard at Dewsbury on Tuesday, in which the Yorkshire (Woollen District) Electric Tramways Company, Limited, were summoned by the Corporation for running a tramcar without a license.

**Mr. Ellis**, town clerk, said that the tramway company had been repeatedly asked to take out licenses for their cars, but they had refused. He contended that under the Town Police Clauses Amendment Act, 1899, tramcars came within the meaning of hackney carriages plying for hire, and under Sections 37 and 45 of the Act corporations had power to grant licenses, and the proprietors of such vehicles running them without licenses were liable to a fine not exceeding £2.

**Mr. T. Jones**, for the defendant company, contended that, even granting that a tramcar was a hackney carriage, the local authority had no power to compel them to procure licenses. Under the Tramways Act, 1870, they were granted that power, but by the light railway order which the company had obtained to run their trams they had no such power.

After the case had been argued at length, the magistrates decided in favour of the Corporation, and imposed a fine of 2s. 6d. and costs.

**Mr. Jones** asked that a special case might be stated, and the magistrates agreed to state one.

# COMPANIES' MEETINGS AND REPORTS

## EDISON AND SWAN UNITED ELECTRIC LIGHT.

An extraordinary general meeting was held on the 12th inst. at Winchester House, when the following resolution was passed: "That the capital of the Company be reduced from £1,000,000, divided into 150,000 'A' and 50,000 'B' shares of £5 each, to £941,090, divided into 150,000 'A' shares of £5 each, 26,436 'B' shares of £5 each, and 23,564 'B' shares of £2. 10s. each; and that such reduction be effected by cancelling paid-up capital which has been lost, or is unrepresented by available assets, to the extent of £2. 10s. per share on each of the 23,564 'B' shares which have been issued, and are now outstanding, and by reducing the nominal amount of each of such 23,564 'B' shares to £2. 10s."

The **Chairman** explained that the last balance-sheet showed that the sum of £62,499 was capital which had been lost or was not represented in the available assets; and, that being so, it must be provided for either out of profits or by writing down share capital before any dividend could be paid. It was understood to be the wish of the shareholders that the latter course should be adopted, and, having regard to the articles of association, any reduction must fall first on the "B" shares, which were deferred both as to dividends and capital. The capital would be reduced by £58,910, and the remaining £3,589 would be provided out of current earnings. The directors saw no immediate necessity for writing down goodwill, etc., which had stood at £443,451 since 1898, as it could in no way affect the earning of dividends. The business of the Company was progressing satisfactorily, and he hoped to see a marked improvement in results during the current year.

## WESTERN TELEGRAPH.

The sixty-first ordinary general meeting was held on Tuesday at River Plate House, Sir John Wolfe Barry presiding.

In moving the adoption of the report (particulars of which were given in our last issue), the **Chairman** remarked that the message receipts for the half-year ended Dec. 31 last amounted to £202,052, or £10,621 less than in the corresponding period of 1902. A large part of this decrease was due to the fact that in the second half of the previous year they carried the whole of the traffic with West Africa in consequence of an interruption to the competitive route. The traffic with the River Plate and the West Coast of South America showed a substantial increase. For the current half-year the March quarter exhibited a decline in traffic as compared with that of 1903, but the diminution was being rapidly reduced.

The report was adopted.

## WEST INDIA AND PANAMA TELEGRAPH.

The ordinary general meeting was held at Winchester House on Wednesday, Mr. W. B. Kingsford in the chair. The report (of which particulars were given in our last issue) was adopted unanimously.

## BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

The third annual general meeting was held on Wednesday at Winchester House, Mr. H. B. Beeton in the chair. Particulars of the report were given in our last issue.

The **Chairman** remarked that the Company ought soon to benefit from the Toowong extension, the opening of which had been further delayed through a new order having to be obtained. This would complete the contemplated extensions, and the only other obligation as to capital expenditure under the contract with the tramways company is the reconstruction of the track, now laid with 77lb. and 55lb. rails, the whole of the remaining material (88lb. rails) required for which is now either on the way or on the point of shipment. There is a total reserve of £24,112. The Company had contemplated meeting capital expenditure by the issue of a further £25,000 of debenture stock, but so far the directors had not considered the conditions favourable enough for placing it. Temporary arrangements had been made with the

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bankers, but if the present improvement in the market continued the directors would soon have to consider the issue of this stock. During the past year the tramways manager had visited London and discussed with the Board plans for the better development and more economical working of the undertaking, and, although there was no definite announcement to make on the subject, the directors were hopeful of advantageous results. The Chairman concluded by moving the adoption of the report and accounts.

**Mr. J. B. Concanon** seconded the resolution.

The **Chairman**, replying to questions, said that it must be remembered that the Company had been working not only an increased street mileage and an increased car mileage, but that they had been doing so under very disadvantageous conditions. When traffic improved, which he had no doubt it would do, the percentage of expenditure would diminish. Their actual operating expenses per car mileage were 5·84d. per car mile run, which he considered a very low figure, having regard to the high rate of wages that had to be paid. The tramways manager was doing everything possible towards economical working.

The resolution was then unanimously agreed to.

The retiring directors (Sir Malcolm McEacharn and Mr. A. P. Ledward) were re-elected.

The proceedings terminated with a cordial vote of thanks to the directors.

## LOCH LEVEN WATER AND ELECTRIC POWER.

A meeting of the shareholders of this Company was held in Edinburgh, Mr. John D. Bonner presiding. The meeting approved of the draft provisional orders for which application was made to the Secretary for Scotland last month—the one to confer further powers on the Company and to extend the time for the purchase of lands, and for the completion of part of the authorised works of the Company; the other to extend the time limited by the Loch Leven Water Power Act, 1901, for the construction of the waterworks, electrical generating stations, and other works.

## GLOBE TELEGRAPH AND TRUST COMPANY.

The ordinary meeting of this Company was held on Tuesday. Particulars of the report were given in our last issue.

The **Marquis of Tweeddale**, who presided, moved the adoption of the report recommending a total dividend for the year on the ordinary shares of 5½ per cent. He said the Company had never been in a better position than it was now. The dividend proposed on the ordinary shares was the largest that had been paid since the commencement of the Company. Last year the depreciation of their securities amounted to £275,381; this year the appreciation was £43,259, representing an increase in the value of their securities of £316,640.

The report was adopted.

## RAND CENTRAL ELECTRIC WORKS.

The report for the past year states that there is a decided improvement in the Company's affairs when compared with the preceding year's accounts. The revenue derived from the supply of power during the year under review has been augmented by £18,043 above the revenue of 1902, and the result of the year's operations shows a working profit of £28,500 before deduction of the sum set aside for depreciation. The directors decided, as from the beginning of this year, to publish monthly the total kilowatt-hours generated and the estimated gross revenue, and from a perusal of these statements, which cover the first four months of the year, it will be observed that there is an increase of revenue of about £8,200 over and above the same period of last year. The receipts derived from the supply of power and rent of plant reached a total of £70,513, as compared with £52,469 from the same source during the year 1902. The statement of accounts shows a gross profit of £28,547 and after deducting the sum of £17,962, set aside for depreciation, there remains a net profit of £10,584, which, together with the balance of reserve account now transferred, reduces the deficit brought forward from last year to £11,947. The total power generated during the year was 8,192,680 kilowatt-hours, and the demand was of a more uniform character. The directors regret to report that they have been unsuccessful in their efforts to obtain from the Imperial Government a refund of the amount of £2,729 appearing in last year's balance-sheet as a claim against them; this sum has, therefore, been written off against reserve account, the balance of which, as previously mentioned, has been appropriated towards the reduction of the debit balance. The question of the extension of the works has engaged the serious attention of the directors for some time past, and it has been decided to increase the capacity of the plant by 1,000 kw. As a first instalment, an order has been placed for a steam-turbine of 400 kw., and if, as the directors have every reason to believe, this type of machinery proves successful for the Company's purposes, the full extension will then be proceeded with on similar lines.

## WILLANS AND ROBINSON.

The exact result of the poll mentioned in our last issue was as follows: for the resolution, votes representing 69,501 shares; against resolution, votes representing 100 shares. In addition, however, to the 100 shares voting against the resolution, there were proxies carrying 10,240 votes in the secretary's hands, but these were not used. The total number of shares issued is 133,332. The terms of the resolution on which the poll was taken are as follows: "That, subject to Mr. Peache entering into an agreement to devote the whole of his time and attention to the service of the Company (with such exceptions as may be arranged), he shall be remunerated by a fixed salary of £2,000 per annum, together with a contingent share of profits calculated as follows—namely, in respect of every half-year in which the net profits of the Company for such half-year shall be sufficient to pay a dividend at the rate of 7 per cent. per annum upon the amounts paid or credited as paid upon the ordinary shares then called up (after paying the prescribed dividend upon the preference shares, and arrears thereof if any) on amount equal to 9 per cent. of the remainder of such profits shall be paid to the said James Courthope Peache. Also that the remuneration of the proposed director should be provided from the fees paid to the existing Board, but it is hereby declared that this is only an expression of opinion of this meeting, and not a binding direction to the Board."

## NEW COMPANIES REGISTERED.

**Marshall's Valve-Gear Company, Limited.**—Capital. £71,500. Objects: to acquire any interests in patents, licenses, and the like, conferring the right to use any secret or other information as to any invention relating to steam and locomotive engines, in particular to acquire from J. T. Marshall, of Francis-street, Leeds, the benefit of certain existing inventions relating to improvements in valve gear for fluid-pressure engines; and to carry on the business of valve gear and locomotive manufacturers, mechanical engineers, electric light, heat, motive power, tramcars, etc.

**J. Stone and Co., Limited.**—Capital, £700 200. Objects: to acquire and carry on at Deptford or elsewhere the business of mechanics, electric and general engineers, etc.

**Crosby Motor and Engineering Company, Limited (80,910).**—Capital, £2,000. Object: to carry on the business of contractors, engineers, electricians, manufacturers of and dealers in motors, mechanically-propelled marine and river craft, etc. Registered office: 6, Crosby-square, E.C.

### Liens Registered.

**Improved Electric Glow Lamp Company, Limited, London, E.C.**—Supplemental lien registered May 6 to deed dated July 18, 1901, for securing £4,000, charged on the undertaking and all the property, including the uncalled capital.

**India Rubber, Gutta Percha, and Telegraph Works Company, Limited, London, E.C.**—Lien registered May 6 for £98 000 4½ per cent. second debentures, part of £100,000 authorised; no trustees; charged on the undertaking and all the property, including the uncalled capital, but subject to 4 per cent. debentures for £300,000, issued in 1896.

**Electric Light Insurance and Maintenance Company (1904), Limited.**—Debenture registered May 6 for £2,000; holder: E. Hill, chartered accountant, 79, Mark-lane, E.C.; charged on all the property and assets, except the uncalled capital.

## APPOINTMENTS VACANT.

**Electrical Engineer**, Weymouth and Melcombe Regis. Salary will be £250 per annum. Applications to Mr. R. N. Howard, town clerk, by June 8. See advertisement.

**Superintendent of Works**, Southampton tramways reconstruction. Applications to the Borough Engineer, Municipal Offices, Southampton, up to 9 a.m. on May 24.

**Electricians in Power House, etc.** See advertisement.

**Junior Draughtsman.** See advertisement.

**Track Engineer**, Birmingham, for construction of 4½ miles of electrically-worked tramways. Salary £5 to £6 per week, according to experience. Also, an **Inspector.** Salary £4 per week. Applications to Mr. John Price, city engineer and surveyor, Council House, Birmingham, by 31st inst. See advertisement.

**Assistant Electrical Engineer**, Wakefield. Salary, £150 per annum. Applications to Mr. C. M. Shaw, Electricity Works, Wakefield, by 30th inst. See advertisement.

## PERSONAL.

Mr. MacGowan, assistant engineer, Oban, has resigned.

The Dundee Town Council have increased the salary of the electrical engineer by £100.

Mr. J. U. Sowter, Dorchester, has been appointed electrical engineer at Bray, county Dublin, at a salary of £240 a year—double that which he was receiving at Dorchester.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cape Town.**—The Tramways Company will shortly require tenders for rails and other material.

**Utrecht (Holland).**—The Municipality require tenders for supply and laying of electric cables by 31st inst.

**Amelia (Perugia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao by July 6.

**Callender's Cable and Construction Company, Limited.**—Tenders are required for 20,000 to 50,000 blue tiles delivered at Kilmarnock. See advertisement.

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**St. Annes-on-Sea.**—The Urban District Council invite tenders for the supply of leadless cable for laying solid. Particulars may be obtained from the Electrical Engineer. Tenders by May 30.

**Batley.**—The Corporation invite tenders for a steam superheater, steam piping, valves, and accessories for the electricity works. Specifications may be obtained from the Borough Electrical Engineer. Tenders by June 2.

**Erith.**—The Urban District Council invite tenders for additions and alterations to the electric light station. Specifications, etc., may be obtained from the Quantity Surveyor, 12, Queen's-road, Erith. Tenders by June 14.

**Pentyrch.**—The Urban District Council invite tenders for supply of motors. Specifications, etc., may be obtained at the offices of Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on June 4.

**Penrhiwceiber (Wales).**—The Penrikyber Navigation Colliery Company, Limited, Penrhiwceiber R.S.O., Glam., invite tenders for 12 months' supply of various stores, including electric lamps and fittings. Tenders by June 2.

**Mexborough.**—The Urban District Council invite tenders for two 100-kw. steam dynamos. Specifications, etc., may be obtained on application to the Engineer, Electricity Works. Tenders by 31st inst. See advertisement in former issue.

**Handsworth.**—The Urban District Council invite tenders for lighting feeders, mains, and roadwork. Specification, etc., can be obtained from Mr. H Ward, Council House, Handsworth, near Birmingham. Tenders by May 25.

**Rochester.**—The Corporation invite tenders for the construction of permanent way and overhead line. Specifications, etc., can be obtained at the office of Mr. E. Rotter, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders by June 3.

**Atherton (Lancs.).**—Tenders are invited for the heating, ventilation, or electric lighting of the Atherton Free Library. Particulars may be obtained from Messrs. Bradshaw and Gass, F.R.I.B.A., Silverwell-street, Bolton, on or before 25th inst.

**Warrington.**—The Electricity Committee invite tenders for (1) four mechanical stokers, (2) water softener and purifier, for the electric light station. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by 30th inst.

**Hackney.**—The Council invite tenders for electricity supply mains (feeders and distributors). Specifications, etc., may be obtained from Mr. R. Hammond, M.I.C.E., 64, Victoria-street, S.W. Tenders by May 26. See advertisement in former issue.

**Coventry.**—The Corporation invite tenders for supply and erection of a 15-ton electrical crane and pipework for the electricity works extension. Specifications etc., may be obtained from Mr. J. A. Jeckell, Corporation Electricity Works. Tenders by 25th inst.

**Royton (near Oldham).**—Tenders are invited for overhead equipment and cables for the Royton and Crompton tramways. Specifications, etc., may be obtained from Mr. Reginald P. Wilson, 66 Victoria-street, Westminster. Tenders by 12 noon on May 28.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for a number of four-ton electric wharf cranes for Clydebank Dock Specifications may be obtained at 16, Robertson-street, Glasgow, from Mr. Geo. H. Baxter, mechanical engineer. Tenders by noon on May 23.

**London, S.W.**—The Guardians of the Wandsworth Union invite tenders for overhauling fire alarms, electric bells, rewiring, etc., at the infirmary. Specifications, etc., can be obtained from Mr. F. W. Piper, clerk, Union Offices, St. John's-hill, S.W. Tenders by 10 a.m. on the 26th inst.

**Norwich.**—The Corporation invite tenders for lighting the streets, roads, and public places of Norwich for one, two, or three years, at the option of the Corporation, from July 1 Particulars can be obtained from Mr. Arnold H. Miller, town clerk, Guildhall, Norwich. Tenders by June 4.

**Kirkcaldy (Scotland).**—The Lighting Committee invite tenders for one extension switchboard panel and cable connections for one 430-kw. generator now on order. Specification, etc., may be obtained from Mr. O. F. Francis, burgh electrical engineer. Tenders by noon on 23rd inst.

**Abergavenny.**—The Building Committee of Visitors of the Monmouthshire Asylum invite electrical lighting schemes for the asylum and tenders for carrying out the same. Particulars can be obtained from Dr. James Glendinning, medical superintendent. Tenders by 10 a.m. on May 24.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for the supply of various stores for year commencing July 1, including electrical stores. Specifications, etc., may be had on application to the Superintendent of Stores, 16, Robertson-street, Glasgow. Tenders by 10 a.m. on June 4.

**Sunderland.**—The Corporation invite tenders for the supply of one 500 kw three-phase induction motor-generator for traction purposes Specifications, etc., can be obtained from the Borough Electrical Engineer Town Hall, Sunderland. Tenders by 27th inst. See advertisement in last issue.

**Bolton.**—The Electricity Committee invite tenders for various stores during year ending March 31, 1905, including meters, motors, transformers, starting switches, etc. Specifications. etc., may be obtained on application to the Borough Electrical Engineer, Spa-road, Bolton. Tenders by 25th inst.

**Shanghai (China).**—The Municipal Council of Shanghai invite tenders for a concession for constructing and working about 24 miles of electric tramways on the trolley system in the streets of Shanghai. Particulars may be had upon applicatien to Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Tenders by 12 noon on July 30.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for 12 months from May 31. Specifications, etc., may be obtained from Mr. W. A Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders by 25th inst. See advertisement in former issue.

**Walthamstow.**—The Urban District Council invite tenders for the following stores for the electricity works: incandescent lamps, switches, cut-outs, cables, enamelled steel conduits, arc lamp carbons, carbon brushes, white cotton waste, asbestos packing, etc. Particulars may be obtained from the Electrical Engineer. Tenders by June 3.

**Southampton.**—The Corporation invite tenders for the supply of 150 tons of rolled-steel rails and the necessary fishplates, anchor joints, soleplates, bolts, nuts, and trebars, according to particulars to be obtained upon application to Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders before 2 p.m. on June 6.

**London, S.W.**—The Fulham Guardians invite tenders for wiring, electric bells, steam-hooter, etc. in connection with fire-alarm systems ot the workhouse and infirmary, Fulham Palace-road, Hammersmith, W. Specifications, etc., may be obtained on application at the office of Mr. E. J. Mott, clerk Fulham Palace-road. Tenders by 4 p.m. on 30th inst.

**Johannesburg.**—The Municipal Tramways and Electric Supply invite tenders for insulated cables and bare overhead conductors and certain accessories. Specifications; etc., may be obtained from the Town Clerk, Johannesburg, and from Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., on and after the 30th inst. Tenders by noon on July 4.

**Partick (Scotland).**—The Town Council invite tenders for water-tube boiler, economiser, feed pump, hot-well tank, and pipework; also condensing plant, oil separator, cooling tower and cast-iron tank, and pipework. Specifications, etc., can be obtained at the office of Mr. Jas. Donaldson, town clerk, Burgh Chambers, Partick. Tenders by 12 noon on 24th inst.

**Madrid.**—The Public Works Department, Madrid, Caretas No. 10, require tenders for 10,000m. of rubber-insulated and 11,000m. of steel-wire cable for Los Jeronimos tel-graphs. Five per cent. deposit is required. Also for the concession for working a telephone system, including Elche, Neveldo, Aspe, Monovar, Elda, Pinoso, and Orevillente. Tenders by 29th inst.

**Argentina.**—Tenders are invited for the construction of a system of electric overhead trolley tramways between the Plaza de Mayo, Buenos Ayres, and the townships of Ortuzar, Devoto, and General Urquiza. Particulars may be obtained at the office of the Section of Public Works, Secretariat of the Municipality of Buenos Ayres Tenders by 2 p.m. on 30th inst.

**Greenwich.**—The London County Council invite tenders for the supply and erection of two continuous coal and ash conveyors of the gravity bucket type, at the electricity generating station, Greenwich, and for the maintenance of the same for 12 calendar months. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on June 14.

**Rotherham.**—The Corporation invite tenders for single vulcanised-bitumen (covered) cables of various sizes; electricity meters of sizes for maximum currents of 2½, 5, 10, 25, and 50 amperes (the supply pressure is 230 and 460 volts continuous current), for 12 months from July 1. Particulars can be obtained from the Borough Electrical Engineer. Tenders by 31st inst. See advertisement.

**Canterbury.**—The Lighting Committee invite tenders for the following: One Lancashire or dry-back marine boiler, superheater, steam-pipes, a 300-kw. steam dynamo, switchboard and connections and extensions to economiser Specifications, etc., may be obtained from Mr. Hammond 64, Victoria-street, Westminster, S.W. Tenders before 10.30 a.m. on June 1. See advertisement in former issue.

**Hornsey.**—The Town Council invite tenders for the following: (Section D) condensing plant; (E) water-cooling apparatus; (F) pipework and valves; (G) water softener and purifier; (H) switchboards and connections. Specifications, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by 30th inst. See advertisement in former issue.

**Erith.**—The Urban District Council invite tenders for a steel trough-floored road bridge, with brick and concrete abutments, etc., over the South-Eastern and Chatham Railway at the Lower-road level crossing, Erith, together with making up the approaches, fencing, kerbing, etc. Specifications, etc., may be obtained from Mr. Charles H. Fry, clerk of the Council, District Council Offices, Erith, Kent. Tenders by June 13.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant in connection with electric lighting and tramways for the burgh: (Specification No. 11) overhead equipment, trolley wires, poles, and brackets, etc.; (12) rolling-stock; (13) wiring of generating station and car-shed. Specifications, etc., can be obtained on and after 10th inst. from the Town Clerk. Tenders by 12 noon on the 28th inst. See advertisement in last issue.

**Manchester.**—The Directors of the Dock and Warehouse Extension Company, Limited, invite tenders for the supply, delivery, and erection on the southerly side of Dock No. 9, 20 movable electric cranes (with spare gear therefor) for cargo working purposes. Specifications, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the Manchester Ship Canal Company, 41, Spring-gardens, Manchester. Tenders before 10 a.m. on May 25.

**Cuba.**—The Directorate-General of Communications, Havana, invite tenders for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200dol. (or about £41) is required to qualify any tender. The concession is subject to the

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provision of the Royal decree of May 10, 1890, and the sheet of general conditions of same date regarding the concession for telephone systems, such corrections being understood as may be necessary for adaptation to the existing *régime*. The competition will turn upon the percentage of the total takings (not less than 6 per cent.) which the concessionaire undertakes to pay to the Government.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Exeter.**—The Corporation invite tenders for (1) construction of permanent way and paving (including copper bonding) of about four miles of route length line, single line, with passing places; (2) overhead electrical equipment of the above lines and of car-shed; (3) supplying and laying of insulated cables and stoneware ducts for the same length of tramway in connection with the above; (4) supply and delivery of 12 double-decked single-truck motorcars. Specifications, etc., can be obtained for Contracts Nos. 1 and 4 at the office of Mr. Thomas Moulding, Municipal Offices, Southernhay West, Exeter, and for Contracts 2, 3, and 4 at the office of Mr. H. J. Munro, city electrical engineer, New North-road, Exeter. Tenders by June 9.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

## RESULTS OF TENDERS.

**Liverpool.**—The City Council have accepted the tender of Morrison and Sons, Wavertree, at £3,000, for erection of an electric sub-station in Rice-lane, Walton.

**Derby.**—The Tramways Committee have accepted the tender of Newton Bros., Full-street, at £193. 3s. 6d., for the wiring for electric light of the new car-shed.

**Tiverton.**—The Council have accepted the tender of Messrs. Manning and Sons, at £1,490, for building the electricity station, and the tender of Messrs. Suter for installation.

**Stepney.**—The Borough Council have accepted the tender of Reavell and Co. Limited, at £66, for an air-compressor required for the purpose of removing dust from dynamo armatures.

**Newport.**—Messrs. W. A. Baker and Co., Limited, have placed a contract with Messrs. Walker and Hodgetts, Limited, St. Simon's-street, Salford, for one three-ton electric motor-driven capstan.

**Bradford.**—The Corporation have accepted the tender of Roberts and Co., Limited, Cutler Heights, Bradford, for the supply and erection of constructional ironwork required for the work in progress at the electricity works, Valley-road Bradford.

**Great Western Railway.**—The Company have accepted the tender of Bruce Peebles and Co., Limited, Edinburgh, for 5,000 kw. in motor-generators, including 10 400-kw. sets and four 200-kw. sets, spares, and switchgear. The motor-generators will be built under the Peebles-LaCour patents.

**Acton.**—The District Council have accepted the following tenders in connection with the electricity works: Lancashire Dynamo Company, motor transformers, booster, and balancer, £3,425; Messrs. Cowans, Limited, switchboard, £1,140; St. Helens Cable Company, cables, lamps, lamp-posts, street work, etc., £31,536 15s. 7d.; Electric Power Storage Company, accumulators, £2,016; and Messrs. James Hitchen and Sons, crane, £170. 10s.

# BUSINESS NOTES.

## TRACTION.

**Salford.**—The tramways are handing over from the year's profits £12 000 in relief of the rates.

**Nuneaton.**—The Board of Trade have granted an extension of 12 months for carrying out this scheme.

**Rowley Regis.**—The District Council have raised the money required for the tramway from Old Hill to Blackheath.

**Bradford.**—There is considerable likelihood of the Yorks Traction Company commencing the work of electrification early next month.

**L. and N.-W. Ry.**—It is now reported that the company does not contemplate the immediate electrification of any section of their lines.

**Electric Automobiles.**—It is stated that the electric automobiles in the service of the Parisian Post Office travel at a speed of 18 miles an hour.

**West Ham.**—The receipts from the tramways for the four weeks ended April 28 amounted to £2,969. Fifty thousand miles were covered, and 880,000 passengers were carried.

**Folkestone.**—The deputation appointed to meet Lord Radnor on the question of the substitution of overhead wires for underground traction was received by his lordship yesterday afternoon.

**Paisley.**—The mile of tramway connecting the system with that of Glasgow has been opened. It is stated that there is a good prospect of an early settlement of the differences with the company.

**Walsall.**—The Town Council have decided to purchase, at an estimated cost of £420, an electrically-equipped water tank for sprinkling the lines, so as to ensure contact and prevent sparking.

**Halifax.**—The Corporation propose to seek powers to construct a line to Elland. The revenue from the Corporation's tramways for the past year amounted to £67,712, resulting in a profit of £496.

**Rawmarsh.**—It is stated that there is still every possibility of the tram scheme being carried out. The Urban District Council and the company have been negotiating recently, and this is expected to bear fruit.

**Norwich.**—A parcels express has been started in connection with the electric tramways. Parcels are collected from tradesmen, taken to a central depôt, sorted, and afterwards delivered by boys to the consignees.

**Bombay.**—A recent issue of the *Government Gazette* notifies the application of the Brush Electrical Company for a license under the Indian Electricity Act, similar to that enjoyed by the Electrical Supply Corporation of Calcutta.

**Howrah.**—The Municipality have decided to accept the offer of the Calcutta Tramways Company for the construction of tramways on the other side of the Hooghly, and the matter is now before the Local Government for final disposal.

**Sheffield.**—The Shoreham-street section of the tramways has been opened. The completion of this section provides a new route to Heeley, and the committee have decided to run two circular services between Albert-road and the city.

**Liversedge.**—The British Electric Traction Company having made application to the Board of Trade for sanction to the abandonment of a part of their original scheme, the District Council are considering whether they shall oppose the application.

**Darlington.**—A trial run has been made on the new tramways, which is stated to have been satisfactory. It will not, however be possible to open the service to the public by Whitsun, as the Board of Trade will not be able to inspect the lines until after then.

**Belfast-Holywood.**—It is stated that the Bill to sanction a tramway between these places, which has been approved by the House of Lords Committee, gives the Belfast Corporation power to supply the company with energy, both inside and outside the city boundary.

**Wolverhampton.**—The Town Council have decided to lay a single track on the Waterloo-road route, instead of a double one as at first proposed, on account of the gas mains. The construction of the double line over the railway bridge, Wednesfield-road, has been resumed.

**Glasgow.**—The new tramway route in Johnstone has been completed, and is ready for the running of the electric cars. The present terminus is to be at the corner of Church-street, but when the next section is finished the cars will be able to proceed to the boundary of the burgh.

**Swinton and Pendlebury.**—The District Council have received the sanction of the Board of Trade to the borrowing of a sum of £26 889 in respect of the purchase of the Manchester Carriage and Tramways Company's tramway undertaking in their district, to be repaid in 21 years.

**Chester.**—The tramway employés have petitioned for an increase of pay, it being stated that their rate of wages is exceptionally low. The Tramways Committee have decided to defer consideration of the question for a month, the manager to meantime obtaining information from other boroughs.

**Camberwell and Dulwich.**—At the last meeting of the Camberwell Borough Council the Tramways Committee submitted a recommendation that the borough engineer and his staff be accorded a vote of thanks for their services in connection with the opposition to the Camberwell and Dulwich Tramways Bill.

**Penarth-Cardiff.**—A large and influential deputation attended a special meeting of Penarth Urban District Council on Monday in support of the electric tramway scheme. A hope was expressed that the Council would either undertake the service themselves or favourably consider the scheme put forward by the syndicate.

**Jarrow.**—The Jarrow and District Electric Traction Company are inviting subscriptions for their first issue of stock. The total capital expenditure on the construction of the 3½ route miles of line and their equipment on the overhead system of electric traction is estimated at £70,000. The local authorities may purchase within six months of Dec. 17, 1926.

**Falkirk.**—In reference to our note of the 6th inst., we learn that when the special committee's recommendation that the new syndicate be allowed to run cars on Sundays came before the Town Council it was decided to take a *plébiscite* of the ratepayers. The syndicate have agreed to pass in full the two years' wayleave due in July if Sunday running is sanctioned.

**London United Tramways Co.**—The company having given notice of their intention to commence the construction of electric tramways over Hampton Court and Kingston Bridges, the Surrey County Council have decided to refuse their consent until they have determined whether the working of the trams will be likely to endanger the safety of the Hampton Court Bridge, and whether it will be necessary to reconstruct or widen either of the bridges.

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**The Underground Electrification.**—The Law and Parliamentary Committee of the Hammersmith Borough Council recommended at the last meeting of the Borough Council that no action be taken on the letter received from the Fulham Borough Council inviting co-operation with a view to securing increased luggage allowances with zone fares when this Bill comes before the House of Commons in committee.

**Brighouse.**—The Halifax Corporation have decided to construct the line from Brighouse to Bailiffe Bridge. Since the opening of the Hove Edge extension to Brighouse about two months ago it has been so successful, that the Halifax authorities are encouraged to provide still further for Brighouse requirements. The Bradford Corporation have replied to a petition asking for an extension from Wyke to Bailiffe Bridge that they do not feel justified in undertaking the scheme.

**Radcliffe.**—The Radcliffe District Council Bill for powers to construct about six miles of tramway, which at one end will connect with the lines to Bury and Bolton and at the other with Whitefield, the terminus of the Salford system, has been passed by a House of Commons committee. The Council are to construct the tramways and supply the electrical energy, and the Corporation of Bury will equip and work the lines. The estimated cost of the works is £79,394. Sanction was given to a restricted supply of energy in bulk.

**Trafford Park.**—The Trafford Park Dock and Railway Bill has been considered by a House of Lords Committee. In regard to the portion of the Bill which relates to the construction of tramways in Trafford Park, it is stated that a settlement has been arrived at between the Trafford Park Estates Company, the Manchester and Salford Corporations, and the Stretford District Council. The Manchester and Salford cars are to run over the Park Estates Company's electric tramways, and the company are to have running powers to the Salford boundary.

**Scarborough.**—Despite the decision of the company to run tramcars on Sunday, the agitation against this arrangement is proceeding. The local Nonconformist Council have sent a resolution of protest to the company, and decided to organise a petition and canvass the town for signatures. The Corporation have intimated to the company their opinion that it is desirable that the tramways in North Marine-road should be continued as far as the junction of Albert-road and the North Foreshore-road. The trams, which run to all parts of the town for 1d., carried during the first week 52,404 passengers.

**Mansfield.**—The Town Council and the Mansfield Woodhouse Urban District Council have received from the Board of Trade, with reference to the Mansfield and district light railway order, a communication stating that the Board have granted an extension of 12 months for the completion of the scheme authorised by such order. It is added that the promoters have been informed that the Board would hesitate to sanction any further extension of time against the wishes of the local authority concerned unless substantial progress is made with the construction of the line during the extended period which has now been granted.

**North-Eastern Railway.**—A series of trials have been run on the new electric section of the North-Eastern Railway between Benton and Tynemouth. Four trains of three sets each left Heaton car-sheds and proceeded to Tynemouth, and returned to Benton coupled together in two six-car sets. It is understood that the trials, which were supervised by Mr. Merz, were satisfactory. An official of the company is stated to have remarked in an interview that the company wanted the Hull Corporation to state the lowest price at which they would supply the necessary power for working the local lines of the company before bringing forward a scheme of electrification.

**Yarmouth.**—The following are particulars of the receipts and passengers carried from April 21 to April 28: Passengers at 1d., 74,168; workpeople, 28,885; scholars, 214; receipts, £320. 14s. 9d. Comparative returns: from April 1, 1903, receipts £297. 6s., from April 1, 1904, ditto £320. 14s. 9d.—increase, £23. 8s. 9d.; April 1, 1903, receipts per car mile 4·61d., April 1, 1904, ditto 5·59d.—increase, ·98d.; April 1, 1903, average daily receipts £10. 12s. 4d.; April 1, 1904, ditto £11. 9s. 1d.—increase, 16s. 9d.; April 1, 1903, passengers carried 73,034, April 1. 1904, ditto 77,267—increase, 4,183; April 1, 1903, mileage 15,474, April 1, 1904, ditto 13,832—decrease, 1,642.

**Swansea.**—At the last meeting of the Corporation the Tramways Committee recommended, on the question of the new tramlines overlaying the gas-mains, the adoption of the sub-committee's report, which advised that arrangements be made with the gas company for the relaying of any gas-main and service pipes where the mains are endangered, or the supply of gas from the mains interfered with; and that the surveyor be instructed to confer with the company as to the latter. The Corporation was further asked to confirm a recommendation that an offer of £6 640. 10s. be made to the company in respect of the electrical mains and works installed in Neath-road, which amount is calculated on the cost price of the works—viz., £8,737. 10s. 8d.—less 6 per cent. per annum for four years on account of depreciation.

**Middlesbrough, Stockton, and Thornaby Tramways.**—The Select Committee of the House of Commons on resuming consideration of the Middlesbrough, Stockton-on-Tees, and Thornaby Electric Tramways Bill, promoted by the Imperial Tramways Company, decided to pass the preamble, subject to the conditions that the Corporation of Middlesbrough should have a proper protective clause as regards the workings in their borough, and that the period for purchase in the Bill shall be 25 years, the purchase to be as of a going concern. Sub-Section 9, called the Thornaby clause, and the words relating to betterment in Clauses 9 and 31, have been struck out. It is proposed that the cars should pass toll free, as proposed in Clause 31, and that the amount to be paid for freeing them from toll should be settled by an arbitrator.

**Leeds.**—A meeting of the Leeds Tramways Committee was held yesterday afternoon. Mr. R. A. Smithson (chairman) presented the annual statement of accounts for the year ended March 25 last, showing that the gross profits for the year were some £12,000 in excess of the previous year. After payment of interest and sinking fund and depreciation charges, which amounted to some £18,000 more than the similar charges for the previous year, the net surplus was about £56,000. The total increase in the revenue as compared with the previous year was £15,000. On the track renewals and repairs alone there was an increased expenditure of over £8,000. The increased amount for redemption of the debt was over £12,000.

**Ayr.**—The County Council have resolved to oppose the Corporation's provisional order for an extension of the system from Prestwick to Monkton. Halfpenny stages on the tramways at Prestwick have been inaugurated. Hitherto the ½d. stages have been confined to the system within the burgh. For the financial year ending May 15, the total receipts of the Corporation tramways amounted to £14,346, as compared with £14 160 in the previous year, and the passengers carried numbered 3,316,380, as against 3,201,586. There was a considerable increase in the car miles run, the total being 353 973, as against 336,049, and the earnings per car mile showed a decrease, being at the rate of 9·7d., as against 10·11d. last year. Although the mileage was greater, the amount of current used showed a decrease, the total being 324,137 units, as compared with 335,859 units in the previous year.

**Blackpool and Garstang Light Railway.**—The Blackpool and Garstang Light Railway Company will apply to the Light Railway Commissioners for an amending order as follows: to extend the time limited by the Blackpool and Garstang Light Railway Order, 1901, and, if necessary, to revive the powers for the compulsory purchase of lands for the purposes of the said order, and to extend the time limited by the said order for the completion of the railways and works thereby authorised. To change the name of the company incorporated by the said order. Copies of the draft amending order can, on and after the 31st inst., be obtained at the office of Mr. H. P. May, 5, Clinton-street, Blackpool, and Messrs. Sherwood and Co., 7, Great George-street, Westminster, S.W. Any objection to the proposed application must be sent to the Secretary, Light Railway Commission, 54, Parliament-street, London, S.W.

**Birmingham.**—The Tramway Committee have further considered the question of tramway extension. The chairman informed the Press that the draft report dealing with the subject had been approved, and would be submitted to the Council at a meeting to be held on May 31. The question of an arrangement being made with Aston for through running was stated to be still under consideration. While there was hope of such an arrangement being arrived at mutually satisfactory to both Birmingham and Aston, the statement made that a basis of terms had been agreed upon was officially denied. The committee decided to place on the Steelhouse-lane route a new car of the Liverpool pattern as an experiment. It is the intention of the committee, however, to see other patterns of cars before making a final selection, and for this purpose Alderman Beale, with the tramway manager, has just visited Nottingham. The route from Station-street to Victoria Park is to be electrified.

**Aberdeen.**—The returns of the tramways for last week show a revenue of £1,219. 6s. 1d., compared with £960. 0s. 3d. in the same week last year, being an increase of £259. 5s. 10d. In 49 weeks the total increase in receipts has been £12 083. 19s. 6d. The expenditure for the week amounted to £573 8s. 11d., compared with £371. 18s. 2d., an increase of £201. 10s. 9d. In 49 weeks the increase in the expenditure has been £7,748. 11s 3d. The number of passengers carried was 290,208, compared with 227,959, and the gross earnings per mile were 10d., compared with 11·2d. in the same week last year. In 49 weeks the total receipts have been £58 923. 4s. 10d., compared with £46 839. 5s. 4d., being an increase, as stated, of £12 083. 19s. 6d. In the same period the expenditure on wages and electricity has been £24 792. 2s., compared with £17,043 10s. 9d., being an increase of £7,748. 11s. 3d. The deputation appointed to visit various towns in the south so as to report on the question of top-covered cars has returned to Aberdeen, and a specification is to be drawn up embodying the best points in the various systems from which it is hoped to produce a very useful top-covered car at a reasonable cost. A section of the Dee-side route, belonging to the Aberdeen Suburban Tramways Company, Limited, is expected to be completed by the first week in June, and the Don-side section a little later.

**Newcastle.**—The solicitors for the company have addressed the following letter to the town clerk: "Dear Sir,—We have duly received your letter to us of the 13th inst., informing us that the Parliamentary and By-laws and the Tramways Committees of the Corporation have considered the proposals (alternative 2) made by our clients, and suggesting further amendments, which, if agreed to by us, those committees are prepared to recommend the Council to accept. It must be obvious to your committees that the directors of the company have in any arrangement to consider both the interests of the public and those of the company. The interests of the public clearly demand that there shall be a consecutive service at all points between Shields and Newcastle. Your modifications of our suggestions make such a service impossible, whether the Corporation or the company were to conduct it. The fact that the riverside manufacturers between Shields and Newcastle, employing nearly 23 000 men, have signed a petition in favour of such a through service, shows the importance of it to the whole district. We think it was made quite clear to the committee at the last interview that alternative 2 was proposed with the view of meeting as far as possible the wishes of the Corporation, and contained the minimum of the terms to which our clients were prepared to agree. They regret that the committees should have made suggested amendments which so far modify these terms as to preclude the possibility of their acceptance by our clients.

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We fear that, having regard to the great divergence between the company and the Corporation, no useful purpose can be served by the directors attending at the town hall again to-morrow afternoon. Our clients very much regret that the efforts which they have made to arrive at a solution of the difficulties at the invitation of the counsel representing the Corporation before the committee of the House of Lords, have apparently not so far met with success." The Council will meet next Thursday to fully consider the matter. The estimated expenditure for the ensuing year on revenue account and capital account amounts to £203 859 and £156 814 respectively A proposition that £20,000 be p ovided for depreciation has been defeated. A further extension of tramways has been opened for traffic on Welbeck-road. The length of the extension is about one mile.

**London County Council.**—The consideration of the County Council's Tramways and Improvements Bill by the Select Committee of the House of Commons was concluded last week by the sanctioning of a short piece of line from Trafalgar-road, Greenwich, in the direction of the Blackwall Tunnel. The Bill proposed the continuance of the line through the tunnel, so as to connect the north and south systems of tramways, but the committee rej cted that part of the scheme. At the last meeting of the Council the Highways Committee recommended that the rebuilding of a portion of the existing carsheds and the erection of workshops at Camberwell be executed by the Works Committee at a cost of £19,000, and that the laying down of rails inside the sheds, the construction of conduits, and the paving of tracks be carried out by the tramways permanent staff, the cost being estimated at £2,000. A supplemental vote of £4,500 was asked for in connection with the Tooting electrification, this excess representing additional works. The plant at Southwark for working the tramways in that neighbourhood will be rather larger than originally intended. Mr. A. P. Trotter, on behalf of the Board of Trade, has inspected the Council's sub-stations, and made recommendations for ensuring safety, for the observation of which the committee have given strict instructions. It was also recommended that sanction be given to the Regent's Park Station of the Baker-street Railway, so far as Section 48 of the Baker-street and Waterloo Railway Act, 1903, is concerned. At Wednesday's meeting of the Camberwell Borough Council the Tramways Committee recommended that a memorial from the Camberwell Trades and Labour Council, praying that representations be made to the County Council as to the necessity for a through service from the bridges to Greenwich, *viâ* Camberwell, be favourably considered. At the last meeting of the Stoke Newington Borough Council communications were presented from the County Council and the Board of Trade. The first stated that, in view of the cost which would be involved by the widening of High-street, and the time which must elapse before it could be effected, the Council was of opinion that the tramways should, in the first instance at any rate, be reconstructed, for the length affected, as single lines with an interlaced slot; and the second announced that the Board of Trade had approved in principle the underground conduit system of electric traction as proposed by the County Council, but that it was unable to entertain the questions of the doubling of tramways and the widening of roads on the County Council's present application. The electrification of the section from Kennington to Brixton has been practically completed, the working having been executed in less than six weeks, no withstanding a strike. The section of the road from Brixton Station to Streatham is to be started at once, and it is hoped to have the electric cars running over the whole route within a comp'e of months. The B ard of Trade have approved of the general plans for the reconstruction for electric traction of the tramway lines in the North and E st of London, the c nduit system being fixed upon The first part to be undertaken is that from Theobald's-road to the London Docks, with other sections to Stamford Hill, Pop'ar, etc. The new system will be worked from the station now being erected at Greenwich.

## LIGHTING AND GENERAL.

**Maidstone.**—The electric light accounts show a profit of over £300 for the past quarter.

**Sale of Plant.**—Particulars of a sale of electric light plant will be found in another column.

**Londonderry.**—The Lighting Committee are experimenting with Nernst lamps for street-lighting.

**Caerphilly.**—The Board of Trade have approved an electric lighting scheme for the Caerphilly district.

**The Ferranti Meter.**—The Board of Trade have approved of the Ferranti patent alternating current meter.

**Southgate.**—The Board of Trade have granted the provisional order applied for by the Urban District Council.

**Bolton.**—The Corporation Electricity Committee have voted £6,818 out of the past year's profits in relief of the rates.

**Spalding.**—The Council will in August consider the advisability of applying for an electric lighting provisional order.

**Nelson.**—An enquiry was held yesterday into the Council's application to borrow £25 000 for electric lighting purposes.

**Middlesbrough.**—An enquiry has been held into an application of the Corporation for sanction to borrow £20 000 for extensions.

**Sale of Business Site.**—Particulars of a sale of over four acres in the heart of Hunslet, Leeds will be found in another column.

**Dalton.**—The Urban District Council have sealed a supplemental agreement with the Urban Electric Supply Company, Limited.

**Mirfield.**—The District Council are negotiating with the Yorkshire Electric Power Company with regard to the supply of electricity.

**Heywood.**—The consumption for the past year was 18,078 units, against 14,626 units for the previous year, an increase of 3,452 units.

**North-Western Electricity and Power Gas Bill.**—This Bill has passed Mr. J. W. Lowther's Committee of the House of Commons.

**Bridgend.**—The electrical engineer (Mr. F. C. Williams) has been instructed to report whether he considered the arc lamps satisfactory or not.

**Southwark.**—The discussion on the electrical engineer's report with regard to consumers' complaints, etc., has been adjourned for a month.

**Willans and Robinson.**—The registers of debenture stock-holders and of transfers will remain closed, prior to the payment of interest, to May 31.

**Stamford.**—The Town Council have agreed that the Urban Electric Supply Company should supply five arc lamps for three years at a cost of £14 per lamp per annum.

**Boston.**—The surveyor has been authorised to visit such electric lighting stations as he may consider advisable before preparing his report on the electric lighting of the town.

**Maesteg.**—Mr. Herbert Lewis has been asked to furnish a report upon the steps to be taken with regard to the Council's electric lighting order, which expires at the end of 12 months.

**Newcastle-upon-Tyne Electric Supply Co.**—We are informed that the recent issue of the ordinary shares of the above company were over applied for to the extent of 65 per cent.

**Islington.**—The permanent staff of the electric lighting department is to be increased to 108 with wages at £199 per week. A new main for power supply is to be laid at a cost of £150.

**Wisbech.**—The Council are considering a recommendation of the Electric Lighting Committee for the acquisition of a site for the generating station and a supply of water thereto.

**Lichfield.**—Although the City Council have failed to secure the extended electric order applied for, they have succeeded in getting the time for the old order extended until March 31 next.

**Gillingham.**—An enquiry has been held into the Town Council's application for sanction to borrow a further sum of £20,000 for the purpose of extending their electric light undertaking.

**Western Telegraph Co.**—The directors have declared an interim dividend, payable June 24, of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31 last.

**Accrington.**—The loss on the past year's working of the Accrington electricity works is £876, compared with £1 323 in the previous year. There has been an increase in the sales of electricity of 44¼ per cent.

**Chester.**—The Council have referred to the town clerk a letter claiming on behalf of Mr. Francis Thursfield, resident engineer of the electricity department, fees for consulting work performed for the Corporation.

**Branch Offices.**—Messrs. Siemens Bros. and Co., Limited, have removed their cable, railway signalling, and patents departments offices into larger premises at Queen Anne's-chambers, Broadway, Westminster.

**Parliament.**—The Order Confirmation Bill and Electric Lighting Provisional Orders (No. 6) Bill has been read a second time in the House of Lords, includes Gainsborough, Kirkby-in-Ashfield, Barry, Caerphilly, etc.

**Blairgowrie Telephones.**—Forty-five subscribers have been enrolled for Blairgowrie and Rattray and 13 in Coupar Angus, and more are expected. The postal authorities are expediting the introduction of the system.

**Pemberton.**—We learn that for the year ending March, 1904, as against the year ending March, 1903, the output of the electricity department was doubled, and the number of 8-c.p. lamps connected increased from 6,500 to 9,700.

**Dewsbury.**—The Dewsbury and District Tradesmen's Association have been considering the local question of electric light charges, and have decided to ascertain the meter rents and prices charged in the principal towns in the West Riding.

**Hampstead.**—The borough accountant's statement shows that the total income from the electric lighting undertaking for the year ended at Lady Day was £57,710. 12s. 6d., as compared with £47,332. 13s. 5d. for the preceding 12 months.

**Stockton.**—The annual report of the electricity works shows a steady progress. During the year 353 958 units were produced at a cost of £3 149. 4s. 3d., as compared with 298,980 units produced the previous year at a cost of £3,158. 17s. 10d.

**Liverpool.**—At the last meeting of the Electric Light and Power Committee it was decided to recommend the Council to apply for sanction to the borrowing of the further sum of £400,000 for purposes connected with the supply of electrical energy.

**Stirling.**—The Town Council have resolved to approach the Secretary for Scotland for authority to borrow £4,300 for probable extensions in connection with the electric lighting of the town during the next three years. The sum already borrowed is £37,000.

**Dorchester.**—The Town Council have compensated Mr. W. J. U. Sowter, the late resident borough electrical engineer, who has been appointed electrical engineer at Bray at £240 per year, for his services in connection with the now collapsed electric lighting scheme.

**Ystalyfera.**—Negotiations have been in progress between Mr. D. W. Davies and the Postmaster-General with a view of procuring telephonic facilities for Ystalyfera and the surrounding districts. Efforts are being made to secure an exchange for Ystradgynlais.

**Caledonian Water Power Electric Co.**—A company is being formed with the object of developing and utilising various water powers, and to construct works for the purpose of generating electrical energy at places in the counties of Argyll, Perth, and Dumbarton.

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**Swansea.**—There are now 510 subscribers, with an equivalent of 54,989 8 c.p. lamps, 39 125 of which are for lighting, 14,983 for power, and 821 for heating; 509 8 c.p. lamps have been applied for since last report. The question of lighting side streets with Nernst lamps is under consideration.

**Grimsby.**—Mr. Vignoles, electrical engineer, in his last report states that the number of units supplied during the past month were: for traction, 35,079—an increase of 6,320 on last year; for public lighting, 6,724—an increase of 171; and private consumers, 22,108—an increase of 8 692.

**Bredbury and Romiley.**—The Board of Trade are enquiring as to the steps taken to carry out the undertakers' obligations under the Electric Light Order, 1900. A sub-committee of the Electric Lighting Committee is to interview the Stockport Lighting Committee in connection with the matter.

**Hampton.**—An offer from the Twickenham and Teddington Electric Supply Company to carry out the experimental lighting in Burton's-road, on condition that the Council would undertake to give the company the contract for lighting the road should the lighting prove satisfactory, has been deferred for a month.

**New Issue.**—The London United Tramways Company are issuing to the shareholders 25 000 new preference shares of £10 each at a premium of 10s. per share. The existing preference shares with which they are to rank are quoted at £11. 5s. each, so that allottees stand to gain 15s. per share over their bargain.

**Hull.**—The Electric Lighting Committee have completed their plans for constructing a line from the Sculcoates-lane power station to the Hull and Barnsley Railway line, for the purpose of carrying coal direct from the railway into the station yard, and thus save the cost and delay from the hauling of the coal in carts.

**Soothill Nether.**—The Yorkshire Electric Power Company propose to lay cables along Wakefield-road, High-road, Old Bond and Owlet-lane, at a depth of not less than 2ft., and the West Riding county surveyor has recommended that the cables should be laid under the footpaths and roadside wastes where possible.

**Devonport.**—The demand for electricity has steadily grown, and Mr. Banbury, in his last report, states that the loss of £3,034, which had accumulated in previous years, would now be reduced to £1,119. The clear profit has thus been £1,915, and in spite of proposed reductions in the price of current, increased success is assured.

**Chatham.**—The borough surveyor has prepared an estimate of the cost of lighting the High-street by electricity and the fixing of the necessary columns. The electric light company will be asked to revise the prices quoted. Application will also be made to the Kent Electric Power Company as to the terms upon which they are prepared to undertake the work.

**Supply of Electricity Bill.**—This Bill, the object of which is to carry into effect the recommendations of the Select Committee appointed in 1898 and presided over by Lord Cross, provides for the compulsory acquisition of land for generating stations, and removes the existing veto of the local authorities, but reserves their right to be heard. The Bill was read the second time on May 14.

**Compagnie Francaise des Tramways Electriques et Omnibus de Bordeaux.**—A dividend for the year 1903 has been declared as follows: 8 40fr. on registered shares by endorsements on certificates; 8 09fr on bearer shares against Coupon No. 5. The company also announces that 160 shares have been drawn, and are now payable at 298fr. per share, the holders also receiving a dividend share.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of £116 363 4 per cent. mortgage debenture stock (redeemable); Edmundson's Electricity Corporation's further issue of 6 per cent. cumulative preference shares of £5 each fully paid.

**Walsall.**—The total number of consumers supplied on April 30 last was 341. The total units generated at the station amounted to 119,634 Other figures are: total output from the main generators, 116,826 units; total units from the transformers, 90,056 (estimated); total units registered on the meters, 101,189. The machinery was run for 685 hours. The wages paid amounted to £125. A 4in. main is to be laid at a cost of £413.

**Longton.**—The output of electricity during April was 7,391 units, being an increase as compared with last year of 11 per cent. The manager has reported that two robberies from slot meters had occurred during the past month. In one case the offender had been convicted and sent to prison for one month, and in the other case there was not sufficient evidence to justify a prosecution, but the amount taken from the meter had been refunded.

**Glasgow.**—The minutes of the Telephone Committee, presented to the Council last week, stated that it had been agreed that the committee should ask the Corporation to consider whether the several departments of the Corporation, other than the fire brigade and police offices, requiring telephones for public service should not take such telephones from the telephone department of the Corporation only. This minute was, however, not approved.

**Newton Abbot.**—At the Urban District Council meeting on Tuesday it was reported that the Board of Trade refused to insert in the company's order conferring additional powers a clause embodying the agreement existing between the company and the Council fixing the price of the current at 7d. instead of 8d. per unit for a certain number of hours per quarter, and 3d. instead of 4d. per unit as the reduced price when the maximum number of hours had been reached.

**Edinburgh.**—The Electric Lighting Committee on Wednesday agreed to recommend the Council to reduce the charge for electric energy for private lighting from 3½d. to 3d. per unit. It was reported that from April 14 to May 12 9,467 applications for lamps were received, as against 8,915 in the corresponding period last year. The total number of applications for the year from May 15, 1903, was 112 516, as against 110,423 the previous year.

**Belfast.**—Mr. M'Cowen, in his annual report for the year ended March 31 last, shows a gross profit of £17,558 on the working of the undertaking, or, after deducting interest and sinking fund and other necessary yearly items, a net profit of £6,128. The price of current has been reduced from June 1 last, and the total cost of production, exclusive of interest and sinking fund, now stands at 1·032d. per unit. The electrical energy sold during the year came to 2,255,579 units, as compared with 1 665,560 units in the previous year.

**Pudsey.**—The Corporation are treating with a local syndicate for the lease or sale of their provisional order. The proposed company would take current in bulk from the South Yorkshire Electric Supply Company at the borough boundary, at about 1¼d. per unit, and distribute it in the town. The Corporation would be allowed to purchase the undertaking at any time at an arranged valuation and on payment of 6 per cent.—or the difference between what has been paid and 6 per cent.—for every year the company has been in existence.

**Hove.**—An offer has been received from the Hove Electric Lighting Company, Limited, to supply the Corporation with the necessary current in bulk at the distributing station to be situate at the Hove boundary in New Church-road, at the rate of 4½d. for the first hour and 1¾d. afterwards, subject, when the quantity shall amount to 250,000 units in any one 12 months to a discount of 10 per cent. The committee favoured the acceptance of this offer. After discussion, it has been decided to refer the whole question of the supply of current for Aldrington to the General Purposes Committee.

**Huddersfield.**—The Longwood Gas Company have deposited in the Private Bill Office of the House of Lords petition praying to be heard by counsel against the Corporation provisional order when the committee stage is reached. The charge for electrical energy for motive power was reduced on Wednesday to 2d. per unit for the first two hours the energy is used each day and 1d. per unit afterwards; but if a consumer guarantees to use the motor at half its full load for eight hours per day (300 days per annum), the charge will be 1d. per unit for all current consumed. The charge for electricity for lighting purposes remains unchanged.

**St. Marylebone.**—Lord Brougham's Committee on Monday concluded the consideration of the St. Marylebone Electric Lighting Bill, which has been opposed by the Gaslight and Coke Company and by the London County Council. A consultation between counsel resulted in the adoption of Clause 34, altered so as to read as follows: "There shall not be charged against the general rate in respect of street-lighting or other municipal purpose for which the energy shall be employed any larger amount than is charged to ordinary consumers using energy during the like hours of supply." The Bill as amended was ordered to be reported to the House for third reading.

**Bray.**—The new plant consists of a Browett and Lindley engine, working at a pressure of 120lb. per square inch, coupled to an 18-pole 150-kw. alternator of 400 revolutions. Its final erection was superintended by Mr. Wilmhurst for Messrs. Johnson and Phillips, while the finishing touches were put to the engine under the guidance of Mr. E. H. Bayley, of Manchester, for Messrs. Browett and Lindley. Mr. Alex. Frazer was the contractor for the building. The specified test of 10 hours' run was carried out on Saturday, with excellent results, the maximum temperature reached being only 110deg. F. Mr. William Brew, B.Sc. (Lond.), M.I.E.E., superintended the tests on behalf of Mr. Robert Hammond, the consulting engineer.

**Electric Fire-Alarms.**—A very large installation of electric fire-alarms is being installed by the May-Oatway Fire Appliances, Limited, in the works of Messrs. J. and P. Coates, Limited, of Paisley. This installation will serve to protect no less than 60 separate buildings. The introduction of these electric alarms is the more interesting because most of the buildings are already protected by automatic sprinklers. The firm evidently recognise the fact that the more prompt alarm given by the electric system is of great value, as it allows the works brigade to get together, and often to put the fire out, before the temperature has reached the point required to release the automatic sprinklers. The installation will involve the use of 18 automatic telegraphs, and the central fire station equipment will be as extensive as any in Scotland—with the single exception of Glasgow.

**National Electrical Contractors' Association.**—The annual meeting of the Northern Section of the National Electrical Contractors' Association was held at the Hotel Metropole, Leeds, on Saturday. Mr. E. C. Wallis (Leeds) presided, and representatives from Newcastle, Leeds, Huddersfield, Manchester, Blackburn, Liverpool, and London were present. The annual report stated that the association at present consisted of 64 members. The officers for the ensuing year were elected, and Mr. Wallis vacated the chair, which was taken by the new chairman, Mr. J. McDermott (Manchester), who gave a short address on the good work done under the leadership of his predecessor, and asking for the help of all members in rendering the next year successful. An extraordinary general meeting was afterwards held to consider the new scheme of reconstitution.

**Lowestoft.**—The Town Council have adopted the Electric Lighting Committee's report on the question of charging a universal flat rate for current and for lighting, which recommended that no more demand indicators be purchased, but that for lighting purposes all future consumers be charged a flat rate of 5½d. per unit, and that all consumers now on the maximum demand system who desire to be charged at a flat rate be charged at a rate of 5½d. per unit for all current consumed. With reference to the proposed railway siding to the works, the engineer submitted a plan, and reported that the estimated cost is £1,200, which the railway company will require the committee to pay, in addition to which a small electric locomotive would be required at a cost of £400. Last year the cost of bunkering and carting coal was £266. 13s. 4d. The further consideration of the matter stands deferred.

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**Hammersmith.**—On Wednesday it was reported that since the last Council meeting 15 additional consumers had been connected, representing a maximum of 412 8-c.p. lamps, that seven customers had been disconnected, and that the present number of consumers taking current from the mains is 1,470. The engineer having reported that with samples of Crynant hard dry coal, which had been tendered for at 16s. 3d. per ton, and showed considerable economy compared with the Fforchwen coal supplied by Messrs. Cory and Son, and that there had also been considerable difficulty in obtaining supplies of Fforchwen coal recently, it was recommended that the engineer be authorised to obtain such Crynant coal as may be necessary during the next 12 months, at the rate named.

**Cardiff.**—At a special meeting of the Electrical and Lighting Committee last week certain information obtained from other towns on the lighting of streets by incandescent gas lamps was considered, and also an offer made by the Cardiff Gas Company to light James-street Docks, on that principle. Mr. Ellis, the electrical engineer, presented a report showing that in nearly every case where incandescent gas lamps were in use the manufacture of gas was in the hands of the Corporation. After discussion, it was decided to test the incandescent burners in six of the existing 150-c.p. lamps for the better lighting of James-street. Mr. Ellis, in putting before the committee the necessity for providing more plant at the power station, said that the town hall would require 8,000 lights and the law courts 4,000 lights. He calculated that for Cathays Park altogether some 30,000 lamps would have to be provided.

**Yarmouth.**—The electrical engineer has reported as follows on the percentage of current consumed on the part of and charged to the Corporation, compared with the total current sold for the six months ending Sept. 30, 1903: total income from all sources, £6,113. Public lighting, £611. 10s.; tramways, £1,104. 4s.; 29 other Corporation accounts, £746. 9s. 5d.—£2,459. 3s. 5d.; total consumed by Corporation, 40 per cent. Total income from private lighting, £4,400. 6s. Corporation private lighting, including pier gardens, town hall, hospital. fishwharf, etc., £746. 9s. 5d; total consumed by Corporation, 16·7 per cent. The consideration of a resolution of the Tramways Committee requesting the Electric Lighting Committee to favourably consider the question of supplying the tramway service with electric current at a reduction of 2½d. to 2d. per unit after a consumption of 100,000 units has been postponed for six months.

**Gravesend.**—The Town Council have adopted a report stating that enquires are being made with a view to adopt some system of free wiring in conjunction with slot meters. The two-rate system of charging consumers has been adopted. As regards hours of supply, during the six months ending Sept. 30 the high rate will be in operation from 6 p.m. to 10 p.m., for the remainder of the year it will commence at 4.30 or 5 p.m. Meters are to be bought as required, and let out at a meter rent of 5s. per quarter, the charge for current to be 3d. and 1d. The engineer has reported that if the steam generated by the destructor is to be of value it will be necessary to materially increase the amount of refuse burnt daily; at the present time it is being burnt much more quickly than it is received, necessitating coal-firing. Arrangements are to be made with neighbouring authorities for the destruction of their refuse. Incidentally, we learn that the the cost of the public arc lamps is £23. 5s. per annum.

**Bo'ness.**—The Town Council have been informed by the Scottish Office that the application of the Town Council for reconsideration of his refusal to consent to a loan for the purpose of the Council's electric lighting scheme was being kept fully in view, but at last week's meeting the Provost said there seemed to be no hope now of altering the Secretary for Scotland's decision. They would now have to reconsider the matter in the light that they would not now have the general installation in time to give a supply of electricity to the new town hall and Carnegie library and new infectious diseases hospital, which buildings had all been fitted up ready to receive the current, and in view of that he proposed "that the Town Council take immediate steps for providing an electric light installation for the town hall, library, and hospital." It is proposed to employ an expert to tap the flow of their 10in. pipe from Bo'mains, and ascertain the amount of pressure with a view to providing driving power for the electric light installation.

**Power Installation.**—Messrs. B. Dellagana and Co, Limited, recently decided to equip their electrotyping, etc., works at Salford throughout with electric motors. In view of the reduction in the price of power supplied by the Salford Corporation it is anticipated that a material saving in labour and cost of power will be effected, apart from the greater convenience in running and cleanliness in their works and equipment. The plant consists of electro-plating dynamos, engraving machines, planning and routing machines, saws, and arc lamps for photographic processes. The dynamos are being driven by separate motors and the machinery is divided up into sections, each line of shafting being driven by a separate motor. The motors consequently are small, ranging in size between 1 h.p. and 3 h.p. By this arrangement, according to the Salford Corporation conditions, they are able to take a 220-volt supply, the motors being equally distributed on both side of the three-wire system. The contract for the motors and switchgear has been placed with Messrs. Walker and Hodgetts, Limited, of St. Simon's-street, Salford.

**Norwich.**—The electricity department have commenced their experiments with Nernst lamps for street lighting. The Council took over the electricity department from the beginning of 1903 and the first three months were taken by themselves. Comparisons we e between the clear year of 1902 and from March, 1903, to March, 1904, show that the undertaking is still progressive. In 1902 the receipts from current were £23 192 last year they were £26 972. The total receipts show an increase of £3,799. The sales amounted to 1,819,708 units, against 1,481,179 in 1902. To produce this the department has expended in coal and oil £179 less than the previous year. This was attributed to the larger engines and the water softener. Against £1,140 in 1902 they were charged £1,416 for rates and taxes. Wages and salaries were together £31,051, against £32,096 the year before. In 1903 there was the salary of the managing director £250, and the secretary £150. The increase in the receipts amounts to about 18 per cent., against an increase of less than 5 per cent. in the expenditure. There is a trading balance of £15,147. Interest and sinking fund took off nearly £12,000. The balance is stated at £4,432.

**King's Lynn.**—The electrical engineer's last report shows that during April applications were received for 159 additional lamps of 8 c.p., or equivalent, making a total of 18 876 lamps from private consumers, while the number of consumers had increased from 456 to 462. The town clerk last week reported the receipt of a letter from the Local Government Board in reference to the application of the Town Council to borrow £11,500 for purposes of electric lighting, and submitted sanction of the Board to the borrowing of £3,172 required to defray the cost of additional works which have been carried out, and £4 807 in respect of the proposed new works. The latter sum represents the total estimated cost of the new works (£5 494), less £5 for removing the gas-engine, which is to be superseded, and £682, the amount of debt outstanding on that engine. As regards this balance, the Board asked that an endeavour should be made to obtain from Prof. Robinson further particulars. It was resolved that the further particulars be obtained and forwarded to the Board. The engineer has also submitted the following statement: Units generated, March, 1904, 41,418 (1903, 35,244); units sold to private consumers (light and power), 20,541 (12 852); units sold at power rates, 9,953 (3 076); cost of fuel, stores, repairs, and wages at station, £120. 12s. 1d. (£106. 4s. 5d.); cost of units generated, 0·6988 l. (0 7233d.); wages of lamplighters and outside staff, £18. 16s. 3d. (£19. 8s. 5 l.).

**Portsmouth.**—At the last Town Council meeting a report by Mr. Manville (to which we have already referred) was submitted which showed that there were two weak points in the existing arrangements of the station—viz, the inadequacy of the supply of condensing water, and absence of a duplicate steam supply to the two newer turbine units. The total cost of the work he recommended was estimated at £5,000, and the committee recommended that this work be carried out, and that application be made for the required loan. Alderman Ellis, in moving the adoption of the report, said the last year had been one of the most successful they had ever experienced. The number of units generated was considerably over three millions. In the previous year it was about 2½ millions. The total revenue was £41,175, as against £35,280, a difference of £5,893 in their favour. The increase in the expenditure meanwhile had not exceeded £700. There had been a great many savings. The engineer had saved £300 in the boiler-house, and he had also effected a saving in the outdoor staff. They had also saved over a quarter of a million gallons of their friend's (Sir John Baker's) water. He thought that with such a favourable balance-sheet the Council would see that they would be quite justified in expending the additional £5,000. The report was carried. The balance-sheet of the telephone department for the year ending March 31, 1904, shows working expenses, £3 899; repayment of principal and interest, £1,464; income, £6 588; and profit, £1 225, which latter sum. added to the profit made in March, 1903, of £25, gives a total of £1,250.

**Bath.**—The accounts of the electric lighting undertaking for the year ended March 31 show a gross profit of £7,652 against £5,895 in the previous year. This is augmented by £1,233, being the balance of the previous year's accounts, making £8,886 in all. The interest on and repayment of loans absorbed £6 584. 1s. 10d., and leaves the committee £2,302 to allocate. The committee have started a reserve fund, placing to its credit £1 233 and carrying forward £1 068. The reserve fund has already a charge against it—£420, the cost of the opposition to the Somerset Power Bill, so that the balance on that account is £813. The committee have passed the following resolution: "That the congratulations of this committee be tendered to the chairman upon the satisfactory result of the business of the department to which he has so largely contributed by the efficient discharge of his duty." An extension of the direct-current main is to be made provided that two prospective consumers will guarantee £6 per annum each. The engineer has been authorised to purchase an alternating-current voltmeter, a new testing set at a cost of £25. 15s. less 10 per cent., and to instal two Nernst lamps of the intensive type giving 250 c.p. light. Applications for new connections have been received for 533·8-c.p. lamps. A transformer pillar is to be removed, and an underground sub-station erected at a cost of £124. 10s. In view of the complaints as to the overloading of the main supplying Alfred-street sub-area, and having regard to the fact that a largely increased demand will shortly arise in this district, it has been decided to convert this area to continuous current at an estimated cost of £700.

**London County Council.**—On Tuesday it was agreed to lend the Woolwich Borough Council £1,000 for assisted wiring of consumers' premises for electric lighting, etc. The Highways Committee recommended that application be made to Parliament in the session of 1905 for powers to enable local authorities in London who have now, or who may hereafter obtain powers to supply electric energy, to wire and fit consumers' premises for the use of electrical energy, and to obtain loans for this purpose. Tenders for the supply of switchgear and water-tube boilers were referred to the Tramways Committee for consideration and report. Notices under Electric Lighting Acts and orders were agreed to as follows: From the Blackheath and Greenwich District Electric Light Company of intention to lay low-tension mains along portions of S. John's-park and Charlton-road; Brompton and Kensington Electricity Supply Company, high and low tension mains along a portion of Cranley-mews; Charing Cross and Strand Electricity Supply Corporation, mains and build a street box in Chichester-rents; City of London Electric Lighting Company, mains along a portion of Broad-wall and Stamford-street; County of London and Brush Provincial Electric Lighting Company, low-tension mains along Earl-street; County of London Electric Supply Company, low-tension mains along portions of Redcross-street and Marshalsea-road;

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Metropolitan Electric Supply Company, low-tension mains along portions of Wigmore-street and Marylebone-lane, and high-tension mains along Crowley-road and Fernhead-road; St. Pancras Metropolitan Borough Council, mains along portions of Sidmouth-mews and Great College-street. Notices were received from the Poplar Metropolitan Borough Council under the Poplar District Order, 1893, which gives the Council no power of approval or disapproval of works.

**Leeds.**—The accounts of the electric lighting department show that the total earnings of the department are £19,707 more than they were a year ago. The working expenses increased by £6,829, but the gross profit is £12,876 more. This has enabled the committee to set apart over £10,000 more than they did last year in respect of interest and sinking fund, and even after making allowance for this sum there is a surplus of £3,430, as compared with that of £1,383 recorded a year ago. Nearly a couple of million more units were sold during the year just closed than during the preceding 12 months. The various items were as follows: receipts from sales for lighting, £66,813. 2s. 11d.; ditto for power, £8,907. 9s. 1d.; sundries, 4s.—total receipts, £75,720. 16s.; working expenses and costs incidental to change of system, £26,183. 8s. 11d.; gross profit, £49,537. 7s. 1d.; interest and sinking fund, £46,106. 17s.; surplus, £3,430. 10s. 1d.; units sold, 6,271,186; average price per unit, 2·90d.; expenses per unit including interest and sinking fund, 2·77d.; surplus per unit, ·13d.; capital expended during the year, £81,097. 4s. 7d.; total capital expended to end of year, £752,508. 16s. 3d. Appended is an analysis of the revenue of the department, and other details down to date: Lighting: number of 35-watt lamps installed at present date, 234,263; ditto at March 25, 1903, 195,835; increase during the year, 39,429 (or 20·1 per cent.). Units sold—private lighting, 4,428,657; street-lighting, 177,170; revenue, £66,813. 2s. 11d.; average price, 3·48d.; units sold per lamp installed, 20·83; revenue per lamp installed, 6s. 0·59d. Power and heating: aggregate horse-power of motors installed, 2,903; increase during the year, 1,467 (or 102·2 per cent.); units sold, 1,665,359; revenue, £8,907. 9s. 1d.; average price per unit, 1·28d.; units sold per horse-power installed, 732; revenue per horse-power installed, £3. 18s. 4d.

**London Gazette.**—A receiving order has been made out on debtor's petition in the estate of William Wenham, electrical engineer, 5 Century-buildings, London-road, Croydon, Surrey. The first meeting in the estate of John James De Lacy and Howard Kyan De Lacy (trading as De Lacy Bros.), electrical engineers, 58, Old Hall-street, Liverpool, will be held at 2 30 p m. on May 25 at the Official Receiver's Office, 35, Victoria-street, Liverpool. The Electrical Inkless Printing Syndicate, Limited, will be wound up voluntarily. Mr. A. J. H. Robertson, chartered accountant, 20, Bucklersbury, E.C., has been appointed liquidator. The Electric Light Insurance and Maintenance Company, Limited, will be wound up voluntarily. Mr. Elles Hill, chartered accountant, 79, Mark-lane, London, has been appointed liquidator. The liquidator has been authorised and empowered to consent to the registration of a new company in the name of the Electric Light Insurance and Maintenance Company, Limited, or some similar name. The estates of A. S. Johnstone and Co., electrical engineers, 57, Hope-street, Glasgow, and Alexander Scott Johnstone, electrical engineer, 57, Hope-street, Glasgow, sole partner, were sequestrated on May 10, 1904, by the Sheriff of Lanarkshire. The first deliverance is dated May 10. The meeting to elect the trustee and commissioners will be held at 12 o'clock noon on the 20th inst. at the Faculty Hall, St. George's-place, Glasgow. All future advertisements relating to this sequestration will be published in the *Edinburgh Gazette* alone. The following persons have been appointed a committee of inspection to act with the official receiver and liquidator of the Electric Timber Seasoning and Preservation Company, Limited: Herbert George de Russett, of Strothers Wharf, Woolwich; John Galloway Watson, of 11, Orchard-street, Portman-square, London, a member of the firm of Fleming and Watson; Alfred Tamsett, of The Village, Old Charlton, Kent, a member of the firm of Tamsett and Co; and John Alfred Longden, of Stanton-by-Dale, near Nottingham. Special resolutions having been passed in 1903 for the voluntary liquidation of the British Schuckert Electric Company, Limited, particulars of debts or claims must be sent to Mr. Arthur Jacob, Clun House, Surrey-street, Strand, London, W.C., by June 30.

**Acton.**—An application is to be made for sanction to borrow £2,500, being the estimated amount required in excess of the £2,500 already provided for in the application already made to the Board in connection with the erection of the electricity transforming station and residence of electrical engineer at "The Friars." Mr. W. H. Trentham, the electrical engineer to the Council, has prepared a report upon the probable demand for electricity in Acton, and the financial results which may be expected to follow. He estimates that the demand for power should be at the rate of 200,000 units per annum for the first year, 450,000 for the second year, and 500,000 at the end of the third year. The revenue during these three years on this scale would be respectively £4,296, £7,421, and £10,546. For the first year, however, Mr. Trentham estimates a loss of £1,056, as the working expenses will for that period amount to £5,352. These for the years are arrived at as follows: The Council will purchase 200,000 units at 1·79d. per unit, which will cost £1,416. Then labour (0·48d.), rent and rates (0·1d.), management (0·4d.), and oil, etc. (0·1d.), will necessitate an outlay of 1·08d. per unit purchased. Carbons and erection of 65 arc lamps for public lighting will account for another £286 (£130 and £156 respectively), which together with interest at 6½ on £44,000 capital outlay, will bring the working expenses to the figure already given. Of the 200,000 units purchased 143,840 will be retailed at a flat charge of 5d. per unit—the Council having decided to supply private consumers at 5d. per unit, and churches and chapels at 4d. per unit—which will bring in a revenue of £2,996. The balance of the 200,000 units will be consumed by the 65 arc lamps, for which £20 per lamp has been allowed, equalling £1,300 for this purpose. In the second year Mr. Trentham anticipates a profit of £246, the working expenses being estimated at £7,175 and the revenue at £7,421. During this year the Council will pay 1·972d. for the 350 000 units it will purchase, of which 293,840 will be retailed at 5d., equalling £6,121, plus £1,300 for the current consumed by the 65 arc lamps. Labour, etc., during this period will cost £1,424, and interest on £46,000 will run away with £2,875. At the end of the third year Mr. Trentham thinks the profit on the undertaking will have increased to £884, the working expenses being £9,962 (500,000 units at 2·15d. per unit, £4,438; labour, etc., £2,099; interest on £50,000, £3,125), as compared with an estimated revenue of £10,546 (443,840 units sold at 5d. per unit, £9,246; arc lamps, £1,300).

## PROVISIONAL PATENTS, 1904.

MAY 9.

**10598. Improvements relating to the conductors and rails of electric and the like railways.** Edwin Ernest Kelsey, Cardium, Lingfield, Surrey.

**10606. Improvements in dynamo-electric machinery.** Rankin Kennedy, 20, Oakwood-drive, Roundhay, Leeds.

**10623. Improvements in automatic trolley controlling device.** Horace Wintworth Nichols, 18, Fulham-place, Paddington, London. (Complete specification.)

**10646. Improvements in or relating to controlling or regulating means for electrical apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (Justus Bulkley Entz, United States.) (Complete specification.)

**10647. Improvements in bearings for the motors of electrically-propelled vehicles.** Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

**10646. Improvements in or relating to electric motor systems.** Coloman de Kandó, 111, Hatton-garden, London. (Complete specification.)

**10656. Improvements in and relating to enclosed fuses for electrical installations.** Wilhelm Fellenberg, 83, Cannon-street, London.

**10662. Improvements in or relating to the supply of current to electrically-propelled vehicles on railways.** Charles Hesterman Merz and Albert Henry Marshall, 46, Lincoln's-inn-fields, London.

**10667. Improvements in actuating mechanism for secondary electric clocks and other intermittently electrically-impelled apparatus.** Phillip Middleton Justice, 55, Chancery-lane, London. (Jamin Seth Morse, United States.)

**10672. Improvements in gas or vapour electric apparatus.** Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

**10691. Electrically-operated typewriters.** Willis Joseph Roussel and Alphonse King, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 10.

**4556a. Balancing devices for high-speed motors and machines.** Sebastian Ziana de Ferranti, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, Feb. 24, 1904.)

**10722. Improvements in and relating to reverse-current electric circuit breakers.** Leonard Andrews, 14, College Land, St. Mary-street, Manchester.

**10723. Improvements in and relating to reverse-current relays for electric circuit breakers.** Leonard Andrews, 14, College Land, St. Mary-street, Manchester.

**10727. An improved electrically-operated travelling perforating machine.** George Kirk, 100, Wellington-street, Glasgow.

**10748. Improvements in or relating to dynamos or the like.** Charles Anthony Vandervell and William Henry Wardes Proctor, 18, Hertford-street, Coventry.

**10794. Improvements in and relating to electrolytic apparatus.** Henry Spencer Blackmore and Eugene Alexander Byrnes, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**10800. Improvements in transformers.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

**10812. Improvements in overhead trolleys or collectors for electric tramway and railway vehicles.** Thomas Blaney, 6, Lord-street, Liverpool.

**10818. A device for winding up clocks automatically by means of an electric motor.** Giovanni Della Barile, 8, Quality-court, Chancery-lane, London. (Complete specification.)

MAY 11.

**10836. Improvements in registering apparatus for meters for gas, electricity, water, or other fluids.** Joshua Hindmarsh Henderson and Charles Napier Higgin, 6, Bank-street, Manchester.

**10839. New or improved device for protecting electric circuits and apparatus.** Samuel Edgar Fedden and William Joseph Howard, 22, Upper Albert-road, Meersbrook, Sheffield.

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**10837. Improvements in fuse leads for electric blasting.** Frederick Render, 6, Bank-street, Manchester.

**10849. An improved life-guard for electric tramway cars and similar vehicles.** Frederick Wagstaffe and Samuel Robert Cameron, 22, Withington-street, Cheetham-hill, Manchester.

**10858. Improvements in receiving apparatus for wireless telegraphy.** Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

**10873. Improvements in the manufacture of electric incandescent bodies.** August Voelker, 4, South-street, Finsbury, London.

**10877. Improvements in and relating to fluid-pressure brake systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10878. Improvements in devices for protecting alternating-current apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10879. Improvements in oil switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10880. Improvements in and relating to power-transmitting mechanism and method of controlling the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10882. Improvements in electric meters.** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

**10896. Improvements in electric installations.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Elektrizitäts Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany.) (Complete specification.)

**10906. Improvements in apparatus for electrically stopping railway trains.** Bernardo Lichtenfels, sen., 18, Buckingham-street, Strand, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 2, 1904.*

1903.

**10213. Automatic electrical switches.** Booker.

**10296. Means applicable to metal-sheathed electric cables for counteracting the effects of induction.** Hardingham. (Felten und Guilleaume Carlswerk Actien-Gesellschaft.)

**10342. Electrical switches.** Thomas and Thomas.

**10502. Means of electrically actuating railway points and signals.** Sykes.

**10698. Phase synchronisation in electromotors with alternating field.** Ziegenberg.

**11585. Overhead trolley or contact arms for electrically-driven tramcars.** Smith.

**11629. Electrical fuses.** Siemens Bros. and Co., Limited, and Berry.

**11846. Apparatus for transmitting synchronous and equal movements to a distance.** Siemens Bros. and Co., Limited, Hird, and Bartlett.

**12105. Automatic cut-outs for electric circuits.** Siemens Bros. and Co., Limited, and Berry.

**12310. Electric circuit controllers.** Carolan. (General Electric Company.)

**12479. Dynamo-electric generators and motors.** Jervis-Smith.

**12502. Controlling electric motors, particularly for electrically-propelled vehicles.** Siemens Bros. and Co., Limited, Siemens and Duke.

**12947. Case for electric light fuse boards and switches.** Bolton.

**13973. Electric recording instruments.** Steele and Kratt.

**14165. Electrodes of gas or vapour electric apparatus for lighting or for other purposes.** Le Tall. (Cooper-Hewitt Electric Company.)

**14731. Electrolytic separation of copper and nickel from mattes and ores.** Willis. (Shields.)

**14963. Electric furnace.** Willis (Sjosted.)

**15366. Electric safety fuses.** Martin.

**15538. Fusible electric cut-outs.** Hedges.

**16249. Telphers.** Siemens Bros. and Co., Limited, and Clift.

**17587. Manufacture of electrodes for electrolytic purposes.** Johnson. (Chemische Fabrik Griesheim Elektron.)

**19367. Insulation of electric conductors.** Pinching and Walton.

**20291. Electric fittings, such as switches or the like, having combined insulating and conducting portions.** Ritchel. (Date applied for under International Convention, Oct. 13, 1902.)

1904.

**1242. Party-line telephone systems.** Dean. (Date applied for under International Convention, June 15, 1903.)

**2273. Manufacture of magnetic material.** Hadfield. (Date applied for under International Convention, June 12, 1903.)

**2420. Trolley arms for electric cars.** Daggett.

**2766. Electric light fittings.** Irving.

**4366. Electric furnaces.** Frick.

**4369. Wireless telegraphy.** Marconi. (Date applied for under International Convention, Oct. 13, 1903.)

**5799. Electrical apparatus for separating coke and other electric conductors from cinders and other substances.** Lelarge.

**6132. Electric accumulators.** Contal. (Date applied for under International Convention, March 24, 1903.)

**6936. Voltametric balances.** Pfanhauser.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-1 |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ⅞-1 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 89-92 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | .. | ¾-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1-1⅛ xd |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 5 | .. | 1⅞-2⅛ |
| —— 5 per cent. Debentures | 100 | .. | 96 99 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | .. | ¾-⅞ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¾-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅜ 1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 93 98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference | 5 | – | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | – | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 18¼-19¼ |
| —— 4 per cent. Debentures | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary | 10 | – | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | – | 35-38 |
| —— 5 per cent. Bonds | 100 | – | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | – | ⅞-1 |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | – | 115-120 |
| Bournemouth and Poole, Ordinary | 10 | – | 11¼-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 100-103 |
| Brompton and Kensington, Ordinary | 5 | – | 10⅜-11¼ |
| —— 7 per cent. Preference | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | – | 6¾-7¼ xd |
| —— Nos. 20,001-30,000 | 5 | – | 6¾-7¼ xd |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 107-110 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5-5¼ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 103-105 |
| Chelsea Electricity Supply | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 107-110 |
| City of London, Ordinary | 10 | – | 10⅜-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | – | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5⅜ 6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 5⅜-6 |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red | 100 | – | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7⅛-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11¼-12¼ |
| —— per cent. Debenture Stock Red | 100 | – | 102-103 |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 102-106 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary | 5 | – | 1¼-1⅜ |
| —— 6 per cent. Pref. | 5 | – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 95-98 |
| Metropolitan Ordinary | 10 | – | 19¼ 20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98 101 |
| —— Preference | 4 | – | 100-103 |
| Notting Hill Electric Lighting | 10 | – | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) | 100 | – | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 1,-14,310 | 5 | – | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-101 |
| Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98-101 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | – | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| South London, Ordinary | | – | 3¼-4¼ |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 |
| —— 3½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4¼-4⅜ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4⅜-4⅝ |
| Westminster, Ordinary | 5 | – | 12¼-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Electric Railways.—** | £ | | £ |
| Central London, Ordinary | 100 | – | 91 94 |
| —— 4 per cent. Pref. | 100 | – | 98 101 |
| —— " deferred | 100 | – | 85 88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-113 |
| City and South London, Consolidated Ordinary | 100 | – | 50-52 |
| —— 4 per cent. Debenture Stock | 100 | – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 124-126 |
| —— " " " '96 | 100 | – | 120 123 |
| —— " " " '01 | 100 | – | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10 10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 4¼-4½ |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99 101 |
| Waterloo and City, Ordinary | 100 | – | 90-93 |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 1-260,007 | 5 | – | 5 5¼ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 127-132 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13¾ 13⅞ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 97-102 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 100-103 |
| —— Ord Pref. | 100 | .. | 99-102 |
| —— Non-Cum. 5 per cent. Pref. | 10 | .. | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 102 104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 | . | 98-101 |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 | – | 9-9¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10 10¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 116-119 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-2⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 4⅜-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 104-107 |
| —— Prov. Cert., all paid | 100 | – | 98-101 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | – | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 99-102 |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-12¾ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18 19 |
| —— 6 per cent. Cum. Pref. | all | – | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8¼ 8⅜ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | – | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | – | ½-1 |
| New General Traction, Ordinary | 5 | – | ½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 | – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | – | 12 12¾ |
| —— 5 per cent. Cum. Pref. | 10 | – | 9⅜ 9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | – | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-106 |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,152 6 per cent. Preference | 1 | – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 | p.c. | 100 p.c. |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | – | 103-105 |
| —— Deferred Stock | 100 | – | 87-90 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | – | 97 99 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 103 105 |
| Oriental Telephone and Electric Company | 1 | – | 15/16 1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 14 | 1,176 | 947 | + 229 | +12,313h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | " 7 | 205 | 233 | - 28 | + 82 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | " 14 | 33 | — | — | — | 1¼ | | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | " 15 | 1,035 | 961 | + 74 | - 2 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | April 23 | 263 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | May 13 | 782 | 729 | + 53 | + 314 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | " 12 | 502 | 406 | + 96 | + 392 | 17½ | 17½ | " 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | " 16 | 299 | 301 | - 2 | + 256 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·89 |
| Bolton Corporation | " 15 | 1,788 | 1,634 | + 154 | + 113 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | " 11 | 977 | 948 | + 29 | + 357 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | " 14 | 4,055 | 3,271 | + 784 | + 4,911 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | " 15 | 865 | 779 | + 87 | + 384 | 7½ | 6½ | " 31 | — | — | — | — | — | — | — |
| Bristol Tramways Company | " 13 | 4,788 | 4,704 | + 84 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | " 7 | 984 | 733 | + 251 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | " 15 | 321 | — | — | — | 8¼ | | — | — | — | — | — | — | — | — |
| Cardiff Corporation | " 14 | 1,872 | 1,704 | + 163 | + 893 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 30 | 178 | 186 | - 8 | + 264 | — | — | " 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | May 14 | 6,703 | 7,143 | - 435 | - 1,475h | 6 | 6 | " 31 | 367,225 | 45,305,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | " 15 | 2,832 | 3,084 | - 252 | - 2,092h | 6⅜ | 6⅜ | " 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork M. T. and L. Company | " 12 | 472 | 463 | - 11 | - 293 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | " 6 | 234 | 219 | + 15 | - 96 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | " 14 | 194 | 192 | + 2 | - 185 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | " 15 | 126 | 110 | + 16 | + 126h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 459 | 7·68 |
| Dublin U. T., electric cars | " 13 | 3,940 | 3,654 | + 286 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 6·06h |
| Dublin S. District, Electric | " 13 | 811 | 732 | + 109 | | | | | | | | | | | |
| Dundee City Tramways | " 11 | 789 | 785 | + 4 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | " 14 | 693 | 635 | + 58 | — | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | " 14 | 14,112 | 15,790 | -1,678 | +59,252h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | " 11 | 281 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | " 4 | 2,749 | 2,270 | + 479 | + 439 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | " 13 | 1,188 | 1,105 | + 82 | — | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | " 14 | 1,932 | 2,205 | - 213 | + 847 | 25 | 19 | " 31 | 87,707h | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | " 14 | 432 | 367 | + 65 | + 460 | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | " 11 | 126 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | " 11 | 211 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | " 14 | 5,241 | 4,813 | + 393 | + 3,215 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | " 7 | 10,067 | 9,646 | + 421 | + 4,375 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | " 15 | 1,656 | 1,603 | + 53 | + 144h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | " 7 | 10,728 | 8,483 | +2,245 | +22,034 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | " 14 | 145 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | " 14 | 11,355 | 10,529 | + 826 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | " 14 | 103 | 56 | + 47 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | " 14 | 3,518 | 3,044 | + 474 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | " 14 | 475 | 285 | + 190 | + 1,856 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | " 14 | 1,714 | 1,464 | + 250 | + 1,280 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | " 16 | 126 | 117 | + 9 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | " 12 | 403 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | " 16 | 3,974 | 3,051 | + 923 | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | " 16 | 4,573 | 4,128 | + 445 | + 985 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,936,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | " 12 | 903 | 939 | - 36 | — | 11 | 11 | " 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | " 11 | 252 | 272 | - 20 | + 127 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | " 6 | 528 | 245 | + 283 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | " 15 | 1,185 | 1,073 | + 112 | + 291 | 18·48 | 18·48 | " 31g | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | " 14 | 649 | 581 | + 68 | + 194 | 10·5 | 10·5 | " 31g | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | " 12 | 688 | — | — | — | 1⅜ | | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | " 11 | 542 | 411 | + 131 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**King's College.**—The forty-fourth annual dinner of King's College will be held at the Hotel Cecil on Monday, the 20th prox., at 6.30 p.m., the Marquis of Salisbury in the chair. Tickets (10s. 6d. each) and information will be supplied by any member of the committee, or on application to the hon. secretaries at the college.

**Private Telephone Lines.**—The Postmaster-General states that during the last two years it has been necessary to refuse to provide long telephone lines between London and places such as Manchester, Liverpool, and Glasgow for private use, owing to the difficulty of finding space on existing routes even for the new wires required for the public service. Estimates of the cost of constructing new routes for additional wires have been prepared, and he is considering whether it will be possible to supply long private telephone lines to all applicants for them.

**Hackney Municipal Enterprise.**—The electricity department of the Borough Council have just issued an illustrated pamphlet relating to the application of electricity to lighting, heating, and cooking. To encourage the use of electricity the Council are supplying energy at low rates, and detailed information is given as to its advantages and the numerous ways in which it can be employed. For heating the Council supplies a multiplicity of apparatus, from radiators and tool-ovens to shaving pots and curling-iron heaters. The pamphlet may confidently be expected to increase the number of the Council's customers.

**The American Institute.**—We have received the April number of the *Transactions* of the American Institute of Electrical Engineers, which contains papers on "Predetermination of Sparking in Direct-Current Machines," by Mr. W. L. Waters; "Effect of Self-Induction on Railway Motor Commutation," by Mr. E. H. Anderson; "The Calculation of Line Batteries," by Mr. W. E. Winship; "Wave-Form Variations of a Long-Distance Line," by Mr. G. H. Rowe; "Data and Tests on a 10,000-Cycle-per-Second Alternator," by Mr. B. G. Lamme; and "The Single-Phase Induction Motor," by Mr. W. S. Franklin.

**A German Amalgamation.**—When, rather over a year ago, a community of interests was effected for a period of 35 years between the Edison and Thomson-Houston interests in Germany, represented by the Allgemeine Company and the Berlin Union Electric Company respectively, it was reported that an entire fusion might take place. This has now been realised, the Allgemeine Company increasing its capital to 4½ millions so as to acquire the Union Company's interest. Already 95 per cent. of the latter's shares have been transferred to the Allgemeine Company, and the absorption is to be completed by the remaining Union shares being surrendered in exchange for new shares in the Allgemeine Company.

**The Benevolent Fund.**—The sixth annual general meeting of the contributors to the benevolent fund of the Institution of Electrical Engineers is to be held to-day at 5 p.m., when the report of the committee of management, with a statement of accounts and the balance-sheet to date, will be received. We have before us a copy of these accounts, which are not creditable to the members of the Institution as a whole. The income of the fund for the past year amounted to the insignificant sum of £49. 18s. This is quite inadequate to meet the calls which are likely to be made on the fund in the near future. The Institution is, of course, a comparatively young one, but we trust that more attention will be devoted to this fund in order that provision may be made which will enable relief to be given to members who fall behind under the stress of heavy competition. The work done in this respect by the Institution of Civil Engineers should induce electrical engineers to support this branch of their Institution.

**Machine-Mined Coal.**—The United States Survey has published a report by Mr. E. W. Parker on "The Production of Coal in 1902." This document shows that the machine-mined coal for that year amounted to 69,611,582 short tons, representing an increase of 20 per cent. over the previous year. The number of machines employed was 5,418, against 2,622 in 1898. Of these, 3,185 were of the "pick" or "puncher" type, 2,182 were chain breast machines, and 51 were of the long-wall design. The proportion of machine-mined coal has more than kept pace with the increased output. By far the largest quantity of the coal so obtained was produced in Ohio, Pennsylvania, Illinois, West Virginia, Kentucky, and Indiana—the States comprising what are known as the "competitive" coalfields.

**Electric Power Looms.**—The adaptability of electricity is exemplified in some of the French and German manufacturing towns where most of the work is done at home. In Lyons, a silk-weaving centre, for instance, an electric distribution scheme was begun in 1895, and some 500 looms are now supplied. For £3. 2s. 6d. a loom is provided with power and light about 11½ hours per day all the year. At St. Etienne electric driving has been utilised to a still larger extent for ribbon work. The charge for current is £3. 15s. per year, and the rental for the motor 10d. per month. In 1901 some 3,100 weavers with a total of 7,000 looms were supplied with current. In the parish of Anrath, near Krefeld, Germany, a ribbon-weaving district, an electric supply company for furnishing power and light to weavers was formed three or four years ago, and now supplies about 1,000 house workers.

**New Books.**—"Static Electricity," by H. Mason (New York: McGraw Publishing Company). The author states that his object in compiling this work is to provide a text-book on static electricity. He does not lay claim to originality, his object being to present the collective knowledge of this subject in a succinct and comprehensive form, and he has succeeded in producing a volume which possesses these qualities.—Messrs. Percival, Marshall, and Co. have just published two further volumes of the "Model Engineer" series, entitled "Patents" and "Mechanical Drawing." The former is a guide to the procedure for taking out patents and registering trade marks and designs, for which lucid instructions are given. In addition, there are chapters on the working of patents, foreign patents, and other matters. "Mechanical Drawing," by F. E. Powell, is designed as an elementary hand-book on engineering draughtsmanship for students, apprentices, and amateurs, who will find it a serviceable guide. These little volumes are priced at the modest sum of 6d.

**Electric Traction in Australia.**—Some statements have been appearing in the Australian Press lately as to the opinion of an expert being obtained upon the proposed conversion to electric traction of the suburban railways and the tramways of South Australia and Victoria. It is understood that, in principle, the late Victorian Ministry was favourable to the project, but was deterred by financial considerations from committing itself to any scheme, though willing to divide the cost of obtaining expert opinion. The new Victorian Government is said to be disposed to act independently, but no official intimation to this effect has reached the South Australian Cabinet. The Premier of South Australia has been in communication with the Victorian Railway Commissioners, and on receipt of further information from them he proposes to consult further with the Victorian Government. In regard to the South Australian tramways, the Premier has announced

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the Government's intention of acquiring the various lines at the earliest date its rights permit. If necessary, a Bill will be introduced during the present session to define the Government's powers more clearly, and to lay down the conditions for conversion to electric traction. The overhead system is favoured, but alternative tenders will be invited.

**Chinese Patents and Trade Marks.**—Attention is directed by Messrs. W. P. Thompson and Co., patent agents, to the agreement just ratified between China and the United States, and they remark that under the favoured-nation clause of the Tientsin Treaty the benefits in relation to patents now secured to the United States are equally applicable to this country. The agreement provides that the Chinese Government shall reciprocate the protection afforded in the United States to Chinese patents by establishing a patent office, and after payment of the prescribed fees, issuing certificates of protection for a fixed term of years. The American agreement also contains a clause in regard to trade marks similar to that included in the treaty of 1902 between China and Great Britain, by which the former undertakes to establish divisional offices for the protection of trade marks. In a recent communication dealing with the matter generally, Lord Lansdowne states: "A working scheme for patent and trade-mark protection is now being evolved, and in the meantime a provisional registration office for trade marks has been established at the Custom House at Shanghai, where we have a registration agent, and the Chinese courts will presumably afford, as they have done in the past, substantial protection against counterfeiting trade marks on the part of Chinese subjects."

**Wimbledon Electrical Exhibition.**—An exhibition has been proceeding at Worple Hall, Wimbledon, under the auspices of the District Council, and will continue until to-morrow night. The Dowsing Radiant Heat Company are exhibiting their luminous electric radiator, which can be turned on and off at will, so that no heat is lost in warming up or cooling down, a considerable saving of current being thus effected. We were shown the Dowsing heat and light treatment, as used on the U.S.A. hospital ship "Maine" and in many other places, by which sufferers from rheumatism and other affections of the joints can be safely subjected to a temperature of anything up to 350deg. F., and which has achieved a large measure of success. The Linolite Company are exhibiting their patent, and visitors have an opportunity of seeing what a concentrated light it supplies for the desk or for illuminating pictures. Messrs. Spearing and Stark, of Merton-road, are exhibiting a braiding machine and a large assortment of light fittings. Metzler and Co., Limited., are showing their piano player, which can be operated electrically, and another exhibit is a miniature of the Ashton Corporation cars. A good display of Maxim lamps is to be seen, and the Langdon-Davies Company have a number of their motors on view. Several of the local firms are exhibiting cooking apparatus. The exhibition, which is being attended by troops of visitors, is illuminated by Foster arc lamps.

**Alternator for the St. Louis Exhibition.**—The *Engineer* of Chicago gives a description of the alternating-current generator manufactured by the National Electric Company for the St. Louis Exhibition. The rated output is 1,500 kw. at 25 cycles and 6,600 volts, running at 83 revolutions per minute, and the power will be used for various purposes. It is of the revolving-field type, leaving the armature stationary and easily accessible. The revolving field is 16ft. in diameter, and weighs about 50,000lb. The armature core is built up of laminated soft-steel punchings, being annealed and japanned before assembling, and ventilating space blocks are inserted at suitable intervals, providing openings extending around the circumference and allowing a free passage for the heat generated in the windings. There are six slots per pole, 2½in. deep by 1½in. wide, each being wound with 14 conductors of 0·37in. by 0·28in. compressed copper strand. The internal diameter of the armature is 16ft. ¾in. and the width of the core 16in. The net weight of the alternator is 135,000lb., and the National Electric Company guarantee an efficiency on one and a quarter and full load of 95½ per cent. and on half load 94¾ per cent. Regarding regulation, the company guarantee 5½ per cent. on power factor 1 and 22 per cent. on power factor zero. The temperature will not exceed 30deg. on armature and magnets on a continuous run at full load, and 40deg. on the armature and magnets on a continuous run at 25 per cent. overload.

**Radioactivity of the Atmosphere.**—Mr. S. J. Allan contributes a paper on this subject to the *Phil. Mag.* He refers to an earlier paper by Mr. Ernest Rutherford and himself, in which it was shown that a negative conductor becomes radioactive in the atmosphere, and that the rate of decay of the radioactivity is independent of the nature of the wire. The radioactivity can be removed from the wire by rubbing it with a piece of felt or leather moistened with ammonia, which then itself becomes radioactive. The rate of decay of the radioactivity of the felt or leather is not, however, equal to that of the wire, and varies with the nature of the felt, but the radioactivity of the ashes of the felt decays at the same rate as that on the wire. The rate of decay of the radioactivity of the residue obtained by the evaporation of freshly fallen snow was found to be different from that of the atmospheric radioactivity. The absorption of various solids was determined, and the experiments indicate the existence of $\alpha$-radiation, readily absorbed, and more penetrating than $\beta$-radiation, and this explains the differences between the behaviour of the felt and the wire, as in the former the $\alpha$-rays would be largely absorbed before reaching the surface of the felt. The absorption in gases was also examined. The increase of the conductivity of air caused by a water spray (at Montreal) was not due to any emanation in the spray, but is produced by the mixture of the water spray with the air. The experiments indicate the complexity of the atmospheric radioactivity and the necessity of further investigation.

**Ice on Third Rails.**—With the inauguration of the third-rail system on certain railway lines in the United States, considerable trouble was experienced owing to the formation of ice on the third rail. The ice so formed in the winter tended to insulate the rail, and special forms of collectors combined with scrapers have been introduced to obviate this fault. We are pleased to see from the columns of our contemporary, the *Electrical World and Engineer* of New York, that the Manhattan Elevated system has succeeded in overcoming this trouble, and that a practically uninterrupted service has been maintained during the past winter. The weather experienced has been most severe, so that the means adopted have been heavily tried. The weather has impeded and delayed the ordinary street car traffic, and in consequence the Manhattan Elevated system has been a great boon throughout the winter. In one day last January the system carried without any kind of trouble 1,046,000 passengers, so that the line is well patronised. On a system of this kind, unfortunately, the increase of traffic with new facilities tends to render the service worse instead of better, as the headway between the trains has to be reduced, and in consequence the schedule times cannot well be maintained. It reminds us of Mr. Swinburne's remark at the Institution dinner this year to the effect that it was impossible to relieve the congestion in London, as whenever traffic facilities were

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increased, at least three times as many people tried to use them. We are pleased to hear that the difficulty with ice on the third rail has been surmounted.

**Tramways and Light Railways Association.**—The *Official Circular* for May contains a letter from the Board of Trade stating that the returns of accidents have furnished much valuable information, and that as a result of the experience so obtained the Board have been able to modify the regulations as to future reports. It is only necessary now to report cases of the guard wire or trolley wire being pulled down by the trolley, overhead work being broken by trolley, guard wire falling on trolley wire, or failure of insulation if accompanied by a heavy short-circuit or an alarming result. Where the trolley head is pulled off the matter need only be reported if personal injury has been caused. In cases of trolley jumping, causing injury to the standard, or doing other considerable damage, or of the trolley boom being broken, the matter should be reported if causing or likely to have caused personal injury. It is unnecessary to report the burning out of fields, failure of controller, etc., unless causing or likely to have caused personal injury or alarming result. A report should always be made in cases of the trolley boom being pulled out or the trolley wire breaking and falling. The *Circular* notifies that, owing to the rapidly-increasing use of electric traction in New Zealand, the Agent-General has been instructed by his Government to enquire of the Board of Trade as to the practice here in regard to the examination of motormen and conductors It is also intimated that up to Feb. 29 increased speed had been authorised on the Corporation lines at Ayr, Birkenhead, Bootle, Bradford, Cardiff, Dundee, Halifax, Leeds, Liverpool, Newcastle, Nottingham, Sheffield, and Sunderland.

**The New Cunarders.**—The contracts have been awarded for the two Transatlantic liners, one of which will be constructed by Messrs. John Brown and Co., Limited, Clydebank, and the other by Messrs. Swan, Hunter, and Wigham-Richardson, Limited, the machinery for the latter being supplied by the Wallsend Company. The new steamers will be propelled by Parsons turbines. The machinery is to maintain under all weather conditions a mean of 65,000 i.h.p. The commission appointed in connection with the vessels recommended four shafts, not only because the four screws will give a higher efficiency, but because it was imprudent to divide the power through a less number of shafts. As recommended by the commission, there will be one go-ahead turbine on each of the four shafts, which will be almost equi-distant from each other. The high-pressure turbines will be mounted on two outside shafts, so as to enable the shafts to be distant from the centre of the ship without interfering with the lines of the hull. These shafts will have the propellers at a considerable distance from the stern of the ship, so that there will be the minimum of disturbance to the flow of water to the two inside propellers, which will be placed right aft in the usual way. On each of the two inside shafts there will be two turbines of the low-pressure type. An extended trial trip will be made on which 25 knots has to be attained, so as to ensure a considerable margin of power in order that 24½ knots may be maintained at sea under all conditions. Messrs. J. Brown and Co. and the Wallsend Company will construct the turbines for the respective vessels under license from the Parsons Marine Steam Turbine Company.

**City and Guilds of London Institute.**—The report of the council for the year 1903 has been published, and we notice that the accounts show a balance of more than £2,000 over the year's expenditure of £36,821. Prof. Unwin has been re-elected dean of the Central Technical College, but has intimated his desire to resign the professorship of civil and mechanical engineering at the close of the current session on account of the strain and his having reached the age limit, though the latter would not strictly apply to him as a "transferred teacher." Prof. Unwin has held the appointment since the opening of the college 20 years ago, and the council desire to record their appreciation of his devotion in organising and developing a systematic course of college training adapted to the requirements of students desiring to become professional engineers, and of the success which has attended his efforts, as well as his services as dean of the college. A diploma course of study at the college covers three years, and it is recognised by London University as an approved course of study for internal students of the university, but only those students who have matriculated are so registered. The number of students of the college who are registered as students of the university is increasing annually. In order to avoid duplication of work, the institute arranged with the Board of Education for over 60 students of the Royal College of Science to attend a special course of lectures and laboratory practice in electrical engineering at the Central Technical College, the accommodation in this department having been increased. The Siemens medals were awarded to A. A. Gomme and R. C. Munro for electrical and civil and mechanical engineering respectively. The £30,000 required for the extension of the engineering and art departments of Finsbury Technical College has now been raised, and plans for the new building have been prepared.

**Light Railway Returns.**—The report of the Board of Trade and the Light Railway Commissioners, just issued, shows that of the 16 orders before the Board of Trade for confirmation on Dec. 31, 1902, one was withdrawn, three are still in abeyance, and 12 were ratified in the course of 1903, during which year the Light Railway Commissioners submitted 39 fresh orders to the Board In the majority of these cases an enquiry was held, objections having been lodged. Of these fresh orders 26 were confirmed, making a total for the year of 38. Confirmation was refused to one order, and the other 12 were still under consideration at the date of the report, but two have since been passed. The Treasury have conditionally agreed to make supplementary free grants, amounting to £2,945, to the Dornoch and the Elsenham, Thaxted, and Bardfield Light Railways. In regard to Class B (electric traction), the figures reflect in some measure a diminished popularity in the procedure under the Light Railways Act. Out of 49 applications during the 12 months (November, 1900, to November, 1901) the Commissioners approved 25, representing an estimated expenditure of £1,237,332; while 24 applications, representing an estimated outlay of £1,199,753, were referred to the Board of Trade. In the following year there was a fall in the applications to 21. The Commissioners approved 14 of these, the total cost being put at £739,562; and 13, representing an estimated expenditure of £725,566, were referred to the Board of Trade. From November, 1902, to November, 1903, the number dropped to 12, of which seven had not been dealt with at the date of the report. Of the five applications presented during the first half of the period, two, representing an estimated cost of £42,290, were approved and one referred to the Board of Trade, the estimated cost being £7,290. Since the Act came into force 459 applications have been made to the Commissioners, of which 257 have been sent to the Board of Trade. The total number of applications involved a mileage of 4,136 miles, the engineers' estimates amounting to nearly £32,017,000.

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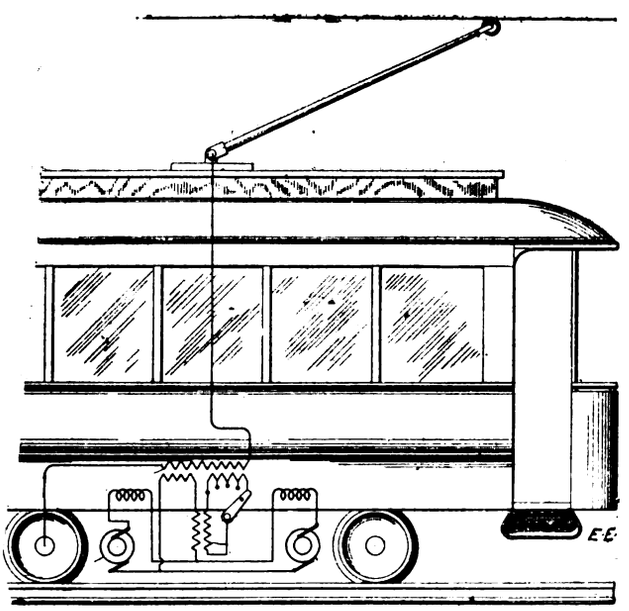
**The Lamme Single-Phase Railway System.**—Two patents have been granted in the United States, on applications filed Dec. 26, 1901, to Mr. Benjamin G. Lamme for his single-phase alternating-current electric railway system, to which we have referred in previous issues. One of these is what is styled on the other side of the Atlantic a "system" patent, and the other a "method" patent. The specifications comprise those used for the English patent, but as against the four claims in the latter, the American "system" patent contains 17, and the "method" patent eight. The illustrations in the case of the "system" patent include a method of voltage regulation, which does not figure in the English patent. It is noteworthy that these patents are granted as from the 3rd inst., although considerably over two years has elapsed since the deposit of the applications. The *Electrical World* of New York gives some particulars and the accompanying diagram The car transformer has two secondary circuits, one of which is closed on itself and the active length made variable by means of a switching device. The variable voltage in this circuit may be impressed upon the motor circuit through the series transformer diagrammatically indicated. By reversing the connections this variable impressed



voltage may be employed either to subtract from or add to the voltage of the motor circuit through all of its varying values, thereby providing the necessary variation of motor speed from zero to the desired maximum. It is stated that with this combined arrangement the motors may be designed for such voltage and such current as are best adapted for their operation, and the controller designed for some other voltage and current best adapted for its operation. Instead of varying the active length of a portion of the main transformer winding, the magnetic relations of the primaries and secondaries may be varied by adjusting one of the parts with reference to the other in a well-known manner; or such adjustment may be combined with means for varying the active length of a portion of a transformer winding.

**Radium.**—Before a large audience Prof. Rutherford, of McGill University, Montreal, delivered his lecture on "Radiation and Emanation of Radium" at the Royal Institution last Friday night. Having described the three kinds of rays now so well known, the room was darkened while Prof. Rutherford showed that the luminosity in a minute quantity of the element and its gas was sufficient to be distinctly visible. Proceeding, the lecturer remarked that the gas emitted by radium possessed all the properties of the element and three-quarters of its power. A few pounds of the emanation would supply sufficient energy to drive a ship across the Atlantic, but each pound would require 70 tons of radium to produce it. In regard to the process going on in the emission of the emanation, he advanced the theory that radium was continuously producing it, but that when produced, instead of remaining constant, it was continuously being changed into something else. He opined that some atoms of the radium in certain conditions became unstable, which caused an explosion, and particles of matter were shot off at great velocities. There was a series of such explosions, due to atomic, not molecular, changes, and resulting in the formation of a series of transition elements. A mass of radium left to itself must therefore throw itself away; probably in about 2,000 years its radioactivity would fall to half value, and after 50,000 years it would cease to exist. It was therefore to be supposed, since radium was produced from minerals more than 50,000 years old, that it was being itself produced from something else, and was itself a transition element. In the self-destruction of radium two things must be produced that are not radioactive—the $\alpha$-rays and the final product. Now helium was always found associated with radium minerals, and the suggestion that that gas was one of the products had been confirmed by Sir William Ramsay, who had shown that the emanation was able to produce helium from itself. The evidence pointed to the view that the $\alpha$ particle was the helium. This was apparently a definite case of transmutation, but there was no evidence as yet that matter in general, apart from the radioactive bodies, was undergoing changes of this nature. Radium, in minute quantities, was distributed very widely over the globe, which suggested the question, How much heat were these minute quantities of radium able to provide, and could they account for the gradual increase of temperature found as we went deeper into the earth? Prof. Rutherford believed that the amount of radium present, uniformly distributed, would be sufficient to account for all the heat lost from the earth, and would explain the temperature gradient as measured to-day. Radium would defer the glacial period indefinitely, and Prof. Rutherford paid a tribute to Lord Kelvin, who was among the distinguished scientists present, for having qualified his calculations by the almost prophetic reservation, "provided no new source of heat be discovered."

**World's Fair Electrical Railway Tests.**—In a recent issue we gave particulars of the four engineering committees which have been appointed under the Railway Test Commission to superintend the trials of electric traction at St. Louis this year. Further details are now to hand, which show that a committee has been appointed to have direct charge of the carrying out of the work of the tests. It will be presided over by Prof. W. E. Goldsborough, and Prof. H. H. Norris, of Cornell University, will supervise the actual trials. A number of electrical engineers will assist him, and he has also retained the services of 10 students in the engineering graduating class at Cornell. We gather that these students are being specially prepared for the work, and that they will devote their whole attention to it while the trials are going on. In consequence, it is hoped that definite conclusions will be arrived at with respect to the plant submitted for trial. We need hardly say that the manufacturers will be represented on this committee. As an example of the class of work which is to be done, we give the following particulars of the tests which will be made with new electric railway systems. They will be divided into two parts—the first dealing with the motors, including the car equipments; and the second with the line and all sub-station apparatus, and with the collecting arrangements for con-

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veying the current to the tramcar or locomotive. The motor trials will include (*a*) test motors to determine efficiency, power factor (if alternating), torque, speed, horse-power output under various conditions as to voltage, frequency (if alternating), and current, to be met in the service for which the system tested is intended; (*b*) the one-hour rating of motors, to be determined according to the standards outlined by the American Institute of Electrical Engineers; (*c*) test motors under constant loads to determine rate of heating during continuous operation. The following tests will be made on equipment when operating upon experimental track: (*a*) acceleration tests on single cars and multiple-equipped trains; (*b*) braking tests of single cars and multiple-equipped trains; (*c*) coasting tests of single cars and multiple-equipped trains; (*d*) motor-heating tests on single cars and multiple-equipped trains. The following curves are to be prepared: (*e*) speed time curves; (*f*) ampere time curves; (*g*) volt time curves; (*h*) real kilowatt time curves; (*i*) apparent kilowatt time curves (if alternating); (*j*) distance time curves; (*k*) tests and curves to determine car and train friction. Tests to be made upon line and auxiliaries: determine (*a*) ohmic resistance; (*b*) inductive reactance; (*c*) power factor; (*d*) efficiency. The determination of data of the copper and iron portions of line, separately and jointly, is to be made under the following conditions: (1) when the electrical energy is delivered from the power-house 'bus bars to the working conductor without translating devices; (2) when electrical energy is delivered from the power-house 'bus bars to the working conductor through supplemental transmission lines or translating devices. If supplementary transmission lines or devices are used in case No. 2, each element shall be tested separately as well as in conjunction with the line as a whole as outlined above. Tests upon each system shall be made to determine the following: (*a*) watt-hours per ton-mile at car; (*b*) watt-hours per ton-mile at sub-station 'bus bars (in case sub-stations are used); (*c*) watt-hours per ton-mile at power-house 'bus bars. All tests to be under like conditions, and when conditions are necessarily unlike, due allowance shall be made to reduce the apparatus tested to a fair basis for comparison. The watt-hours per ton-mile, as stated above, to be determined from the summation of the specific tests hereinbefore outlined, and checked by integrating wattmeters placed on the power-house 'bus bars, sub-station 'bus bars (if sub-stations are used), and the car.

**Telephone Protective Devices.**—In the May number of the *American Electrician* there is an interesting article by Mr. F. J. Dommerque on the protective devices used in telephone engineering. In this the author deals with the development of fuses to protect telephones from external currents; he also deals with the question of heat coils and lightning arresters in the following way: "The best heat coil consists of a coil of German-silver wire on a conducting shell surrounding a metallic pin, to which it is soldered with an alloy of a low-temperature melting point, the whole (Fig. 1) being mounted in a hard rubber or fibre case, and held upon a fork between a strong German-silver spring and a ground plate at one end and supported by another spring at the other end. The outer spring is arranged so that when the coil becomes heated and the fusible metal melts, it pushes the entire coil down and forces the pin through the enveloping shell upon the ground bar. A heat coil of this kind and its mounting upon the main distributing board frame is shown in the figure, the heat coil being also shown on an enlarged scale at the right. In another form of heat coil, when the fusible metal melts, the two springs spread apart and pull the pin out of its enveloping shell or sleeve, the one spring making ground connection by means of a projecting pin, as shown in Fig. 2. As will be noticed from these illustrations, the lightning arrester and heat coils with their springs are mounted upon an iron bar, which forms the ground bar of the main distributing board. In some cases an alarm device is added, which closes a battery circuit through an alarm bell whenever a heat coil goes, as a signal for the trouble man to replace the coil and reclose the circuit.

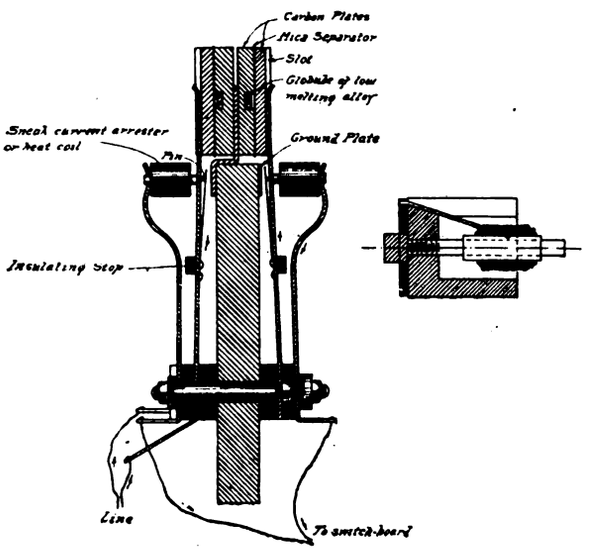


FIG. 1.

There are so-called self-soldering heat coils on the market, but they should be carefully investigated as to their construction before buying, as it is not easy to construct a coil that will restore every time. The specifications for heat coils vary according to whether they are to be used for common battery or for local battery systems. The specification for the heat coil in the figure for local battery is: resistance, 41·5 ohms of No. 37 B. & S. double silk-covered German-silver wire, 36in. long; the inner end soldered to the copper tube, the other end to the German-

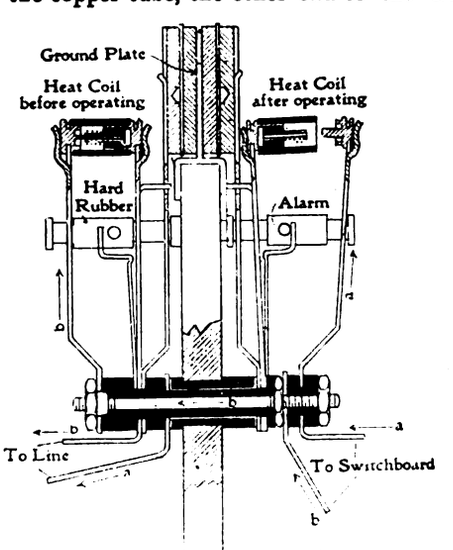


FIG. 2.

silver washer; the coil to operate in less than 45 seconds with a 0·16 ampere. For common battery: resistance, 5·25 ohms of No. 30 B. & S. double silk-covered German-silver wire, 23in. long; the inner end soldered to the copper tube, the other end to the German-silver washer; the coil to operate in less than 60 seconds with 0·4 ampere. Some specifications call for a larger fusing current, but reduce the time of operation." A combined lightning arrester fuse and heat coil for a subscriber's station is also illustrated. The concluding part of the article deals with the protection of overhead wires by means of lightning arresters.

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## LEICESTER CORPORATION ELECTRIC TRAMWAYS.

*(Continued from page 783.)*

### Boiler Plant.

For generating steam there are four boilers of the Lancashire type (Fig. 8) made by Messrs. Yates and Thom.

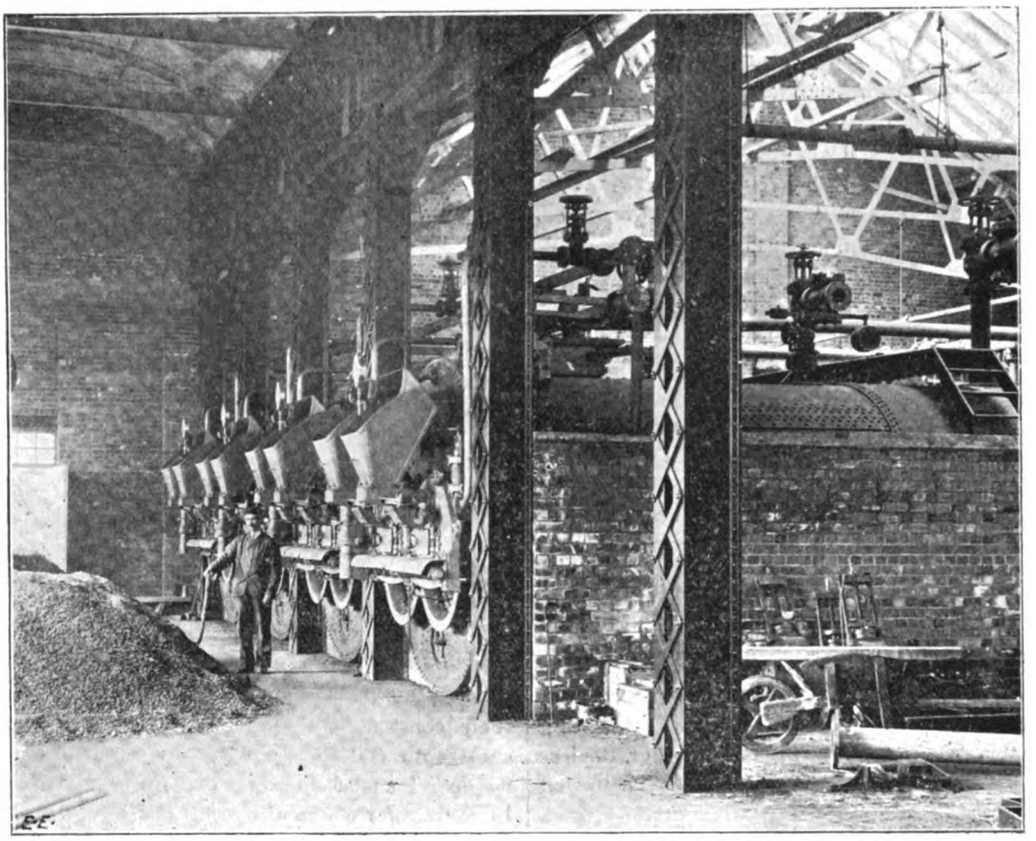

FIG. 8.—View of the Boiler Plant in the Leicester Tramway Generating Station.

Each boiler is 33ft. long by 8ft. 6in. diameter, with two flues, each 3ft. 5in. diameter, constructed for a safe working pressure of 160lb. per square inch, the shell plates being $\frac{13}{16}$in. thick, flue plates $\frac{19}{32}$in. thick, and the end plates $\frac{3}{4}$in. thick. They are constructed on the most modern lines, each shell being in five rings of one plate each, and were tested satisfactorily to 260lb. per square inch. All the boilers are equipped with a full set of fittings and mountings by Hopkinson, and are also supplied with stokers of the Bennis type. Messrs. Yates and Thom have also supplied the steam-piping coupling the boilers and engines together, which consists of wrought-steel tubes with flanges welded on. The arrangement of the pipes is in the form of a ring main, so that the supply of steam to any engine can still be maintained even if portions of the range may be temporarily out of action. There is also a very complete arrangement of separators fixed in the main range so as to thoroughly drain the system in every direction. The feed pipes are also of wrought steel, with flanges screwed on, the ends of the pipes being riveted over in the recesses formed in the face of the flange, the arrangement of same being very complete, and admitting of the feed being maintained to any or all the boilers either direct or through the economiser, being measured on its way through Kennedy meters in the usual way. The feed is taken from the hot-well supply from the surface condensers before mentioned, and in order to get rid of the emulsified oil a special treating plant has been installed.

The separation of the oil from the condensed steam is effected by the Davis-Perrett patent electrical process, which was described in our columns recently.* As is well known to engineers, oil in condensed steam is largely in a state of emulsion, so as to be incapable of being separated by mechanical filtration. In this process the water passes through a series of tanks arranged in parallel, and is subjected to the action of an electrical current, the result of which is to immediately destroy the emulsion and form a flocculent precipitate, which can then be easily removed by subsequent filtration, leaving the water absolutely pure. The electrical portion of this plant has been supplied by Messrs. Davis-Perret, Limited, of 13, Fenchurch-avenue, E.C., and the filters used (Fig. 9) are of the Wilson patent automatic self-cleansing type, made and supplied by Messrs. Masson, Scott, and Co., Limited, of Fulham, S.W., who have erected the entire plant. The water as it issues from the 10 divisions of the electrical tanks is received into two collecting tanks, from whence it passes into

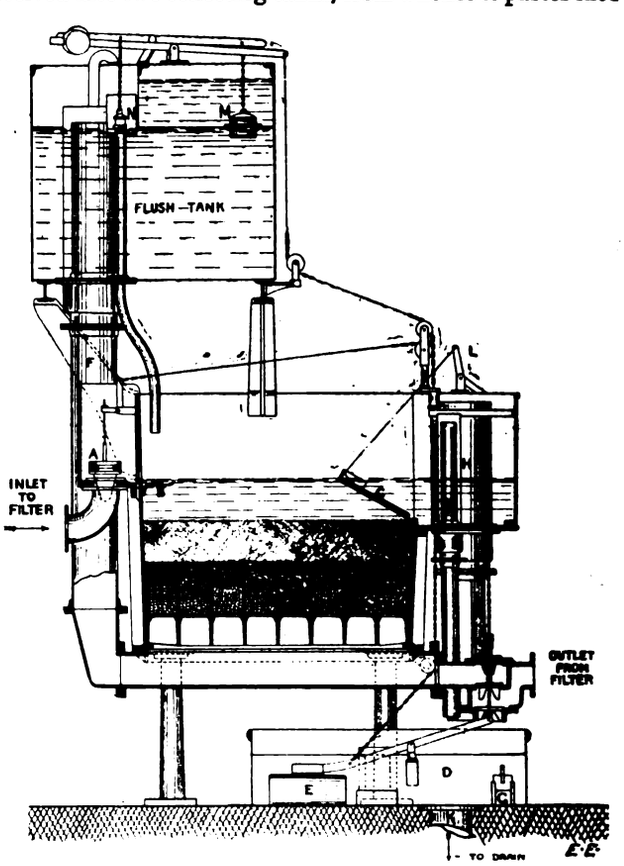


FIG. 9.—Sectional Elevation of the Wilson Automatic Self-Cleansing Filter.

the patent filter continuously, and is delivered into the pure-water storage tank, from which the boiler feed pumps draw

* *Electrical Engineer*, vol. xxxiii., p. 88.

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the supply for the steam-boilers. The filter is fitted with a flush cistern, which contains the exact quantity of water

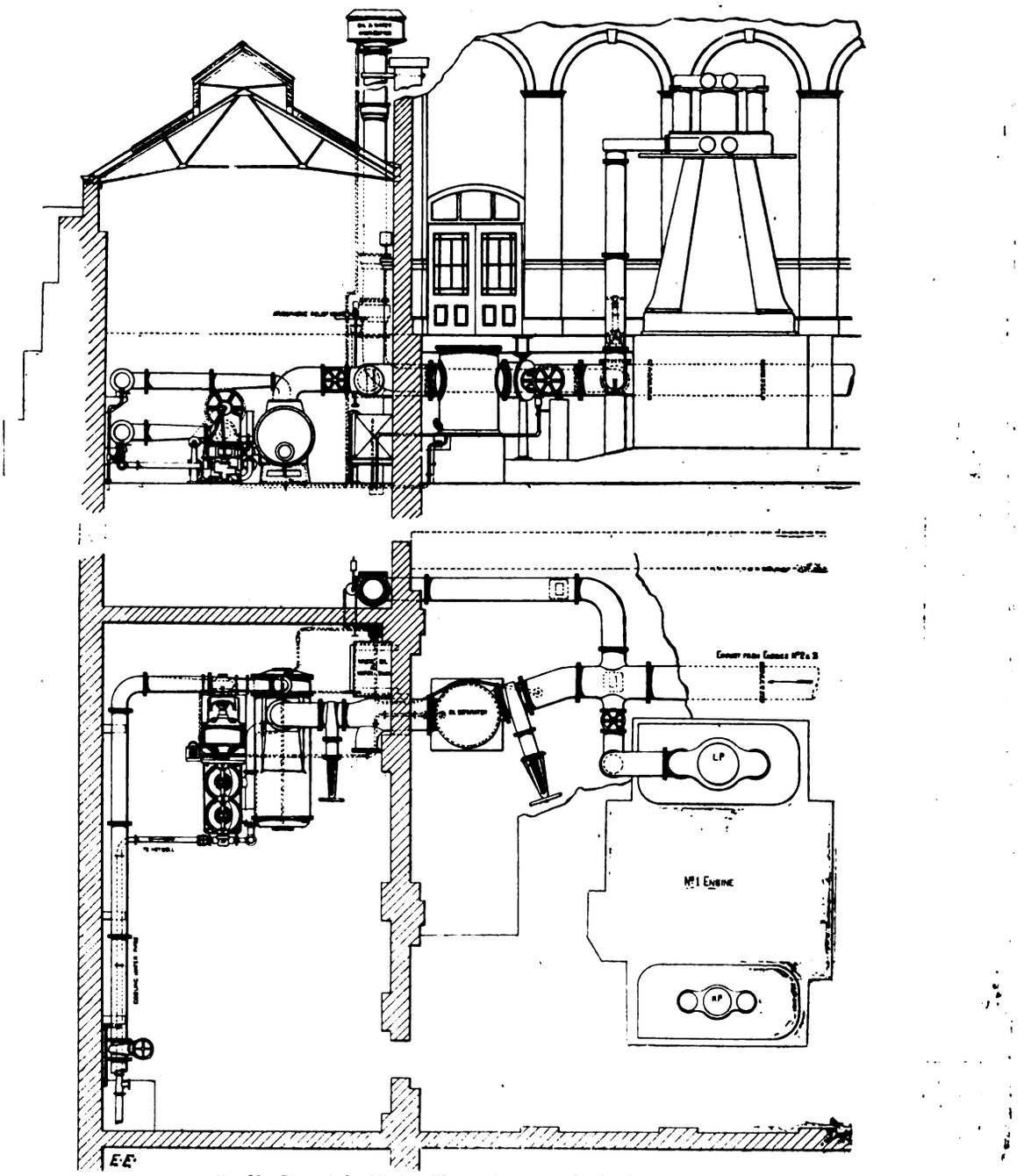


FIG. 10.—Plan of the Mitrlees-Watson Company's Condensing Plant.

necessary to wash the filtering medium when required. No attention is necessary when working the filter, as all its operations are automatic, and when the filtering medium

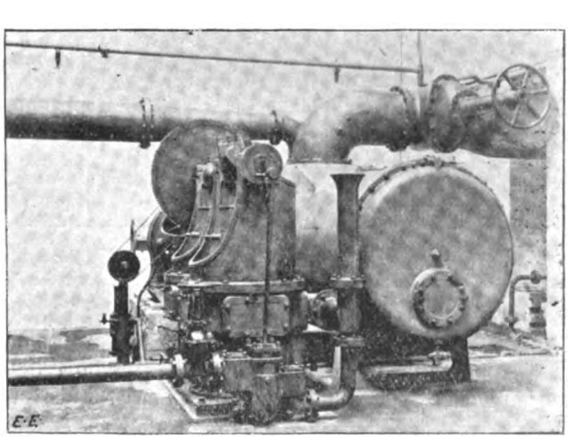


FIG. 11.—View of one Condenser.

becomes blocked up with an accumulation of impurities on its surface, the wash takes place, and the filter after the medium is cleansed resumes its ordinary operation of filtering. The bottom of the filter is cellular, each cell being divided vertically into two parts, the division plates being perforated to allow of the water passing through. The upper part of the cells contains stones which support the sand; first the larger stones, and then the smaller stones upon which the sand rests. The lower part of the cells forms an air space and trap The water enters the filter at the point A B through holes in the side plates of the filter by the bend pipe indicated. The water passes through the sand medium and stones, and leaves the filter by the outlet valve shown. The outlet valve is shown closed, but during the filtering operations this valve is, of course, open to allow the water to leave the filter. As the surface of the filter becomes coated with impurities the level of the water gradually rises, owing to the fact that it enters the filter more rapidly than it passes through the sand, owing to the obstructions. When it reaches the top it overflows a siphon pipe, H, shown in the illustration, and through this siphon it descends rapidly into the float chamber, D, underneath. In this float chamber is a float fixed on to a lever. The water raises this float, and by so doing it closes the outlet valve by which the unfiltered water escapes from the filter, and at the same time allows the water from the flush cistern above to flow down very rapidly into the underside of the filter. The water descend-

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ing with considerable force presses upon the air in the under side of the cells, forcing the air up through the sand, which is thus broken up, and is thoroughly washed by the water as it rises up through the medium. The sand would escape from the filter except for a board, C, extending right across the filter, and which, being fitted with a float, rises up as the water rises in the filter, and prevents the sand from passing out of the filter. When the flush water is exhausted

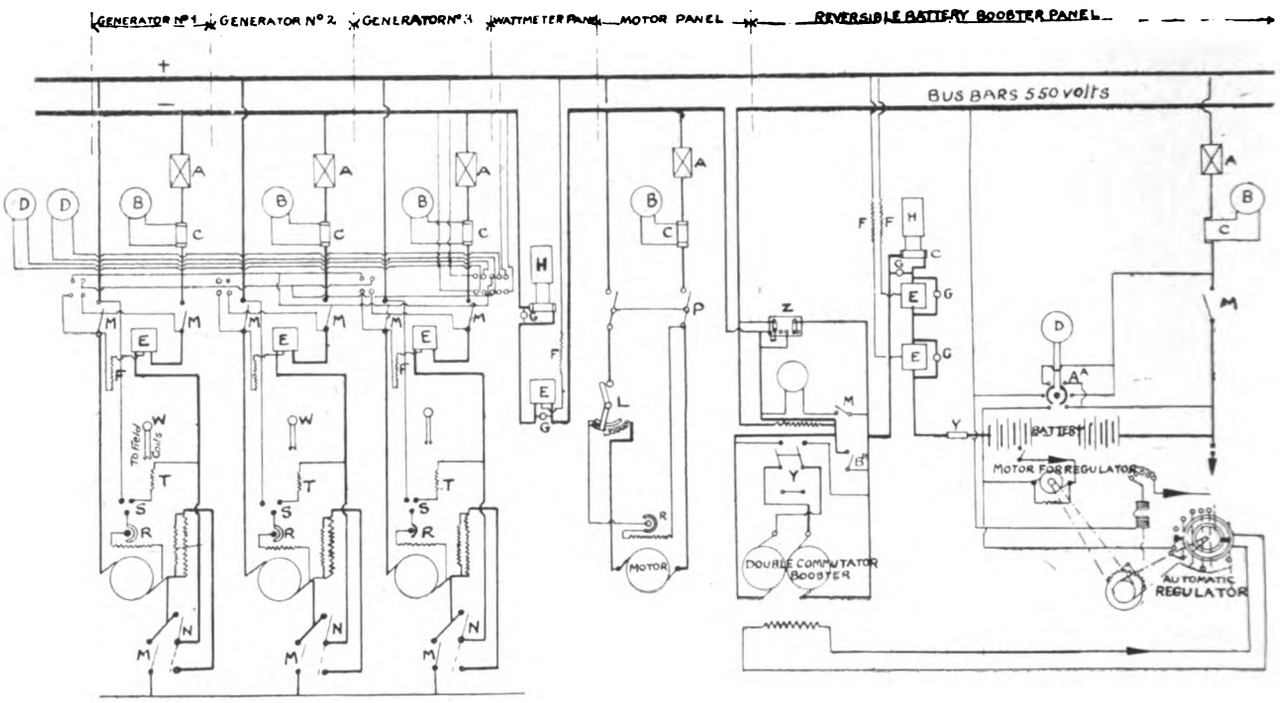


FIG. 13.—Diagram of the Connections to Switchboard, Leicester Tramways (left side).

the operation of washing is complete. The water escapes from the float chamber, D, and the float, E, falls again to the bottom of the chamber. The outlet valve is again open, and the ordinary operation of filtering is proceeded with. The whole operation takes only about three minutes, and while this is going on the collecting tanks are sufficiently large to receive the water passing from the electrical tanks, so that the continual passage of the water is not interfered

exhaust steam per hour. This plant, together with the exhaust steam pipes and accessories, have been made for Messrs. Dick, Kerr, and Co. by the Mirrlees-Watson Company, of Glasgow. The exhaust steam from the several engines is led into a common exhaust main running along one side of the engine-house and then to the condenser house, which is situated at one end of the main building; there is a branch from this pipe leading to a vertical atmospheric pipe which is fixed to the outside wall of the building, and terminates in an improved form of exhaust head and silencer. At the bottom of the vertical length of pipe there is fitted an automatic atmospheric relief valve, arranged to open to atmosphere when the pressure in the exhaust main reaches a predetermined limit, and consequently automatically comes into use should the vacuum fail from any cause. The exhaust steam before reaching the con-

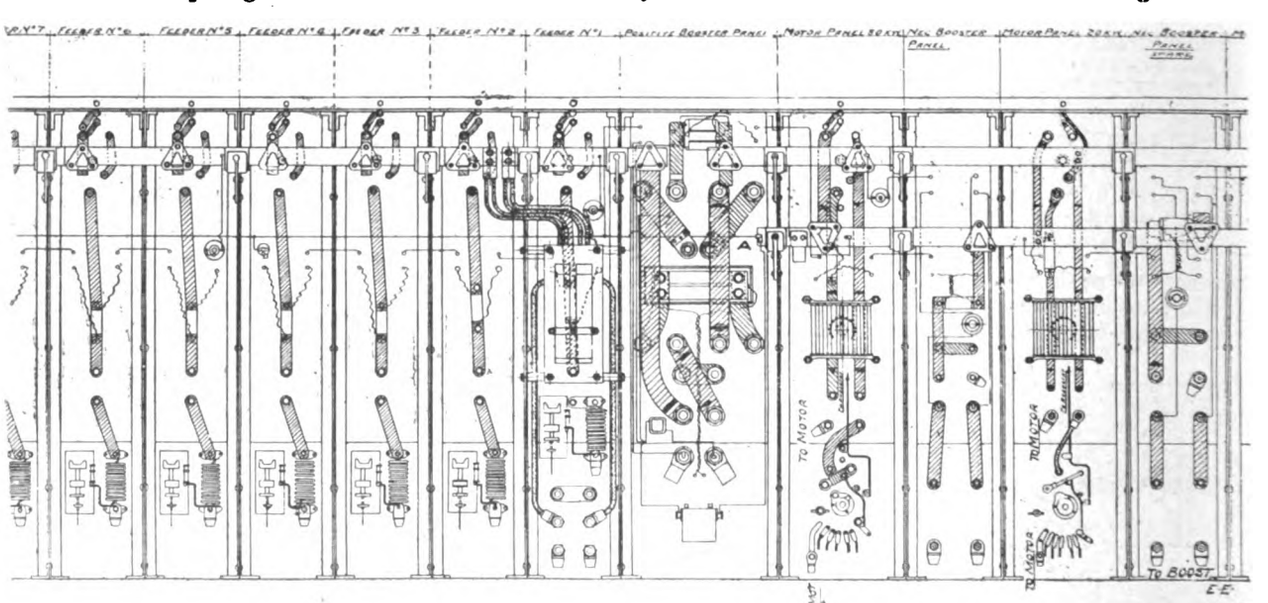


FIG. 14.—Arrangement of Back Connections to Switchboard, Leicester Tramways (left side).

with. When the filter resumes filtering operations after the wash, it empties the collecting tanks from the amount of water accumulated during the wash.

The feed pumps are manufactured by Messrs. Hall and Sons, Peterborough, and are of their well-known vertical direct-acting type.

## Condensing Plant.

The condensing-room plant (Figs. 10 and 11) consists of a surface condenser capable of dealing with 25,000lb. of

denser passes through an oil separator, manufactured by the Klein Company. The surface-condensing plant consists of a set of twin electrically-driven air-pumps of the Edwards patent type, and a centrifugal circulating pump. These are both driven by a double-wound series-parallel motor manufactured by Messrs. Dick, Kerr, and Co., Limited. The condenser, which has 2,500 square feet of cooling surface, is designed on the Mirlees-Watson counter-current system, the exhaust steam and cooling water each

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passing twice through the full length of the condenser and in opposite directions. Suitable baffle and diverging plates are arranged so as to very effectually distribute the steam over the entire surface of the tubes. The covers can be removed for cleaning purposes without disturbing any pipe joints. The air-pumps have barrels 18in. diameter by 10in. stroke, and run at a speed of 100 revolutions per minute. The centrifugal pump, regulated by means

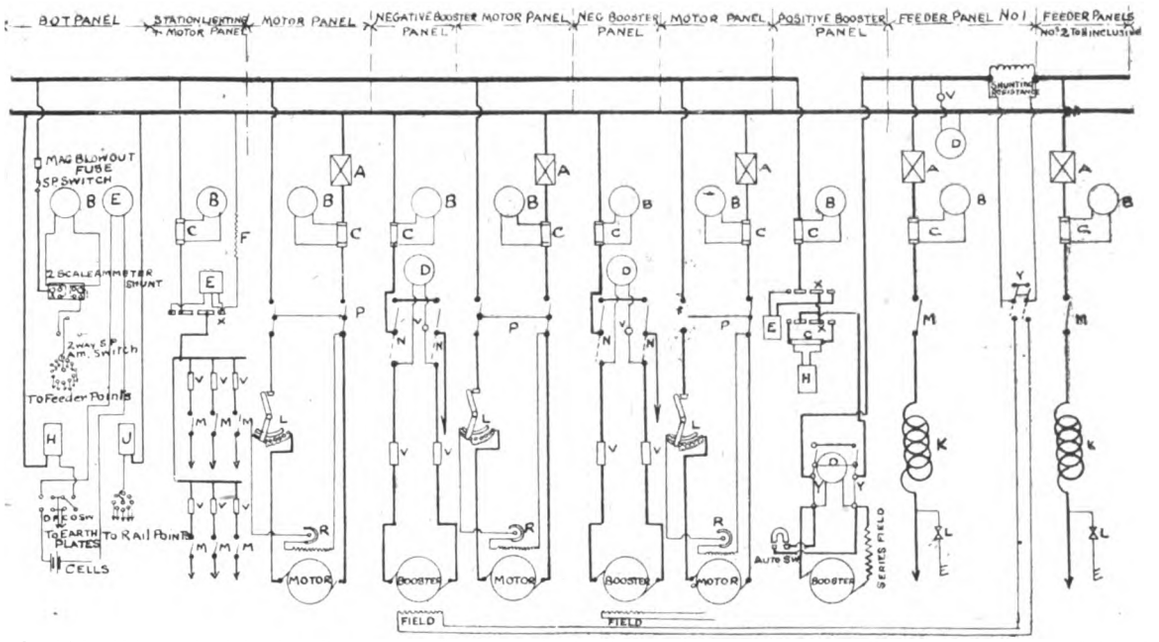


FIG. 13.—(Right side). A, circuit breaker; B, ammeters; C, ammeter shunts; D, voltmeters; E, wattmeters; F, wattmeter resistance; G, S.C. plug switches; H, recording ammeters; J, recording voltmeter; K, kicking coil; L, motor starters; M, S.P.S.T. switch; N, S.P.O.T. switch; P, D.P.S.T. switch; R, regulating field resistance switch; S, field switch; T, non-inductance resistance; V, S.P. fuses; W, pilot lamps; X, short circuit and circulating links; Y, D.P.C.O. switch; Z, three-way D.P. switch; AA, voltmeter switch; BA, reverse current cut-out.

of a series-parallel controller, is capable of delivering 1,500 gallons per minute, and is direct connected by a flanged coupling, while the air-pumps are driven by single-reduction gearing having machine-cut teeth. A small plunger pump is carried on the air-pump bedplate, and driven from a crank disc mounted on the end of the crank-shaft. There is another small pump driven by chain gearing, which draws the oil and water from the oil separator

the valves are of the Corliss double-ported type, being placed in the cylinder ends. By this arrangement one half of the cylinder end forms a steam-box. The high-pressure barrel is steam jacketed with boiler pressure steam. The steam-valves are worked by Messrs. Yates and Thom's well-known trip gear, the closing of the valves being accomplished by powerful spring dash-pots. The exhaust valves have a plain vibrating motion, derived like the motion

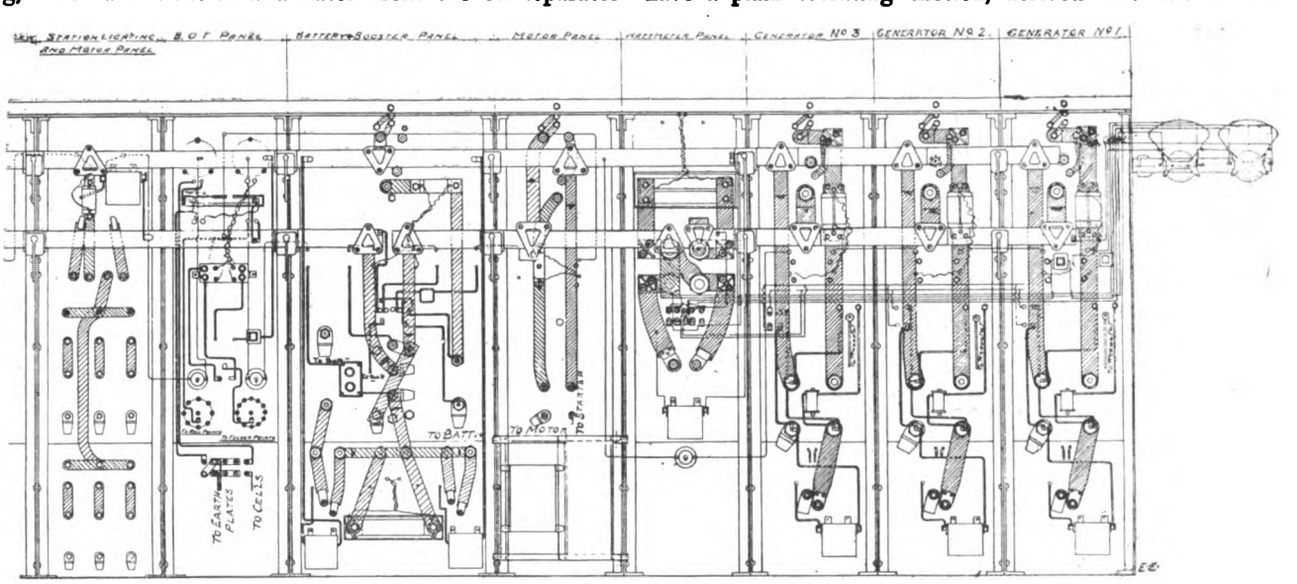


FIG. 14.—(Right side).

and discharges same into the waste-oil tank. The air-pump crankshaft is carried on an improved form of frame, which has been designed to give a much greater stability than the usual form of A-shaped frames. The exhaust steam and all water piping is so arranged that a further plant can be installed and connected up at a future date.

## Engines.

The engines are of Messrs. Yates and Thom's vertical cross-compound Corliss condensing type, having cylinders placed at opposite ends of the crankshafts, with the crankshafts at

for the steam inlet valves, from eccentrics fixed on the crankshaft.

Special attention has been given to the question of governing, and a very powerful and sensitive governor is fitted to each engine, having various special devices attached to it for electrical generating engines dealing with largely varying loads and for ensuring good parallel running. Each engine is also fitted with a special safety stop arrangement, which will completely stop it in the event of the speed reaching 10 per cent. above the ordinary working speed, and will also stop the engine

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in the event of any failure of the governing gear, while at the same time it does not interfere with the engine taking excessive overloads, even beyond the full range of the cut-off gear.

The flywheel is 16ft. diameter, and weighs about 25 tons, being keyed on to the crankshaft alongside the generator, to which it is also coupled by means of turned bolts fitting in a flange cast on the boss of the flywheel and passing through holes bored through the generator arms. A very complete system of lubrication has been fitted to these engines, consisting of two ram pumps worked by a drag shaft from the main cranks, and delivering oil under pressure to all the main bearings about the engines. The various parts of the engines are protected by oil-throwers and covers so as to prevent splashing, the sides of the A frames being enclosed by means of massive cast-iron plates, having access doors worked into them. The eccentrics are enclosed in neat planished steel covers, with oil-throwers attached to the shaft, which effectually prevents any tendency for oil to creep along the shaft. This arrangement ensures a very clean engine and the maximum amount of efficiency, the oil being used over and over again.

There is very little steam-piping visible in the engine-room, merely a short branch to each engine from the ring main in the boiler-house, the exhaust piping being placed in the spacious basement.

## Generators.

There are three direct-current generators (Fig. 12) direct-coupled to the Yates and Thom vertical engines, the output of each generator being 500 kw. when running at 95 revolutions per minute, current being generated at a voltage of 500 to 550. The machines are of the compound-wound type. They are in every respect in accordance with the standard practice of Dick, Kerr, and Co., the magnet frames being of cast iron, the pole-pieces being built of laminated steel and cast into the magnet frame.

The field coils are wound upon steel spools, one section of the spool being occupied by the shunt winding, the remaining portion being filled up with the series winding; the former winding consists of double cotton-covered wire, the series being ribbon copper insulated with mica and special cloth. The armature is built up on a special form of spider, the section of the rim being broken in order to avoid shrinkage strains; the spider is provided with a long bearing surface, and is bored accurately to the engine-builders' gauge. The armature core, which consists of steel punchings, is built up on the arms of the spider; a number of spacing discs are placed every 3in. and 4in. among the laminations to form ventilating ducts for cooling the interior of the core and the windings.

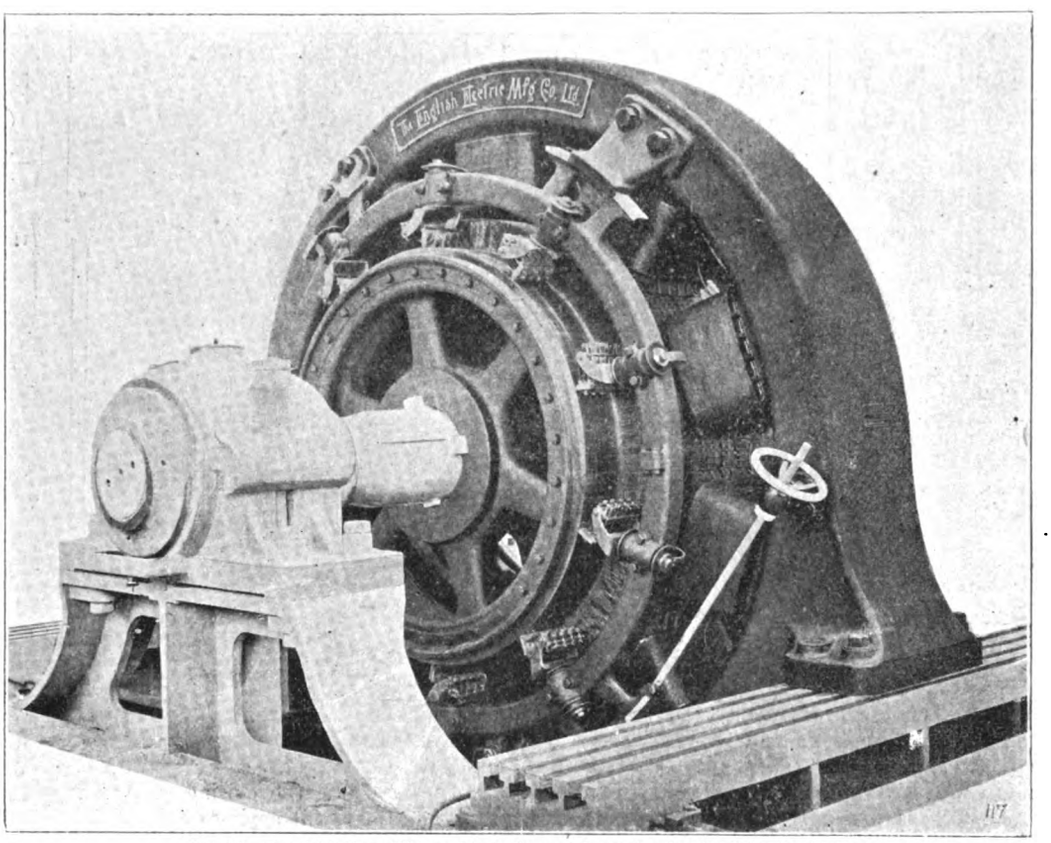


FIG. 12.—The Dick-Kerr 500-kw. Direct-Current Generator for the Leicester Station.

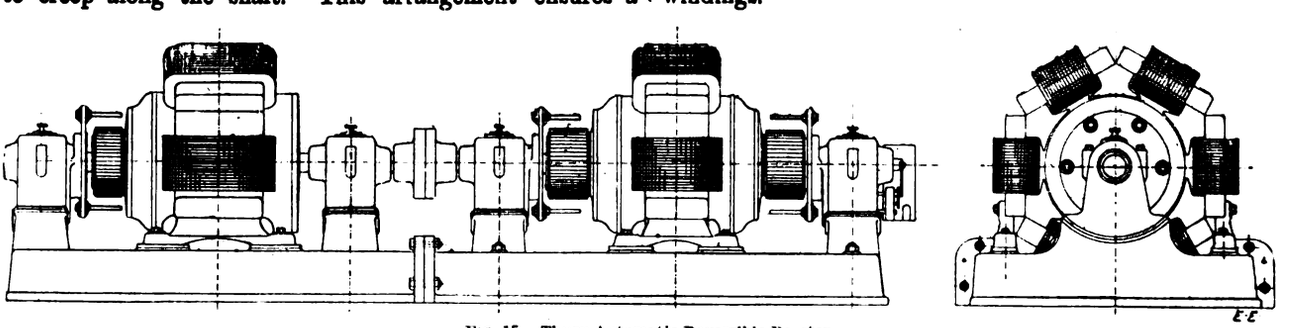

FIG. 15.—Thury Automatic Reversible Booster.

The armature laminations when built up are clamped together by cast-iron flanges, which are also designed to support a portion of the armature windings which extend beyond the ends of the core. The laminations are punched so that when assembled the outer edges form slots into which the armature coils are placed. The coils are former-wound, and are readily replaced and are interchangeable; they are insulated with a special material into which mica largely enters, and are rendered impervious to moisture by a special varnish. The commutator is built up on its own spider, which is carried

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on the extension of the armature casting, and on this the commutator is built up of a series of hard-drawn copper bars, which are firmly clamped together by means of steel end-rings.

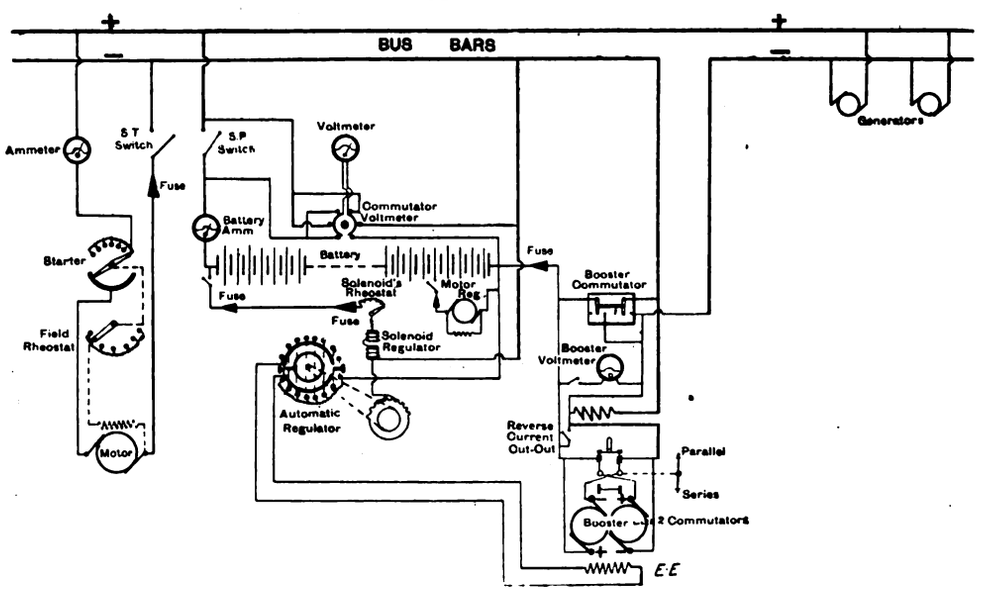


FIG. 16.—Diagram of Connections to Thury Automatic Reversible Booster.

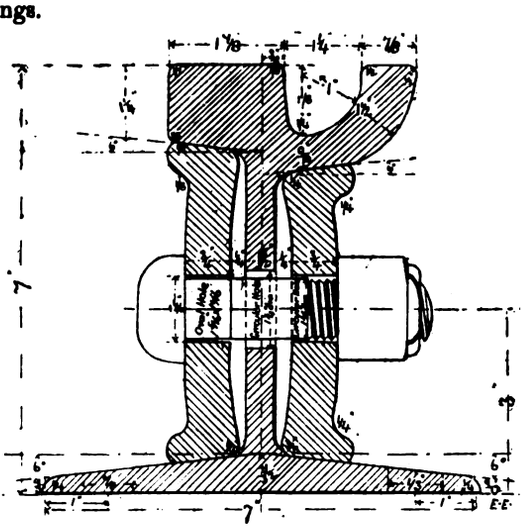


FIG. 17.—Section of Rail for Curved Track.

The building up of the commutator is one of the most distinct features of this type of machine, a copper bar being built up with its mica insulation in a special form of jig. The commutator ring is then placed on the special form of spider, the end rings being afterwards fixed into position and the whole securely bolted together. The brush-holders are designed so that the current does not pass through any moving joints. These give adequate adjustment, and are mounted on a massive rocker ring attached to the generator frame. The brushes can be rocked simultaneously by means of a hand-wheel, and screw geared to the brush rocker ring.

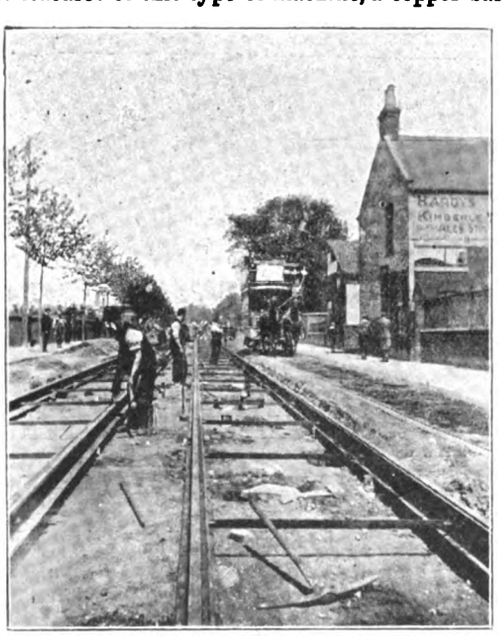

FIG. 18.—Laying Permanent Way in Loughborough Road.

## Switchboard.

The switchboard supplied by Messrs. Dick, Kerr, and Co. is an extensive one, consisting of 25 panels of white marble, which control, besides the three 500-kw. generators, a negative feeder booster set of 20 kw. capacity, a positive feeder booster set of 60 kw. capacity, an automatic reversible battery booster set of 40 kw. capacity, as well as the station lighting and motors and the distribution.

The general arrangement of the switchboard is shown in Figs. 13 and 14, the former being a diagram of the connections and the latter a back view. It consists of the following panels: three generator panels, each carrying one ammeter, one circuit breaker, two single-pole quick-break switches, one watt-hour meter, shunt regulating switch and resistance, a single-pole field-breaking switch with resistance, and a four-way voltmeter plug receptacle; one watt-meter panel, carrying one recording ammeter, one recording watt-hour meter to register the total energy generated—

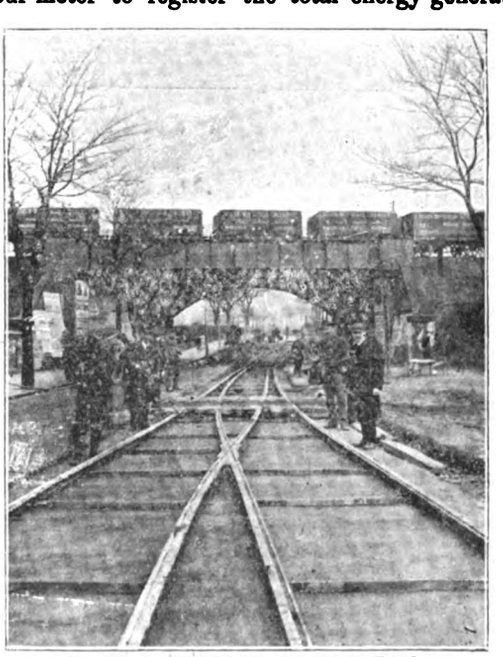

FIG. 19. Interlacing Track, Aylestone Road.

short-circuiting plugs for both these instruments are also provided; one reversible booster motor panel; one

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reversible booster panel — this latter carries circuit breaker, battery voltmeter, booster voltmeter and ammeter, double-pole three-way switch, one single-throw single-pole quick-break switch, one single-pole fuse, two watt-hour meters, and one recording ammeter; one standard Board of Trade panel; one station lighting and motor panel; two motor panels and two negative booster panels, one of each being spare; one 80-kw. motor panel; one positive booster panel, carrying one ammeter, one voltmeter, one watt-hour meter, one double-pole change-over switch, and one recording ammeter with short-circuiting and isolating links; 11 standard traction feeder panels, each carrying one ammeter, one circuit breaker, one single-pole quick-break switch, one kicking coil, and lightning arrester.

The motor starters throughout are of Messrs. Dick, Kerr, and Co.'s special slow-speed type, with automatic overload and no-load release and metallic shield blow-out device. The circuit breakers are also of their new standard type with metallic shield blow-out. Ammeters and voltmeters throughout are of the sector illuminated dial type.

We looked in vain for the cables connecting the generators and boosters with the switchboard. Well might we, for these cables are contained in separate ducts, which converge to the position below the switchboard gallery, whence they are diverted to the board above through fireproof channels concealed behind the tiled panelling of the engine-room wall. The cables themselves are of the fireproof insulated type supplied by Messrs. Glovers, Limited. The feeder cables where they branch from the switchboard are concealed in the same way.

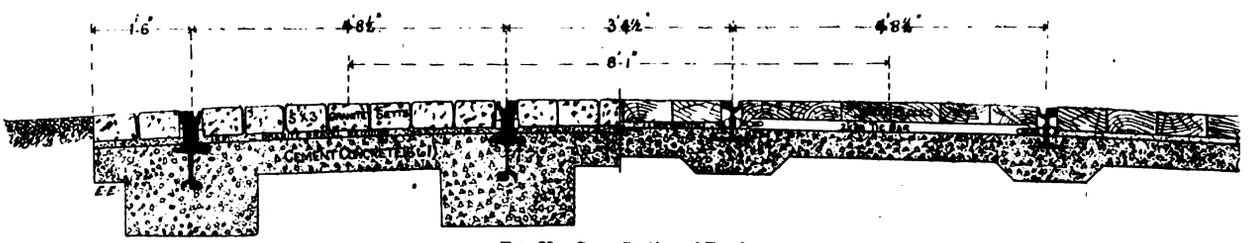


FIG. 20.—Cross-Section of Tracks.

## The Battery.

The battery is composed of 240 cells of the standard Tudor pattern, type No. 413 H F 19; it is capable of giving 600 amperes for one hour, or 900 amperes for short periods, and can be charged normally at 270 amperes, or at 450 amperes for short periods. The cells are in lead-lined wood boxes resting on glass oil insulators; the stands are entirely of pitch-pine without any metal fastenings, and they rest on large porcelain oil insulators to ensure perfect insulation of the whole battery from the earth, which is an important point in traction batteries where one pole is directly connected to earth.

## The Automatic Reversible Booster.

This battery will be worked in conjunction with a Thury automatic reversible booster and regulator, the duty of the combination being to keep the load on the main generators constant. It is claimed that the Thury regulator enables (1) a saving to be effected in the initial outlay for plant; (2) constant operation of the machinery at normal load, thus ensuring the highest economy; (3) being automatic in its action, a reduction of manual labour. The Thury booster differs considerably from those of other makes, principally in the armature construction, that of the Thury system having a smooth core. It is claimed that this prevents sparking under working conditions. Besides the spark-

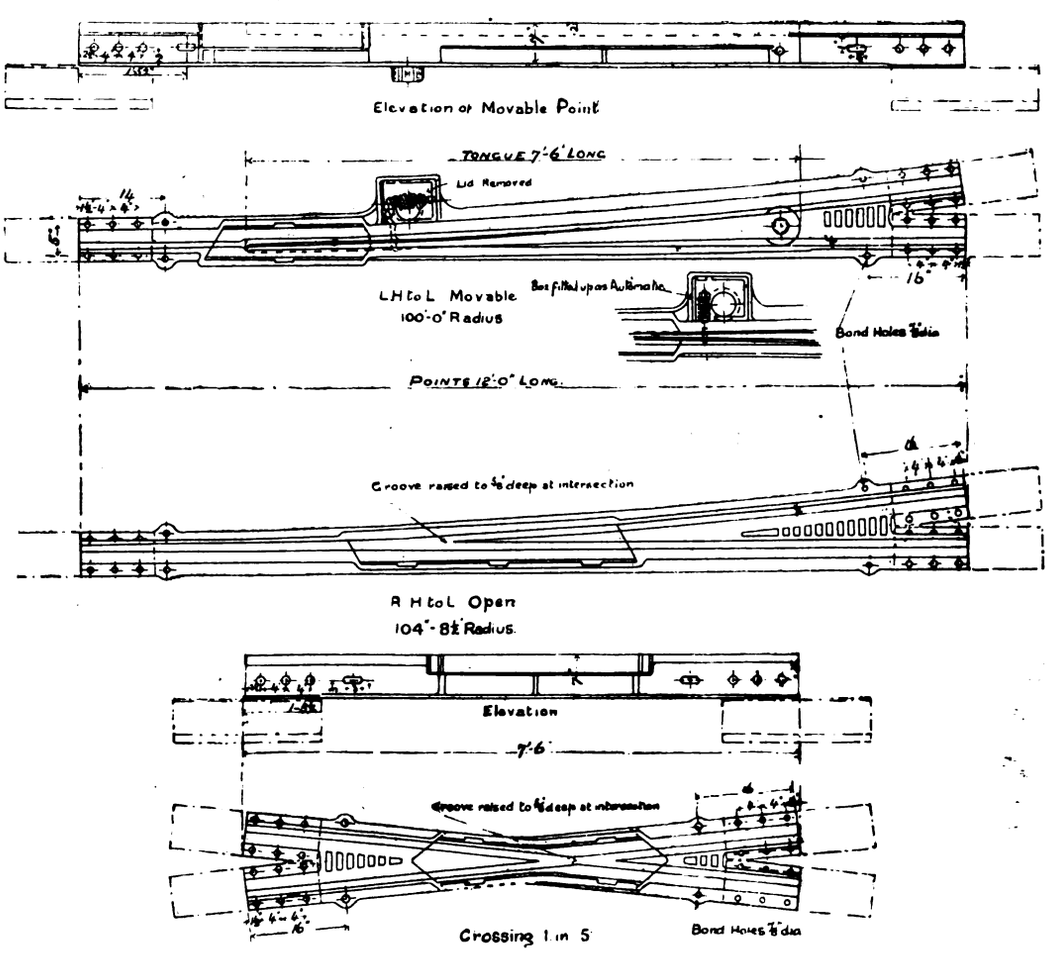


FIG. 21.—Details of Hadfield's Improved Points and Crossings.

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ing question, it also assists the booster to answer instantaneously to the heavy and sudden load variations on the line. The Thury system, besides a smooth armature core, has tangential field coils. The armature winding being placed as near as possible to the periphery, and the field iron being reduced to its possible minimum amount, the result is a most sensitive type of dynamo which can act almost as quickly as the load peaks occur. The automatic operation of the booster system is as follows: If the external load be less than the normal, the excess power of the main generators is utilised for the battery charge. For this purpose the differentially excited booster adds its voltage to that of the dynamo, and effects with same the charging of the battery. If the external load is equal to the normal output of the main generators, the excitation of the booster effected by the two differentially excited wound coils is nil. There is consequently no pressure at the booster terminals, the dynamo and battery pressures are equal, and the main generator supplies power for the traction load only. If, on the other hand, the external load is higher than the normal output of the generators, the battery's duty is to supply the excess output required. It is enabled to do this by the booster, as the booster excitation coil carries the increased working current, and adds the voltage of the booster to that of the battery. It is obvious that a booster containing little iron, and with the armature winding placed near to the periphery, will have less magnetic inertia and greater sensitiveness than a type which does not combine these features.

Having thus described its action, it may be of interest to add a few particulars of the Thury plant supplied to the Leicester Corporation. The booster (Fig. 15) is a dynamo with two commutators for connecting up in parallel or in series, which will enable it to meet all the requirements as regards the automatic regulation of the load on the plant and charging of the battery. The apparatus for connecting the two commutators from series to parallel is an ordinary switch, the operation of which is most simple, and can be easily followed from the diagram of the connections (Fig. 16).

## System of Working.

Under normal conditions of working the generators will be run in parallel with the battery, but, being over-compounded, they can also be run as single machines to give the requisite 550 volts on the line. Or, as a third alternative, they can be run in parallel on the 'bus bars, the latter being then connected through the positive booster designed to give 50 volts at full load. In the latter case the over-compound windings and battery would, of course, be cut out. By this arrangement the possibility of complete breakdown is reduced to a minimum, while the supply to the line is not complicated by the use of transformers—the system, in fact, gaining immensely in reliability from its simplicity.

## Permanent Way.

The scheme sanctioned by Parliament comprises 19 miles 3 furlongs of double track and 3 miles 5 furlongs of single track, being over 42 miles of equivalent single track. It was decided to construct the whole of the permanent way and lay the conduits for the feeder cables by direct labour without the intervention of a contractor, and, judging from the progress and quality of the work, the committee have no cause to regret their decision. The construction of the permanent way and the laying of the feeder conduits was commenced by the Corporation staff in April, 1903, and, notwithstanding the abnormally wet weather which has prevailed throughout most of the period of construction, the total length of track which it was decided to carry out immediately, amounting to about 33 miles, was completed in April last, and the remainder is in hand. This and the other branches of the scheme were so mapped out and pushed forward by Mr. Mawbey that the whole should be completed about the same time, and thus minimise the period during which expended capital was unremunerative. Throughout the period of construction night labour was

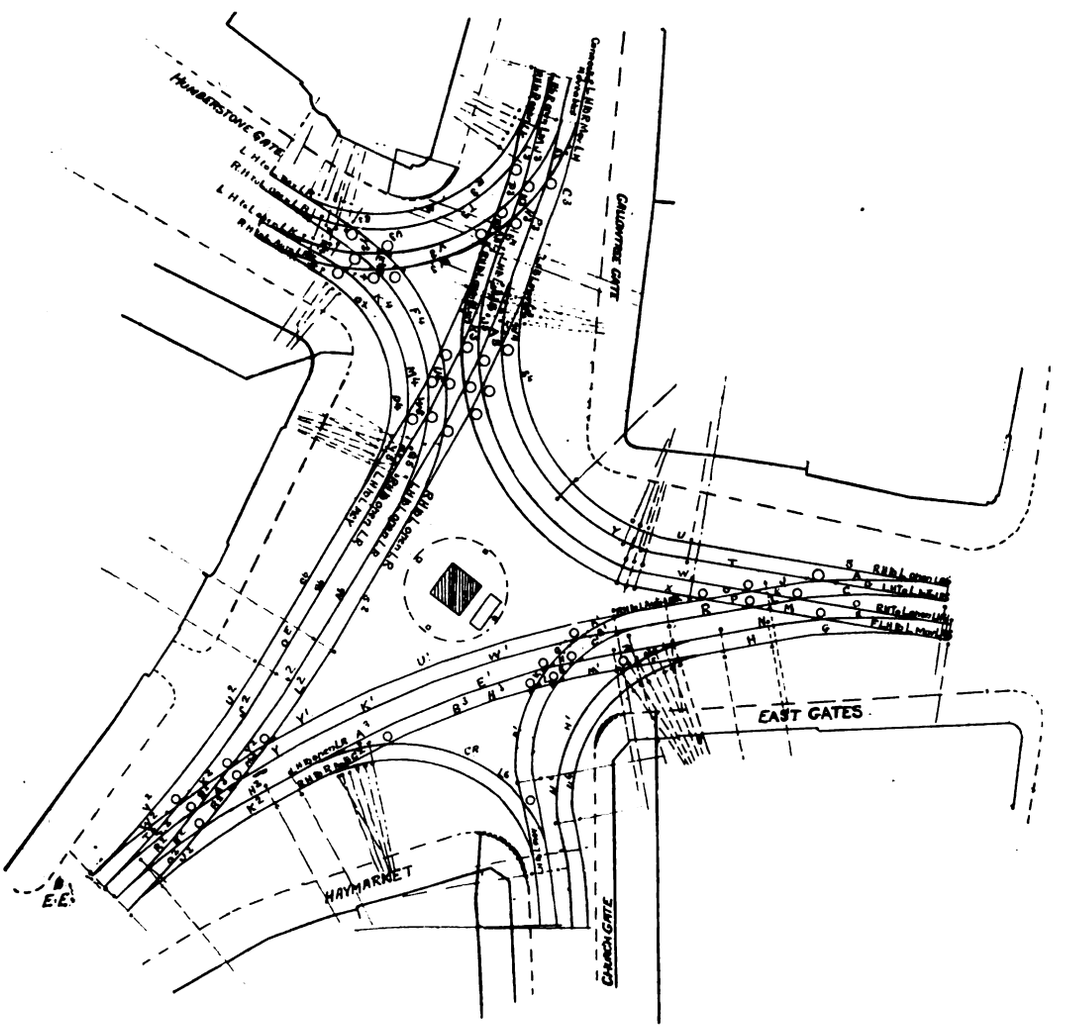


FIG. 22.—Arrangement of Tracks at Clock Tower Junction.

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avoided as being detrimental to good work, although a considerable amount of overtime was made during the daylight of the summer months. Generally speaking, the routes comprised in the scheme are moderately straight, with no excessive gradients, the steepest being 1 in 16 for a distance of about 50 yards. It has been found necessary to lower the roadway under seven of the railway bridges—in one case as much as 2ft.—in order to obtain sufficient headroom for double-deck cars. This work was carried out at considerable expense, necessitating the lowering of gas and water mains, the diversion of sewers, and in one instance the underpinning of the abutments of the bridge. The sharpest curve on the system is 37ft. radius to the centre of the track. A minimum radius of 40ft. for all curves was aimed at, and with one or two exceptions this has been attained. The distance from centre to centre of tracks of the permanent way with side-pole construction is 8ft. 1in., giving 3ft. 4½in. from gauge edge to gauge edge between tracks, and for centre-pole

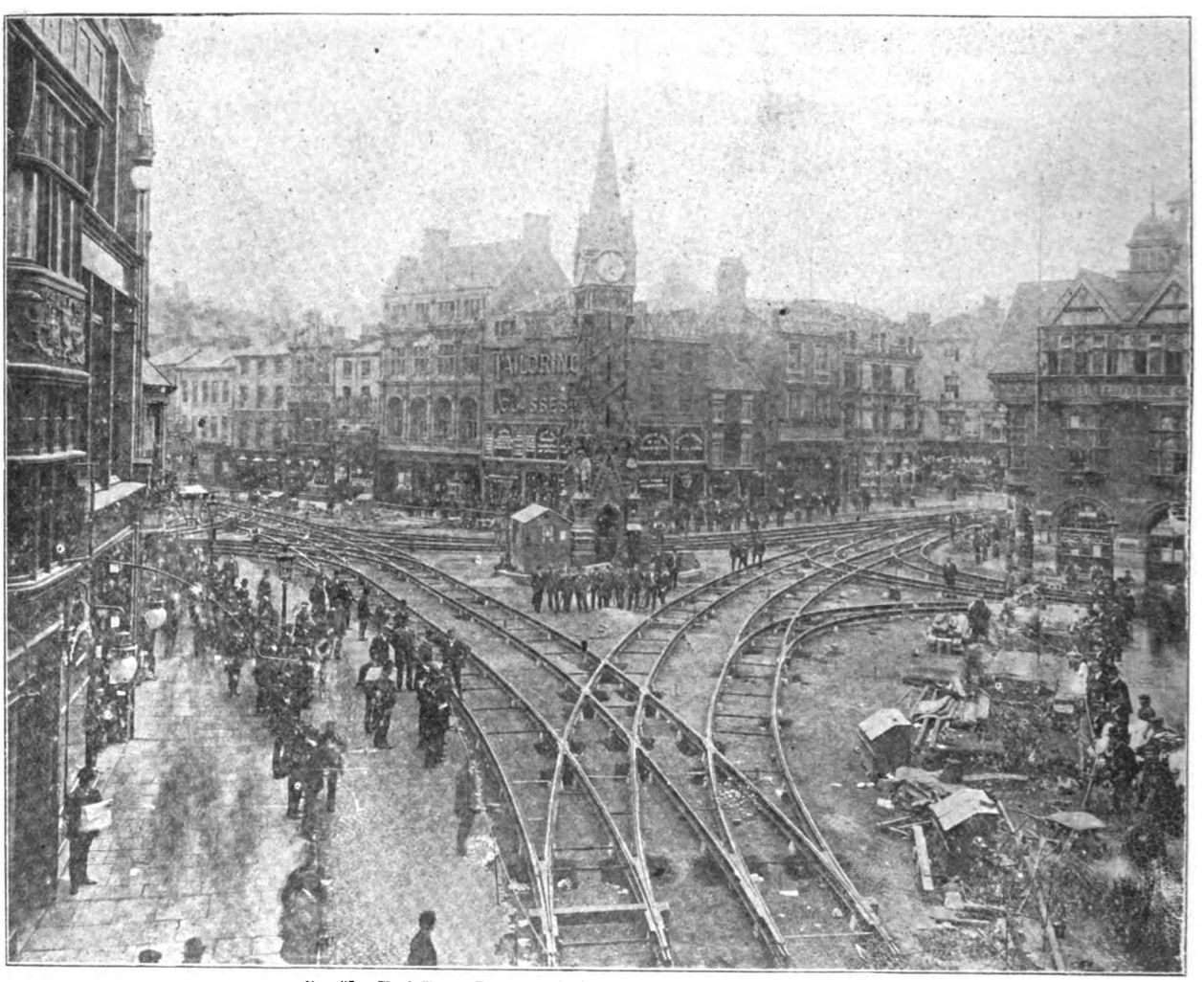

FIG. 23.—Clock Tower Junction, the heart of Leicester system of Tramways.

construction 10ft. 11½in., giving 6ft. 3in. between tracks. The gauge of the track is 4ft. 8½in. The rails, which are in 45ft. lengths, weigh 100lb. per yard for the straight running track, the grooves being 1⅛in. wide. Those for the curved track (Fig. 17), of a radius of one chain or under, weigh 105lb. per yard, the grooves being 1¼in. wide. Both classes of rails are 7in. deep and 7in. across the flange. The fishplates weigh 54lb. per pair, and are 2ft. in length, each pair being drilled for six 1in. diameter fish-bolts, fitted with Ibbotson's patent lock-nuts. Cooper's patent anchor, 2ft. long, has been used on all joints throughout the work, each joint being secured to the rails with 12 ¾in. diameter steel rivets (except on special track-work, where bolts are used), the riveting being done by the patentees. No intermediate joints have been used excepting round curves. The tiebars, which are placed 7ft. 6in. apart, are of flat steel section, 2in. by ⅜in., with Messrs. Bayliss, Jones, and Bayliss's patent ends, each bar being secured by four nuts, one on each side of the web of each rail. The composition of the steel for the rails is as follows: carbon, between ·40 and ·55 per cent.; manganese, under 1·00 per cent.; phosphorus, not to exceed 0·07 per cent.; sulphur, not to exceed 0·07 per cent.; silicon, not to exceed 0·07 per cent. The composition of the steel for the fishplates is similar to the above, except that the carbon is between 0·25 and 0·35 per cent.

In laying the permanent way the ground was excavated to the required depth, and the rails laid and packed up to the required level on wedge-shaped blocks of concrete, 10in. square at the base and 8in. square at the top. Where bad ground was met with, or the surface worked up owing to inclement weather, these blocks were again supported on circular blocks of concrete 6in. thick and 18in. in diameter to distribute the weight over a greater area. When the rails were truly levelled up, a concrete foundation, composed of six parts of granite gravel and destructor clinker to one part of best Portland cement, was then laid, a space of about 1in. being left under the rails for packing, great care being taken to make the concrete perfectly solid for a space of 6in. on each side of the flange of the rails. The space between the concrete and the rails was then very carefully packed by means of beater picks with 6 to 1 fine concrete in a semi-dry condition. The total depth of concrete under the rails is 7in., and under the paving 6in. A straight length of permanent way is shown under construction in Fig. 18. Short lengths of interlacing track have been used in Belgrave-gate, Humberstone-road, and Aylestone-road. In the latter case (Fig. 19) this was done in order that the cars might pass under the centre of the arched railway bridge, and thus obtain the maximum headroom. In Belgrave-gate and Humberstone-road this method of construction was adopted at narrow portions of the carriage-way in order that sufficient room might be left for vehicles on either side of the track. Very ample provision has been made for the drainage of the track. In addition to a liberal supply of drain boxes on all the tracks, all the movable points have a 4in. diameter spigot cast on to the drainage

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box, which is trapped and connected to the sewer. The drains from these boxes pass through a disconnecting chamber, in which a silt pit is formed before being connected to the sewer. During the laying of the track the borough engineer frequently had the anchor rivets cut off, the bonds and fish plates removed, and the rails lifted in order to see if the rails were solidly packed up, and so carefully was this process watched that in no single instance were the rails found to have been imperfectly bedded.

Generally speaking, the track (Fig. 20) has been paved with 5in. by 3in. granite setts from the local quarries, except in the centre of the town, where 9in. by 4in. by 3in. jarrah and karri hardwood blocks were used. The granite setts were laid on a bed of gravel and grouted up with pitch. The wood blocks were laid on 1in. of cement screening.

The lowest tenders received were for foreign rails and fishplates, but the committee determined to accept the lowest of the English tenders—viz., that of the North-Eastern Steel Company, Limited, of Middlesbrough. This selection has been amply justified, the rails having been supplied fully up to the specification, and giving every satisfaction. There has never been any delay in delivery; on the contrary, the department have always had a good stock of rails in hand. The advantages and facilities thus realised have very fully justified the action of the committee and the Council in placing their contracts in our own country, where their conditions of labour and other matters could be satisfactorily complied with. The bolts, nuts, tie-bars, and copper bonds have been supplied by Messrs. R. W. Blackwell and Co., Limited, while the whole of the special track work was supplied by Hadfield's Steel-foundry Company, Limited. There are a large number of interesting examples of special work, and it is satisfactory to learn that English workmanship has produced a class of work that for design and construction cannot be beaten by any procured from abroad. The standard points adopted are 12ft. long with tongues 7ft. 6in., and embodying Hadfield's latest improvements. All the points and crossings (Fig. 21) are composed of Hadfield's patent "Era" manganese steel, each casting, moreover, having a manganese steel renewable centre. In designing the various junctions, sufficient clearance has been allowed round all curves for the largest type of double-bogie car wherever possible.

All the work throughout the scheme has been standardised as much as possible. For the equilateral loops points 12ft. long, having a radius of 200ft., were adopted, with a crossing 8ft. 6in. long with an angle of 1 in 6. All the loops have a lead of 36ft. 10in, ensuring easy running. For side loops the points are 12ft. 6in. long with a radius of 150ft., the crossing being a 1 in 6 with a lead of 38ft. 6in. All the cross-overs are built left-hand. A standard 100ft. radius point 12ft. long is used with a 1 in 5 crossing 7ft. 6in. long. The cross-overs are 60ft. and 75ft. long, and the movable point is placed in all cases on the left-hand side. The car then has all the points as trailing, making a continual tread run for the wheel. This is a decided improvement upon much of the present tramway work. The lay-outs, including the cross-overs and loops, have been constructed on the floors at Hadfield's works. In designing these to ensure easy running and to standardise the parts, the curves as far as practicable are spiralised. As regards accuracy in forwarding the various lay-outs, it is creditable to learn that no trouble has been experienced in fitting the work on the road. Particularly was this the case with the clock tower junction (Figs. 22 and 23). This is the largest tramway junction in the United Kingdom, and is a very fine piece of special work. The total weight of this lay-out was over 100 tons, but it was so carefully designed that it was laid by the Corporation staff in 10 days. Referring to Fig. 22, it is seen to comprise 10 running tracks. It forms, in fact, the heart of the whole system. Where the traffic will be heaviest, connected movable points have been adopted. Standard 60ft. radius points have been used throughout, all being 9ft. long, even before the car-sheds, where the crossings are also of the same design as upon other lay-outs. Cooper's patent anchor joints have also been used upon the special track work. The fact that all the points and crossings are of the leg type not only has enabled this to be done, but also the use of the standard fishplate, thus facilitating laying the work on site. The bonds used are of the solid copper crown type of 4/0 B. & S. gauge. Two bonds are inserted at each rail joint. The track is cross-bonded every 40 yards, and the way every 80 yards. Where special track work occurs, the castings are connected to adjacent rail ends by 30in. bonds, and are also bridged by long bonds adjoining rail to rail.

*To be continued.)*

## TYPES OF DIRECT-CURRENT LOW-TENSION SWITCHGEARS.

BY W. E. WARRILOW, A M.I.E.E.

(*Continued from page 668.*)

It is quite a common practice in low-tension stations to provide several 'bus bars, on which a number of machines

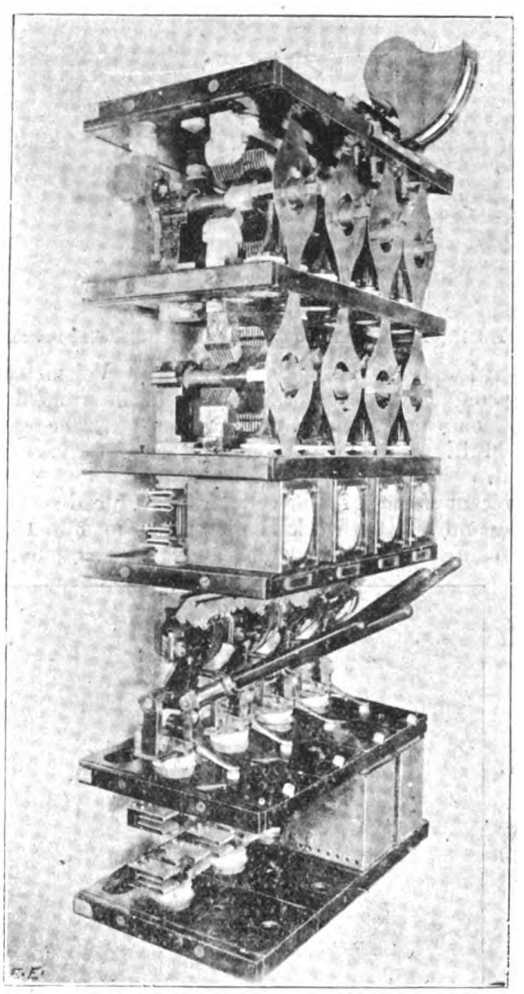

FIG. 14.—Cellular Panels with 'Bus Bar Switches.

and circuits can be run. Flexibility is doubtless the object in view, as considerable advantages obtain with a board so constructed, in being able to ring changes with both dynamos and feeders in case of breakdown. Flat back boards are usually provided with horizontal bars behind the supporting slabs and vertical bars (shorter) on the front of the gear, holes being drilled at the points of intersection, into which screw plugs can be inserted. With the cellular construction the same function is performed by a multi-way switch having contact points corresponding to the number of bars. The arrangement, which admits of a maximum of four bars per pole, provides for the bars and switches at the top of the board (Fig. 14) above the instruments and main switches. The switch spindle carries the main current from a special bearing at the back of the panel to a laminated finger registering and engaging with contacts on the bars themselves. A stop on the spindle indicates mechanically when the switch is midway between two contacts, though a dial plate at the front of the board directs the switchman as to the correct bar, etc.

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When it is desired to connect bars together, two plugs are inserted, in sockets corresponding to the bars, on the face of a special fitting which can be seen in the sixth panel from the left (top row, Fig. 15). A long handle is employed to operate the respective switches, the spindle ends being squared for the purpose. The arrangement admits of speedy manipulation, and the chance of short-circuiting bars on one switch is entirely obviated. Mistakes of this character can easily be made with loose plugs. The particular panels illustrated above are fitted with carbon

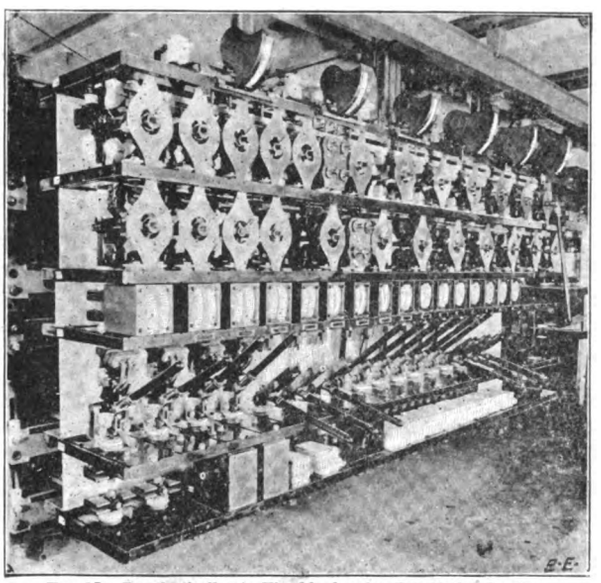

FIG. 15.—Panels similar to Fig. 14, showing Paralleling Device.

break switches in the body of the gear. Voltmeters with rolling contacts surmount the board, the instruments being pulled from side to side to make contact with the respective bars. Multi-contact switches and loose connections are thus avoided.

A recent form of the cellular gear for direct-current lighting and traction work is illustrated in Fig. 16. The board controls three dynamos and two traction feeders, main panels accommodates the hand-wheels for the dynamo resistances, the latter being fixed under the table itself.

An interesting example of this class of board applied to high-pressure direct-current control is depicted in Fig. 17.

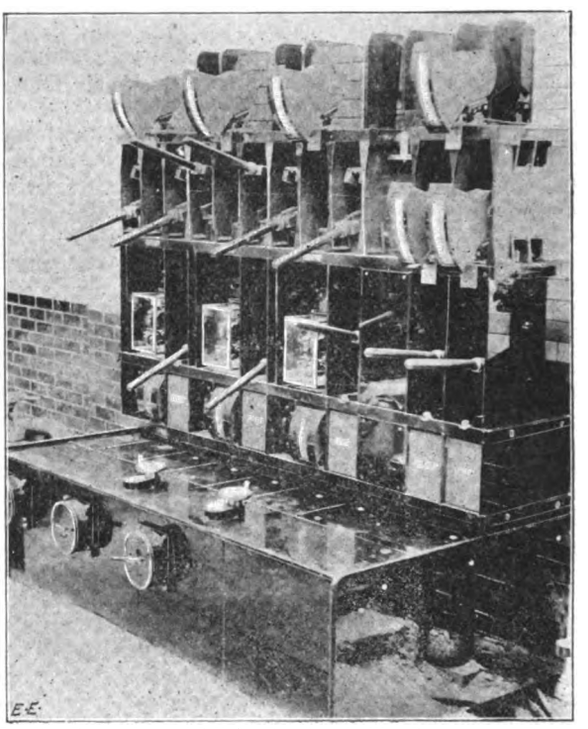

FIG. 16.—Recent form of Cellular Board controlling Dynamos and Feeders.

The panels illustrated form one half of a gear supplied to the Hull Corporation, whose electric supply has been derived since its inception from a high-pressure station run on the Oxford system with rotary transformers. The latter, installed in sub-stations, are started and controlled from the main station in a manner now well known. The board shown controls three dynamo and 15 transformer panels, a diagram of each being illustrated in Fig. 18.

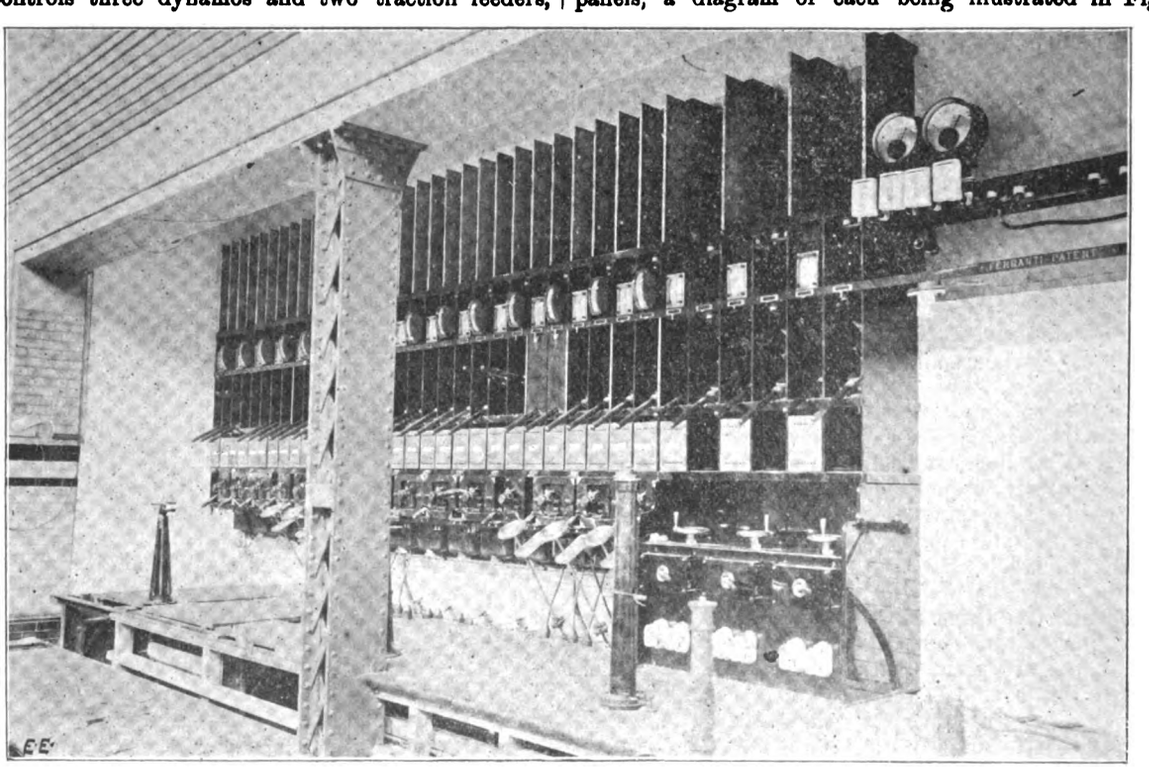

FIG. 17.—High-Tension Cellular Board controlling Direct Currents (Ferranti).

connections being taken from the lighting 'bus bars to an adjoining board. Wattmeters and fuses are included in the dynamo panel equipment, while change-over switches above the switch panels afford a selection of either lighting or traction load for the machines. Horn break switches are provided throughout, the arc tip being mounted well back on the top slate. The usual regulating table below the Horn break switches are fitted to each panel, there being automatic devices of the reverse and maximum types respectively on machines and feeders. The dynamo panels (500 kw. each) are double-pole, with horn switch on one pole and chopper switch on the other. The latter is of the two-way type and has a half-cock position for paralleling. An auto-release actuating on the passage of maximum or

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reverse currents knocks up a catch, which releases the switch and permits it to fall into the intermediate contact, which is in circuit with a water resistance. As soon as this occurs the resistance is gradually inserted by the action of a weight drawing up a plunger in the water-tank. Release is effected by an electromagnet in series with the main circuit. The tanks and tackle are fixed below the switch platform, but the dashpot and hand release project above the platform floor, and can be seen in the foreground. Disconnecting plugs are included to permit of the isolation of the resistance for cleaning, etc. The transformer panels to the left of the machines have horn switches on each pole, an ammeter, voltmeter, starting switch, and regulating resistance. A starting resistance, for use in running up the distant transformers, is provided for every four panels, and a throw-over switch is employed to bring this particular resistance into circuit. Sliding panels entirely prevent the closing of any two switches at one time, and the resistance must be inserted if the transformer is being switched on. Reference to the diagram will make the arrangement clear, while in the view of the complete board the panels and their equipment can be plainly seen. Short-circuiting switches are also provided, which de-energise the magnetic switch at the sub-station, and so cut off the particular transformer from the network.

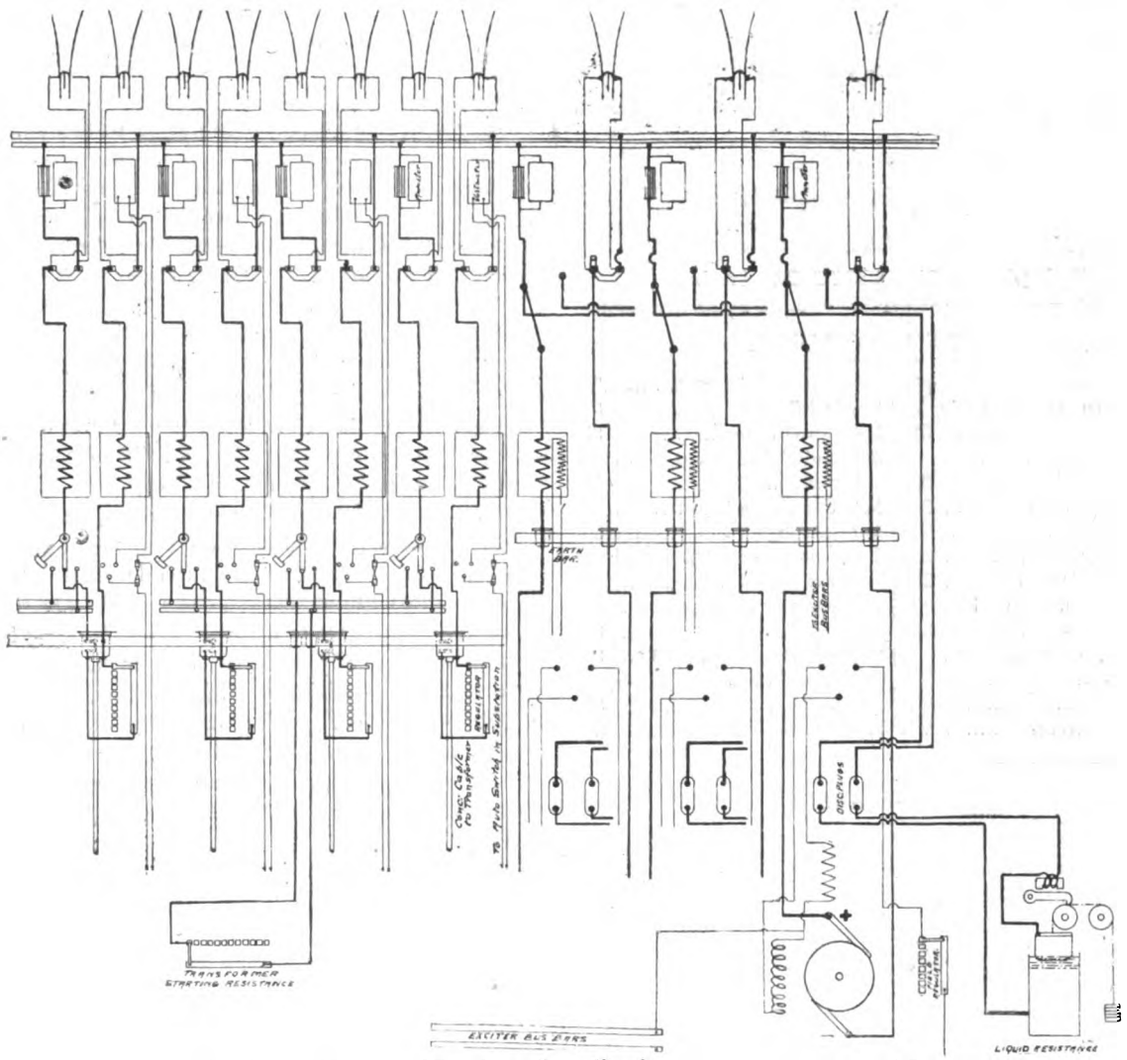


FIG. 18.—Diagram of Dynamo and Transformer Connections for High e r rect ent Gear.

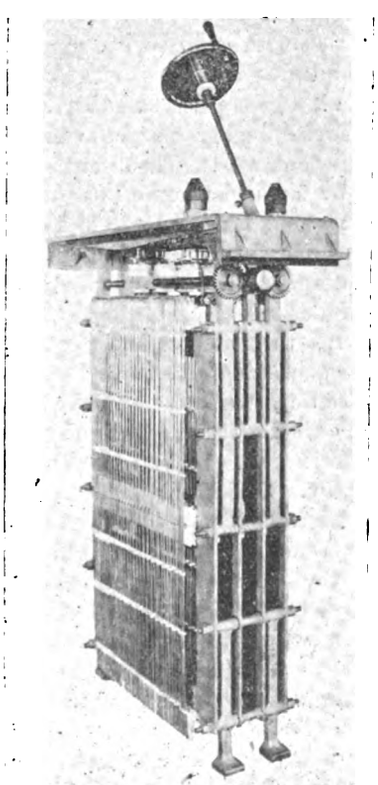

FIG. 19.—Regulating Resistance for High-Pressure Direct Currents (Ferranti)

A complete regulating resistance for dealing with these high pressures is illustrated in Fig. 19, from which the general design can be gathered. The contacts, both fixed and sliding, resemble the well-known Ferranti rheostat, and they dispense entirely with any bundle of wires leading to separate resistances, with attendant risks of burn-outs. Porcelain bridges cemented to cast-iron distance plates act as "formers," whereon the resistance wire is wound, and each turn is isolated from its neighbour by twists of asbestos cord. The upper bridge receives the fixed contacts, through which each wire passes, and is firmly secured by grub screws, afterwards sweated up solid. A face is given the whole line of contacts, and two "brushes" secured to a holder in porcelain insulators form the slider. Four such frames, in two pairs, make up the complete resistance. A shaft, having a coarse spiral thread, actuates the sliders through the medium of a hand-wheel and gearing mounted above the complete frames. Two protected terminals only are required to connect the resistance in circuit.

*(To be continued.)*

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THE

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## ELECTRICAL UNDERTAKINGS.

The importance of any industry, and also its progress, can well be judged by the amount of money which is employed in the same. The interest which the industry returns on the capital invested is also closely interwoven with the progress of the same, as unless the remuneration is reasonable, more money will not be forthcoming for the extension of old enterprises and for the starting of new ventures. The electrical industry can be well gauged from this point of view by reference to the various editions of the "Manual of Electrical Undertakings," which is compiled under the direction of Mr. Emile Garcke. The edition for 1904 is the eighth volume which has appeared. When the first issue was made in 1896, the aggregate capital issued by electrical companies and the loans obtained by municipal authorities amounted to £61,109,525. At the beginning of 1904 the aggregate amount had increased more than threefold, being £226,926,938. An analysis of the various branches of electrical undertakings divides up the capital subscribed, including debentures, under six headings. The first of these includes telegraph companies, but excludes the Government Telegraph Department. During the eight years the increase in the capital expended in telegraph undertakings is comparatively small, being from some 31 millions up to 33½ millions. The average dividends on the capital so invested are fairly uniform, and are at the rate of 4¾ per cent. The certainty of the investment enables money to be obtained easily for telegraphic purposes when required, but the industry has reached a stage when rapid development ceases. In telephone work this is hardly the case, but here again the return on capital seems to be settling down to about 4¾ per cent. The electric supply undertakings, on the other hand, have been vastly increased during the past eight years. Thus, in 1896 the thirty-eight supply companies in existence had a total capital of £5,831,073. In 1904 the number of companies has increased to one hundred and seventy, with a total capital and debenture issue of £24,458,352. It would, of course, not be fair to take the average return on this sum, because a number of new undertakings would be included which have not had an opportunity of reaching the commercial stage. The returns show, however, that with eighty-one companies employing 20½ million pounds, the average return for last year was 5·03 per cent. It is a good point that this average return is quite half of 1 per cent. higher than the average return in the previous issue of the manual. The electrical supply undertakings owned by municipal authorities had employed in 1896 some £1,967,000. Here the rate of increase in capital employed is much more marked, owing to the fact that it is to private enterprise that we owe the earlier developments in any industry. In electric lighting and power supply, therefore, the corporations commenced work only after the pioneering companies had proved the feasibility of electric distribution. Having once started, however, the Electric Lighting Acts were specially favourable to municipalities, who could also obtain money for the purpose most easily. Starting last, therefore, these municipal electrical undertakers now take the lead and employ £27,794,452, or some three millions more than do the companies. In traction work the companies more than hold their own, owing to the range of electric tramways being much more extensive than municipal areas. The old horse tramways were looked upon as means for communication within a town. Electric traction serves the same purpose more economically, but extends much farther, and competes with overwhelming success in certain cases with the suburban railway system. It is to this latter phase of the development of electric tramways that

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companies have been able to hold their own. The progress of such traction undertakings has been more marked than even the supply systems. Thus from 1896 to 1904 the capital invested has gone up from six millions to 61½ millions. This is for company work alone, the corporations now employing 21¼ millions for electric traction purposes. The return of this capital should be considerably higher than with supply undertakings, but up to the present, owing to the extremely rapid advances, the average rate earned is still below 5 per cent. The remaining two classes of electrical undertakings are manufacturing and miscellaneous The manufacturing undertakings employ nearly 36 million pounds, and we regret that the capital so employed is not very remunerative. The average figures given show a return of 5 85 per cent. on 25¾ millions; the other 10 millions if included would reduce this average, and even if this were not so, engineering manfacturers should be able to earn between 10 and 15 per cent. Competition, first from America and latterly from the Continent, has disorganised the electrical manufacturing business, with the sole advantage that the users of electrical plant in this country can buy at almost cost price. By the theory of evolution our surviving manufacturers should be hardy, and fit to continue the strife for existence. We trust, however, that in time their profits will increase in the same way as have the bulk and value of the excellent publication from which we take the above figures.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### LIGHTNING.

SIR,—This is a subject which has interested me for a good many years, and doubtless your correspondent is conversant with most of the literature on it. However, in case he is not, I would refer him to Chambers's "Encyclopedia," to Sprague's "Electricity," to Prof. Silvanus P. Thompson's useful text-book on "Electricity, etc.," and to the last edition of Ganot's "Physics." From these he will find that up to the present there is practically no scientific explanation of ball lightning. It is at all events very rare, and due allowance must be made for the difficulty and suddenness of the observation of it, if it exists—and this seems to be admitted—as also for the terror often present in the minds of persons near thunderstorms, and then again, for the difficulty in describing so strange a sight and for persistence of vision. If it has ever been produced experimentally, some authors would seem to think it must have been accidentally, but I am not sure that this would be the case in Planté's experiment with 2,000 of his cells, or probably 4,000 to 5,000 volts with a condenser, and a good deal of electricity at command. He obtained the effect by means of a plate and a wire both moistened by dilute sulphuric acid. I would recommend your correspondent to study the phenomena of atmospheric electricity generally, more especially in moist air, as I think he will probably find that a stratum of clean, still, moist air would be likely under proper or favourable electric circumstances to furnish a path such as is described for the movement of the "ball of fire." I have often watched thunderstorms in open country, and have had this subject in mind, but I have never seen it, and I am disposed to think that if the phenomenon had been seen by a trained observer the description would be somewhat different. Is it not difficult to account for an explosive "ball of fire" moving independently? If self-contained, whence the appearance of fire? What known electric phenomenon can be compared to it in adhesion? Yet we cannot doubt the general description, which reminds us of one of the ancient plagues of Egypt mentioned in Exodus ix., 23—viz.: " . . . thunder and hail, and the fire ran along upon the ground. . . . So there was hail, and fire mingled with the hail, very grievous, such as there was none like it in all the land of Egypt since it became a nation." Students of ancient history think this refers to "ball lightning" (see Bishop Ellicot's "Commentary"). Now for the cause. Knowing what we do of the wide differences of electric potential in the atmosphere in short distances, may we suppose three strata of air, the first and third being positive and negative and causing a short of brush discharge across the middle one. This would give the appearance of a ball of fire and the complete discharge of the first and third layer would be a flash of lightning, and might quite easily be described as an explosion, especially if it occurred near anything familiar and destructible. Wheatstone showed by his revolving mirror that a brush discharge is really a series of partial sparks, and I do not think it would be a great effort of imagination to suppose this series of discharges moving with comparative slowness until it came to a different condition in the atmosphere which could facilitate the flash or "explosion" of the usual description.

St. Elmo's fire, known by various names in different districts, is so easily compared to a brush discharge that it really presents no difficulty.

In conclusion, I would thank you for allowing this interesting subject space in your valuable journal, and I would also hope that some others would be good enough to give their experience and views.—Yours, etc,

Wickwar, Glos., May 25, 1904. F. GRAHAM ANSELL.

### BLACK OXIDISING METALS.

SIR,—Can any of your readers oblige me by giving me the names of firms who deal in black oxidising metals, especially those who make Russian iron a speciality, or recipes and process of above material.—Yours, etc,

H. F. PURSER.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E, A.M I.C.E., ETC.

*(Continued from page 745.)*

THE WORK OF MARCONI.

*Marconi's System.*—This system has already been referred to in several places throughout the preceding articles.

SIGNOR MARCONI.
(By permission of the Biograph Company).

Guglielmo Marconi, a young Italian (whose mother, however, was an Irishwoman), came to England in 1896. He had previously made experiments at Bologna, and brought with him to England a patent the originality of the claims in which has been the subject of some discussion. Some critics have asserted that most of the things therein described were already well known to workers at this subject. Be this as it may, Marconi was the first to really show us what Hertz-wave telegraphy could accomplish, and

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whether he be original or not is of little consequence. He had what, to an inventor, is far more valuable than any patent—viz, indomitable perseverance and a thorough belief in the ultimate success of the system or systems (for he has introduced many changes and modifications) he advocated. There is no doubt that the aid of a powerful company has been of the greatest value to him; it has enabled him to experiment on a stupendous scale and to *create records*. The public like a man who creates records;

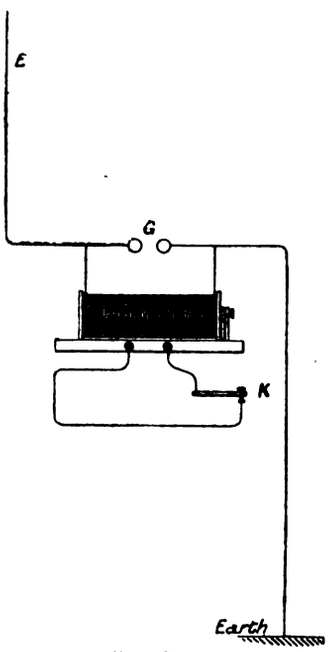


FIG. 36.

hence Mr. Marconi, at 29 years of age, has attained a place in fame and history such as few men reach even at twice that age. Mr. Marconi was welcomed by Mr. (now Sir W.) Preece, then electrical engineer to the Post Office, and the authorities gave all facilities for his earlier experiments, which were carried out on the roof of the General Post Office, London, later on at Salisbury Plain, and between Lavernock Point and Flat Holm in the Bristol Channel.

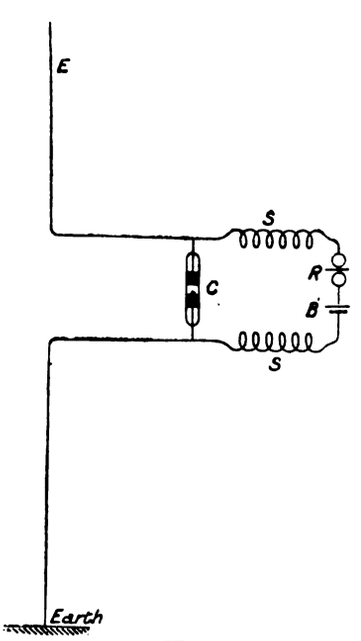


FIG. 37.

Deferring for a moment a consecutive history of his success, reference may be made to his system, and to some of the apparatus employed by him with such success. One of the earlier arrangements is shown diagrammatically in Fig. 36, where E is the elevated wire or aerial which is cut, and in the space thus provided is placed the spark-gap, G, of a Ruhmkorff coil, the primary circuit of which has the usual battery and key by which a longer or shorter series of impulses may be sent out. The receiver is equally simple, consisting of the aerial, E (Fig. 37), one end of which, as in the transmitting apparatus, is earthed. The aerial has a space in it in which is the coherer, C, relay, R, and battery, B. It will be noticed that the ends of the coherer are joined to inductance or choking coils, S S, to confine the oscillations to the coherer.

The newer arrangement is much more complicated, especially that used for long-distance work. Very powerful

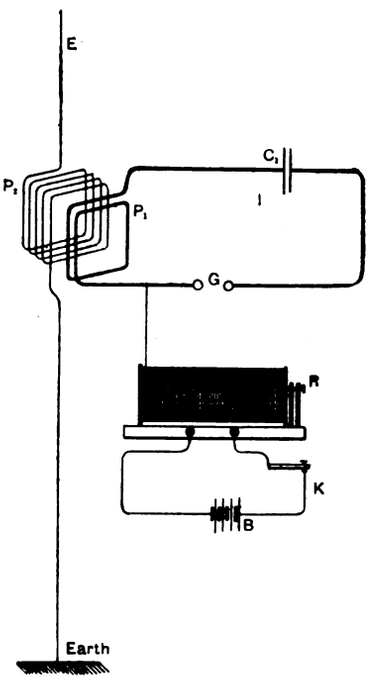


FIG. 38.

impulses are radiated at high pressures. So far as we can ascertain, the transmitting apparatus may be depicted in outline, somewhat as in Fig. 38, where E is the aerial (for long-distance work usually of multiple form as shown in Fig. 39), with the secondary coil, $P_2$, of an oscillation transformer (probably more or less like a large Tesla oil

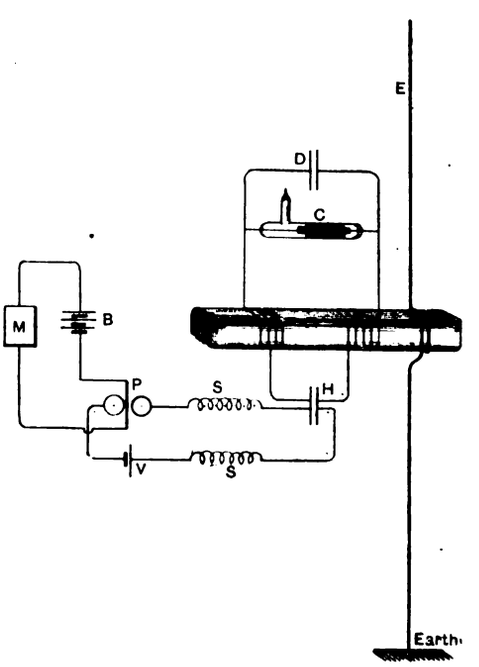


FIG. 39.

transformer) in it, the primary coil, $P_1$, of which is connected to a condenser or series of large condensers, $C_1$, and to the spark-balls, G, of a powerful coil with mechanical break. The source of power is here represented by a battery, B, but is really an alternator in the case of large stations such as those at Poldhu and Cape Cod. There is also a key of special form, by which the length of the impulses or trains of waves may be varied to give definite signals. The receiving apparatus (Fig. 39) has the aerial, E, with the primary coil of an oscillation transformer in it, the

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secondary coil of which is split and contains a small condenser, H, the coherer, C (or magnetic receiver when a coherer is not employed) and another condenser, D. The two sides of the small condenser, H, are joined to another circuit containing the choking coils, S S, the single cell, V, and the relay, P, which, when actuated by the feeble impulses received through the coherer, closes the auxiliary circuit in which is a more powerful battery, B, capable of working the Morse machine, M. There is also close to the coherer tube, and as a shunt to the Morse printer, a tapper actuated by a small electromagnet after the manner of the trembler or armature of an electric bell. This tapper taps or de-coheres the coherer, so as to render it again a bad conductor. However, for long-distance work the coherer is replaced by the magnetic receiver, in which case the Morse printer is not required, the records being read by telephone.

The main features of later improvements will be gathered from the foregoing. Of course, for large distances large amounts of energy must be radiated. This energy depends on the capacities employed in the exciting circuit and on the discharge potential. It is evident that aerials should have large surface, a single wire has not; hence the multiple forms of aerial used by Mr. Marconi, as shown in Fig. 40. Then, again, where induction coils are used, a

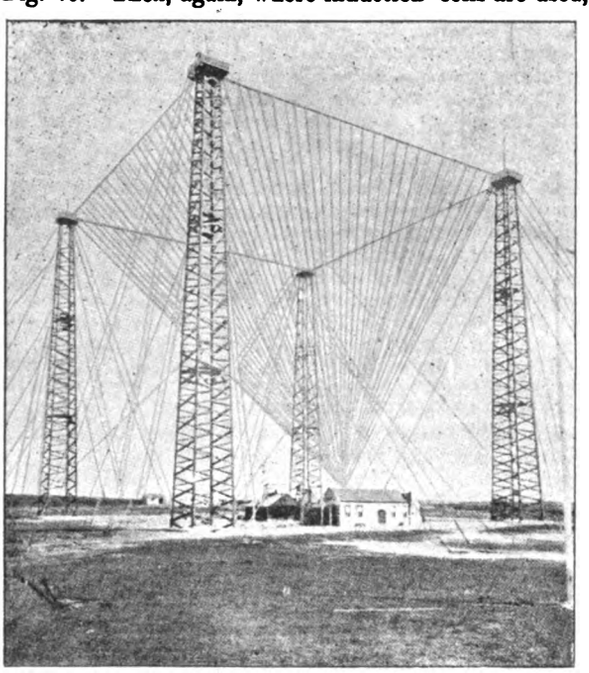

FIG. 40.—The Poldhu Wireless Telegraphy Station.

certain capacity only may be employed in the exciting circuit without interfering with the working of the coils. Since the discharge potential is nearly inversely as the capacity, the available energy would seem to be nearly constant in cases like those referred to, and it is usual to tune the aerials to two or three turns of the Tesla secondary.

Marconi's solution of the difficulty is to first devote all the available energy to produce oscillations of any period in a primary circuit of the highest possible capacity. These oscillations are then brought to a high potential by means of the first Tesla coil, which charges another capacity, so that its period of discharge can be adjusted to the aerial by a second Tesla coil. M. Ferrie proposes to divide all the capacities which the transformer can charge into two or more groups placed in different oscillating circuits, but mounted on the same oscillator. All these circuits, adjusted to equal periods, act on the aerials through as many Tesla coils whose secondaries are mounted in series or parallel. Adjustment is made by trial with a thermal ammeter which must show the maximum reading. By the introduction of syntonisation and the use of the magnetic receiver, Mr. Marconi has been able to signal—indeed, to telegraph on many occasions—across the 2,500 miles of ocean lying between Poldhu and Cape Breton in Nova Scotia, and more recently between Poldhu and Cape Cod in Massachusetts, over 2,800 miles, thus achieving a triumph for wireless telegraphy deemed impossible a few years ago.

At Poldhu (see Fig. 40), if report speaks correctly, an alternator of about 120 h.p. generates the current, which is interrupted by a magnetic or mechanical interrupter. The radiator consists of naked wires, 200ft. long, arranged in a sort of inverted pyramid suspended from horizontal wires which stretch between two pairs of towers 65½m. (215ft.) high and 60m. (196·8ft.) apart, the apex of the pyramid being connected to the power house. The wires are about 1m. apart at the top, and they can be used in sections. The potential to which they are charged is so high as occasionally to cause sparking between the top of one of them and an earthed conductor 7ft. or 8ft. away.

*(To be continued.)*

## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

*(Continued from page 790.)*

### 3. SPARE PLANT AND THE RATING OF PLANT.

*Spare Plant and Overload Capacity.*—The whole question of spare plant and its proportion to the output of the station is an important one in design, as also is that of securing the correct relative capacity of the various pieces of apparatus making up a complete unit: the boiler, the engine, the generator, and the switchgear. On the one hand, if the various components in the station which make up a complete unit have different degrees of reliability, or if some require more overhauling and inspection than others, then obviously different margins of spare plant are required. Again, while every piece of apparatus may be said to have one point at which it works at maximum economy, overload capacity is generally obtainable at small expense, though possibly by some sacrifice of running economy. We suggest that a very great saving can be made in the total cost of production, through a reduction of capital charges (see Fig. 1), if proper attention be paid to these points as follows: (1) by correctly apportioning the spare plant for each piece of apparatus making up a complete unit; (2) by correctly apportioning the overload capacity of each piece of apparatus making up a complete unit; (3) by designing the plant so that the economical rating of each component is identical; (4) by relying upon the overload capacity, not only for dealing with sudden emergencies—say, a shut-down of one of the units that may happen to be running at the time—but also depending upon it for the ordinary peak load of the station, or when other plant is being overhauled. In a gas-engine, as the economical rating coincides with the maximum rating, both peak and breakdowns can only be met by installing additional plant. In the case of a steam station, if the load under normal (not peak) conditions is equal to the economical rating of one machine only, then it is clear that while it might be possible to take care of the peak with the overload capacity of that machine, an additional unit is essential to allow for periodical overhaul and to guard against failure through the breakdown of a unit section.

*Effect of Peak at Neptune Bank Power Station.*—The three factors to be met by the installation of machines having an overload capacity and by the provision of spare machines are: (1) the peak; (2) periodical overhaul; (3) breakdowns. Whether any or all of these factors are best met by additional plant or by overload capacity depends on the number of units installed and on the relation between the peak and the overload capacity procurable; but in any case it seems to us important to take the overload capacity into consideration in designing a station, and to consider it a feature in design—not merely a casual advantage which may happen to come in useful. We attach 12 typical load curves, one for each month of the year 1903 for the Neptune Bank power station (Fig. 10). As a matter of fact, if we take the year in question and consider the normal load as 100, the peak load is 100 per cent. higher, or 200. The total number of units sent out of the station while the load was at or below normal (100) was more than 80 per cent. of the total number of units sent out during the year. In other words, if this 100 per cent. peak is represented by 100 per cent. extra plant, the 100 per cent. of extra plant only turned out a proportion of the balance of 20 per cent. of the total units.

*Overload Capacity in the Components of each Unit.*—While, therefore, it is important that the plant should operate economically at normal rating, it is of equal importance that it should have a uniformly high overload capacity. Little regard need be paid to the running costs at the peak, as the resulting fractional increased coal consumption is far more than balanced by the saving in capital charges.† The steam-turbine lends

* Paper read before the Institution of Electrical Engineers.

† It does not follow that even the fuel costs must necessarily be increased by forcing the plant at the peak. In the case of a very short peak, such as is formed by the load of works which shut down at

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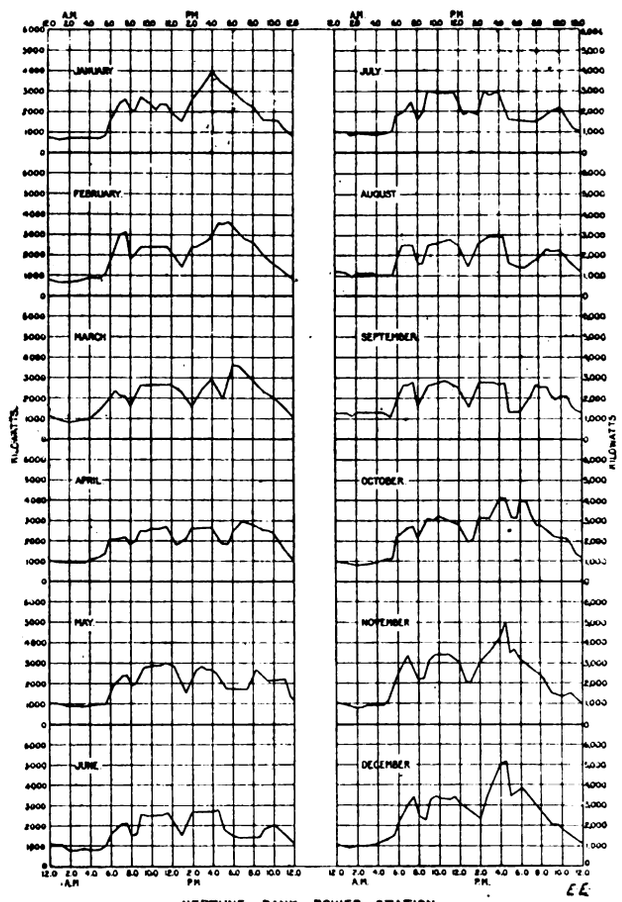
itself admirably to dealing with large overloads, as by means of a by-pass admitting high-pressure steam to the low-pressure section of the turbine the capacity of the turbine can be increased 50 per cent., though this is, of course, accompanied by a certain drop in economy. Standard designs of alternators can be built without excessive cost to stand an overload of 50 per cent. for two hours. If, therefore, the boiler plant has a similar range of elasticity, the peak can be met by simply forcing all plant beyond its economical production point, and by doing the same in the engine-room if any of the units are out of commission for overhaul. There is no great difficulty in securing that the boilers shall have the necessary elasticity even under natural draught, but under mechanical draught the solution is easy. In fact, the adoption of artificial draught improves the control of the boiler-house plant so enormously under ordinary conditions that it is, in our opinion, desirable to instal it apart altogether from the question of emergency output.




NEPTUNE BANK POWER STATION.
LOAD CURVES ON TYPICAL DAY FOR EACH MONTH IN 1903.

FIG. 10.

*Basis of Rating Power Stations.*—Apart from actual personal experience, it is only by comparing one station with another that an engineer can hope to improve his design, so far as low capital cost is concerned. It is, therefore, important that the basis of comparison should be fair and uniform, but it is not a particularly simple problem to define what this uniform basis should be. It is evident, for instance, that for all practical purposes a station containing, say, four steam-turbines, each of a normal economical rating of 2,500 kw., is of larger capacity than a station containing two turbines each of a normal economical rating of 5,000 kw., while these steam stations are respectively of larger capacity than a gas-engine station containing four units of 2,500 kw. normal economical rating, or two units of 5,000 kw. normal economical rating. As can be seen at a glance from the following table, there are eight different ways in which a station may be rated :

| | Continuously. | For a short period. |
|---|---|---|
| Maximum possible load | (1) | (5) |
| Maximum economical load | (2) | (6) |
| Maximum possible, less allowance for spare plant | (3) | (7) |
| Maximum economical, less allowance for spare plant | (4) | (8) |

(1) On the basis of the maximum *possible* load which the station is capable of dealing with continuously, making no allowance for spare plant.

(2) On the basis of the maximum *economical* load which the station is capable of dealing with continuously, making no allowance for spare plant.

(3) On the basis of the maximum possible load which the station is capable of dealing with continuously, *less an allowance for spare plant.*

(4) On the basis of the maximum economical load which the station is capable of dealing with continuously, *less an allowance for spare plant.*

(5) On the basis of the maximum *possible* load which the station is capable of dealing with for a short period, making no allowance for spare plant.

(6) On the basis of the maximum *economical* load which the station is capable of dealing with for a short period, making no allowance for spare plant.

(7) On the basis of the maximum possible load which the station is capable of dealing with for a short period, *less an allowance for spare plant.*

(8) On the basis of the maximum economical load which the station is capable of dealing with for a short period, *less an allowance for spare plant.*

*Suggested Common Basis for Rating Power Stations.*—Of the above, No. 4 would seem at first sight to be the most reasonable—*i.e.*, rating the station on the basis of the maximum economical continuous output, making due allowance for spare plant. This would certainly be correct if we were dealing with load factors of 100 per cent., as, of course, in such cases practically the only value of overload capacity is for dealing with a sudden emergency due to the failure of one of the running units. As, however, we are considering essentially a station for power supply where the load factor over the year may be expected not to exceed 25 to 30 per cent., low cost of production will be facilitated by the engineer considering capital expenditure rather from the point of view of the most economical way of dealing with the peak load, or, in other words, if in estimating the capital cost he considers that the rating of the station is based on its maximum possible output for one or two hours—that is to say, on the basis of No. 5. The authors consider that by proper attention to spares and overload capacity the cost per kilowatt of maximum output of a power station can be reduced from 20 to 40 per cent., depending, of course, on the load factor to be dealt with.

*Size of Unit.*—The selection of a suitable size for the generating units is a question which is intimately associated with that of spare plant and capital cost, more particularly where future extensions are taken into account. That the *number* of units should be kept as low as possible (especially with steam-turbines) may be taken as axiomatic ; and this, of course, points to units of large size. On the other hand, a limit is set to this reduction in *number* by the following factors : (*a*) the amplitude of load variation throughout the 24 hours, or at different seasons of the year ; (*b*) the capital cost of spare plant. In general, a solution which meets (*b*) will also be consistent with (*a*).

(*To be continued.*)

5 o'clock overlapping the lighting load, the all-day economy of the boiler-house may be actually improved, due to the fewer boilers kept under steam. On account of possible low steam pressure, however, this is only safe with proper induced draught, giving ample margin for forcing.

## TRADE NOTICES AND NOVELTIES.

### Ediswan Publications.

From the Edison and Swan United Electric Light Company, Limited, we have a copy of their catalogue Section IX. (electric bells, etc.) and some leaflets. The bell catalogue has been restricted to all the chief selling lines. It deals with ordinary, medium, and best quality bells on wood bases, cheap metal-framed bells, continuous ringing and "Whittington" bells, and various other types, amongst which we notice some very high-class mining bells. Indicators of two qualities receive attention, and there is a well-classified selection of pushes for all purposes. Space is also devoted to electric bell pulls, burglar alarms, and bell switches. With regard to batteries, the "Ediswan" dry battery and the "O. K." dry cell figure very prominently, while Leclanché cells of the ordinary and agglomerate type are also listed. A well-made and reliable type of linesmen's detector is shown with and without dry cells ; also the necessary bell wires and other accessories. A lucid explanation of the action of the electric bell is included ; also several diagrams of electric bell circuits, which should be useful for the small wireman. The leaflets comprise No. L 2,033, describing the linolite system of lighting ; A 2,034, showing reduction in prices of the well-known "Economic" fuseboard ; two leaflets of domestic telephones ; and a supplementary page to catalogue Section VI., illustrating some quaint electric light brackets constructed of hand-made fret metal, inlaid with mother-of-pearl.

### Reverse-Current Relay for Direct-Current Circuits.

It is now becoming very generally acknowledged that for protecting direct-current generators and ensuring immunity from discontinuity of supply, circuit breakers, which cut off the

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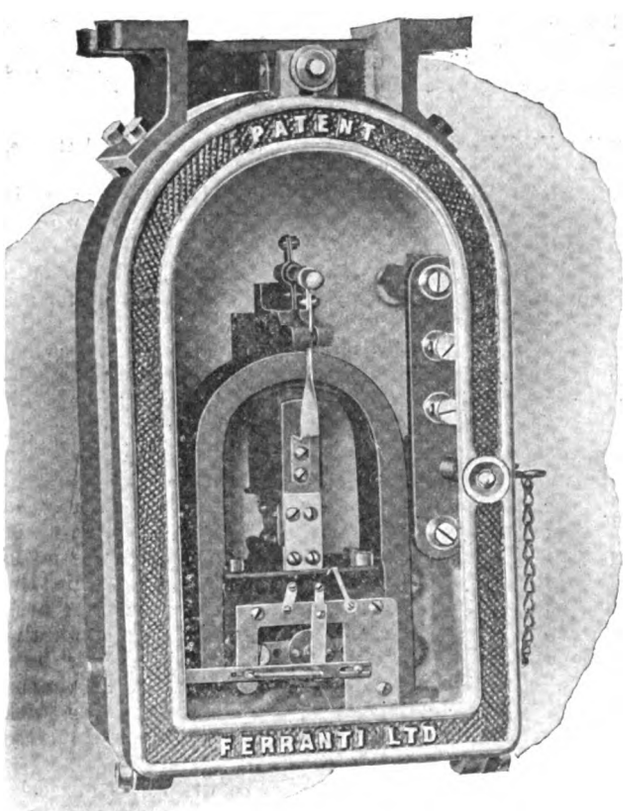
machines from the 'bus bars when a current of a predetermined magnitude flows through them in the reverse direction to the normal, are to be preferred to all other protective arrangements. Such reverse-current devices are being used also at the present time on other circuits than those of generators, though it is on these latter that they find most application. Several types of reverse-current devices have already been put on the market. Generally, they consist of two coils, one connected in the main circuit and the other as a shunt across the 'bus bars. They all labour under the disadvantage that the current at which they operate varies very much with the 'bus-bar volts. The accompanying illustration represents the reverse-current relay recently put on the market by Messrs. Ferranti Limited (Garrard's patent). It consists of a moving-coil polarised relay. The moving coil is operated by the fall of potential across the ammeter shunt. With the current in the forward direction the contact carried by the moving coil impinges against a stop. On the occurrence of a reverse current of a certain magnitude, which is fixed by the amount the controlling spring is set up, the moving coil rotates, and makes contact in the auxiliary circuit mentioned below. This auxiliary circuit is one of eight Leclanché cells, and on being completed causes a small electromagnet to attract its armature. This latter closes a pair of heavy carbon contacts, which complete the circuit of the tripping coil of the circuit breaker. The object of the auxiliary circuit is to remove the sparking which is due




Ferranti Reverse-Current Relay.

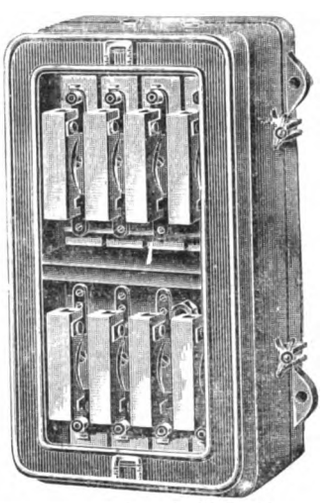
to the induction of the trip coil, from the necessarily light contacts carried by the moving part of the relay proper. The trip coil is connected across the 'bus bars, and is constructed with such a factor of safety that even if the 'bus-bar volts should fall to one-sixth of their normal value it will be sufficiently strong to open the circuit breaker. Generally speaking, the connections are so made that a coloured lamp is lighted immediately the relay operates, thus indicating at a distance which circuit breaker has operated. The relay is provided with a push button. On pressing this the device is caused to work and the circuit breaker to open. If desired, parallel push buttons can be arranged at a distance from the switchboard, so that the circuit breakers can be operated therefrom. Of course, the whole relay can be placed at a distance from the main board if it be wished. The relay can be placed on any direct-current circuit. It is already in operation in several supply stations in this country, where, we understand, it has given every satisfaction.

### Motor Controllers.

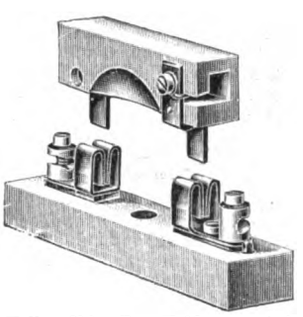
List No. 105, recently published by Messrs. Witting, Eborall, and Co., Limited, Temple Bar House, London, E.C., deals with controllers of the firm's standard types for direct-current and three-phase motors. A great deal of care would seem to have been bestowed upon the designing of these controllers, judging from the excellent electrical and mechanical features which they combine. For the rest, the list is well illustrated, and includes particulars of the resistances used in conjunction with the controllers, besides some useful notes on the arrangement of the apparatus described.

### G. E. C. Section S Catalogue.

Section S catalogue, recently published by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., deals with branch switches, fuses, cut-out boards, ceiling roses, lampholders, Robertson lamps, and Nernst lamps. We note that in regard to the fuseboards listed the spring-clip type of fuse is largely used. This fuse permits of safe and easy replacement, and is at the same time well designed. For circuits up to 250 volts the firm's patent hollow china fuse is mounted on the best quality cut-out boards, while for a cheaper pattern board, a new type channel fuse is used. It is noteworthy that these boards can, if necessary, be fitted in cast-iron cases, which thus ensures protection both from mechanical injury and climate. Particulars and prices of the newly-designed "Quadrant" switch are given. This switch, we understand, has already received the full appreciation of consulting engineers, insurance offices, and all buyers of branch switches. Attention is drawn to the fact that the porcelain used throughout the fittings shown in this list is of the very best possible quality and of British manufacture. The metal work is in all cases substantial, and where used for carrying current particular



Cut-out Board fitted with Double-Pole Hollow China Fuses.



Hollow China Fuse Holder mounted on Porcelain Base.

care has been taken to observe the law of conductivity and prevent undue heating. Reductions in prices are announced in connection with the "Robertson" lamps listed, but not, we are told, at the expense of quality.

## BOOTLE ELECTRICITY ACCOUNTS.

The accounts of the Bootle electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £98,985. Abstracts of the revenue account and general balance-sheet are appended.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 5,158 | 18 | 4 |
| Distribution of electricity | 222 | 13 | 5 |
| Rates and taxes | 354 | 4 | 0 |
| Management expenses | 908 | 1 | 6 |
| Law and parliamentary expenses | 29 | 2 | 6 |
| Special charges, insurances, etc. | 52 | 19 | 0 |
| | 6,725 | 18 | 9 |
| Balance carried to net revenue account | 7,846 | 3 | 0 |
| | £14,572 | 1 | 9 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter | 6,186 | 16 | 2 |
| Sale of current under contract | 4,837 | 11 | 9 |
| Public lighting | 3,511 | 13 | 10 |
| Sale and repair of lamps, etc. | 36 | 0 | 0 |
| | £14,572 | 1 | 9 |

GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 89,070 | 14 | 9 |
| Sundry creditors and floating liabilities | 7,053 | 8 | 3 |
| Revenue surplus | 161 | 3 | 1 |
| Balance—loans repaid and sinking fund | 11,355 | 18 | 9 |
| | £107,641 | 4 | 10 |

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| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works ..... | 93,802 | 18 | 4 |
| Sundry debtors for current supplied, etc. ..... | 4,799 | 15 | 0 |
| Stores on hand..... | 190 | 0 | 2 |
| Cash in hands of treasurer and engineer..... | 8,848 | 11 | 4 |
| | £107,641 | 4 | 10 |

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on May 19 the following were the candidates balloted for:

*Member.*—C. F. De Nordwall, 125, Charing Cross-road, W.C.

*Associate Members.*—B. Pontifex, care of Messrs. G. N. Haden and Sons, Trowbridge, Wilts; W. Shearer, 83A, Morningside-drive, Edinburgh; J. E. Starkie, Corporation Electricity Works, Burnley; C. A. Taylor, 97, Cathles-road, Balham Hill, S.W.; J. T. Walton, King's Lea, Manchester-road, Swinton.

*Students.*—R. L. Beamish, Faraday House, Charing Cross-road, W.C.; J. Duckworth, 25, Stand-lane, Radcliffe; H. S. Ellis, 177, Warwick-road, Kensington, S.W.; C. G. E. Gradisky, 13, Maple-avenue, Chorlton-cum-Hardy, Manchester; H. C. Greenwood, 27, Springfield-place, Leeds; S. Henderson, 9, Queen's-gardens, Benton; W. Johnson, 15, Farmdale-road, East Greenwich; P. H. Morgan, East Dene, Charteris-road, Woodford Green, Essex; W. Robson, Cranleigh, Osborne-gardens, Monkseaton; L. Van Vestraut, Faraday House, Charing Cross-road, W.C.

## PERSONAL.

Mr. A. W. White has resigned his post as general manager of the Portsdown and Horndean Light Railway, and is succeeded by Mr. J. Fereday Glen. Mr. A. W. White recently joined the directorate of the Provincial Tramways Company.

The salary of Mr. W. R. Spavin, the tramways general manager, Portsmouth, has been raised from £350 to £400, and to £500 in two annual instalments of £50 each.

The last house dinner of the Municipal and County Club season, when the Lord Mayor of London was the guest, was held on the 19th inst. at the Club, Whitehall-court, and was attended by about 100 members. Mr. G. L. Gomme, F.S.A., the president of the club, occupied the chair.

At a smoking concert held at the Royal George Hotel, Chester, last week, Mr. Thursfield, the retiring chief electrical engineer, was presented with a silver rose bowl and a pipe. The presentation was made by Mr. A. Dimmack (chief assistant), who, in a few well-chosen words, expressed the regret of all the employés that Mr. Thursfield was leaving them. Mr. A. Dimmack has been made responsible until the new chief (Mr. Britton) takes up his duties.

## FORTHCOMING EVENTS.

FRIDAY, MAY 27.

**Physical Society.**—At 5 p.m., Royal College of Science, "The Law of Action between Magnets and its Bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers," by Dr. C. Chree, F.R.S.

**Institution of Electrical Engineers.**—Benevolent Fund: At 5 p.m., annual general meeting.

TUESDAY, MAY 31.

**Royal Institution.**—At 5 p.m., "The Solar Corona," by Mr. H. F. Newall (Lecture II.).

**Society of Arts.**—"The Economic and Industrial Progress and Condition of India," by Mr. J. E. O'Conor.

**Institution of Mechanical Engineers.**—Chicago Meeting (to June 3).

THURSDAY, JUNE 2.

**Rontgen Society.**—At 8.30 p.m., "Experiments to Determine the Effects of Form and Winding upon Resonance Phenomena," by Dr. C. A. Wright.

FRIDAY, JUNE 3.

**Royal Institution.**—At 9 p.m., "The Development of the Theory of Electrolytic Dissociation," by Prof. Svante Arrhenius.

SATURDAY, JUNE 4.

**Society of Engineers.**—General meeting.

**Institution of Electrical Engineers.**—Annual general meeting, June 9, at 5 p.m.

**Wimbledon District Council.**—(To 28th inst.) public electrical exhibition at Worple Hall, Wimbledon.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

**British Association of Waterworks Engineers.**—Annual meeting, June 9 and 10. June 11-18, visit to Belgium.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

691. What is the best simple test for ascertaining the number of degrees of hardness of boiler feed water in order to check the working of the water-softening plant. I want a simple method which can be readily carried out in the engine-room without the use of elaborate laboratory apparatus.—G. I.

692. For commercial testing, describe what you think the best equipment of a test bed for machines from 20 kw. to 200 kw., so as to procure the greatest facility in laying down, setting, etc. Describe the switching and controlling arrangements.—TESTER.

ANSWERS.

*Question No.* 684.—State the principles underlying thermal storage, and, if possible, give rough details of existing plant.

*Answer to No.* 684 (*awarded* 10*s.*).—Thermal storage is a system which enables a small boiler to be worked economically on a very variable load, this being made possible by heating to boiler temperature, and storing a large quantity of water, this to be used as hot feed for the boiler during periods of heavy demand. At such times the furnaces are merely called upon to provide latent heat and produce steam at the same temperature as the feed water—*i.e.*, at the temperature of the storage tank. The idea is one which has not gained universal approval by any means, the principal arguments of the system's opponents being that immense storage accommodation is necessary to obtain any real benefit, this involving great expense, as may be imagined. The economy of the system, in the opinion of experts, is also open to doubt, unless provision can be made for storage at pressures much in excess of that at which the steam is to be utilised, this desideratum not having been accomplished yet. Thermal storage tanks are naturally cheaper to construct than boilers, as they need only be a plain cylindrical shell with egg-shaped ends or flat ended if properly stayed; the plates, however, must be as thick as those of a Lancashire boiler of similar diameter. One real advantage of the system might be mentioned. The storage tanks permit of considerable quantities of scale-forming impurities, and sludge settling previous to the water entering the boiler, the latter thus being kept largely free of these undesirables.

In a paper read before the Institution of Civil Engineers some little time ago Mr. C. N. Russell describes the installation at the Shoreditch refuse destructor, of which the following is a summary: The feed water for the boilers was drawn cold from storage tanks by three-throw pumps, which forced it through economisers placed in the main flues, where it was raised to a temperature of about 200deg. F., depending upon the heat of the flue gases and condition of economiser. The water was then forced upwards into a large feed-water storage cylinder, 30ft. by 8ft., fixed about 20ft. above the boilers, and was connected direct to the main steam line, and which was, therefore, at the same temperature and pressure as the boilers, which were fed directly from this cylinder by gravity, the water flowing into the boilers freely without any strain or racking action on the check valves. The steam was generated in the boilers at an average pressure of 140lb. per square inch.

The whole object of thermal storage is to provide feed water to the boiler at the same temperature as the latter, and that a first-class economiser under favourable circumstances is capable of doing this few will deny. The necessity for a thermal storage system, therefore, is hard to realise.—F.

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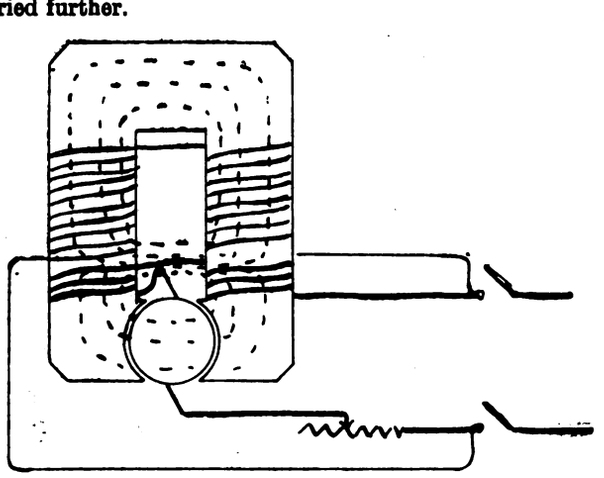
*Question No.* 685.—A compound-wound motor in use for driving a printing machine has a peculiar characteristic. It does its work all right, but on stopping and testing the poles with a compass the writer finds they have reversed—*i.e.*, the working magnetism is opposite to the residual magnetism. Particular care has been taken that the dynamo is not connected up differentially, as the connections have been changed every conceivable way, but with the same result — the poles invariably reverse when starting or stopping; in both cases immediately on opening or closing the double-pole switch.

*Best Answer to No.* 685 (*awarded* 10*s.*).—The reversal of polarity probably exists only in the compass needle employed and not in the motor at all. If, when the machine is running and the field is fully excited, a small compass needle be brought fairly close to one of the poles, its indications will be quite unreliable, for whichever end of the needle happens to be nearest to the pole will remain pointing that way, due to the fact that its own magnetism is temporarily completely obliterated and replaced by an induced magnetism of opposite polarity to that of the motor pole. When the motor is switched off and the poles are only magnetised by the slight residual magnetism, the compass needle is no longer overpowered, and then gives correct indications of polarity. The fact that the two indications are always opposite to one another in the case in question may be accounted for by the motor being so placed that the normal (north and south) direction of the needle is opposite to the direction the needle should occupy when giving correct indications of the motor polarity. In this way the needle would approach the fully magnetised pole in the wrong direction, and would be retained in that direction by the overpowering induced magnetism. With the residual magnetism, on the other hand, the needle would assert its own polarity sufficiently to swing round on approaching the motor pole.

It should be easy to decide whether the above explanation is correct by keeping the compass needle a yard or two away from the pole when fully magnetised. In this way no reversal should occur, and the polarity indicated should be the same whether running or standing.—Q.

*Answer to No.* 685 (*awarded* 7*s.* 6*d.*).—The probable reason for the peculiar behaviour of the compound-wound motor is that the series winding, instead of being distributed fairly uniformly over the field coils, is concentrated to some considerable extent on those ends of the magnet limbs nearest to the armature. A motor with its field winding arranged in this manner might behave in the way stated in the question, the permanent magnetism near the pole-tips only being in the opposite direction to the working magnetism; if this is the explanation, consequent poles would be produced in the field limbs, and might have been detected by the use of the compass if the investigation had been carried further.



In the accompanying figure there is shown diagrammatically an arrangement such as described above, and the approximate disposition of the residual magnetism is shown by dotted lines. When the double-pole main switch is opened while the motor is running, the induction of the windings of the motor tends to keep the currents flowing in the same direction as before, but the induction of the shunt winding—which we may take for granted is much larger than the induction of the series coils and armature—succeeds in overcoming the inductive effect of the latter and reverses the current in them; this current is not very large, it cannot, in fact, be greater than the normal shunt current, or, indeed, equal to it, since the E.M.F. which produces it is only maintained by the decrease of that current, but if the series winding is concentrated as described, the magnetising force underneath it may be in the reverse direction to what it would be if due to the shunt coils alone. The reverse residual magnetism is no doubt quite small in amount as compared with normal magnetisation, but this might not be easily detected with a compass needle. Of course, when the motor is started up again the direction of magnetisation is governed simply by the direction of the supplied current, and the contrary residual magnetism is wiped out.—SUPERHEAT.

*Answer to No.* 685 (*awarded* 5*s.*).—As the question distinctly states that the motor is not connected up differentially, the cause must not be looked for as being due to momentum of armature and connected machinery. If connected up differentially, such momentum might cause reversal of the polarity of the magnets. It would be interesting to know the position in which the compass was held when polarity of magnets was noted. To ensure a reliable test, the compass needle should be held well away from the action of the armature's poles. It is quite possible that the conditions may have been such that the polarity of the armature had a greater effect than the polarity of the magnets on the compass needle. Supposing that the polarity of the magnets is actually reversed, the probable cause is as follows: When the double-pole switch is opened, the inductance of armature and series winding, also the inductance of the shunt winding, come into play. On their circuits being broken, the tendency is to keep the currents flowing in the normal direction. This is a direct result of Lenz's law. Now if, when the double-pole switch is opened, the shunt winding is left in parallel with the armature and series winding, these two circuits will be in opposition. Given an armature with considerable induction and a large number of series turns, the sum of these two effects may overpower the effect due to the shunt winding. Thus a current will be forced round the shunt in an opposite direction and so cause reversal. Very soft iron magnets and large backward lead to the brushes would be causes helping towards reversal. On closing the switch current is sent round shunt winding in the normal direction, thus again causing a reversal of the polarity of the magnets.—M. M.

## PHYSICAL SOCIETY.

At the meeting of the above society on May 6, Mr. J. Swinburne, vice-president, in the chair,

A paper, entitled "**Some Instruments for the Measurement of Large and Small Alternating Currents,**" was read by **Mr. W. Duddell.** The author, after some preliminary remarks on the available means for measuring alternating currents, proceeded to describe three thermal instruments which he has constructed for this purpose. The first instrument is essentially a sensitive Ayrton-Perry twisted-strip ammeter, which is very quick in action for a thermal instrument, and has been used for observing and recording P.D.'s and currents which varied as rapidly as one per second. It is compensated for change in the surrounding temperature by forming the sides of the frame which holds the twisted strip with the same wire that the strip itself is made from. With the instrument exhibited a current of 22 milliamperes gave a deflection of one-quarter the scale distance—*i.e.*, 250mm. at 1m. scale distance. The mechanical periodic time is only about $\frac{1}{4}$ second. Using this instrument in series with a high resistance, the author has made observations on the variations in the voltages of alternators caused by cyclic irregularity of the engine. By working to a false zero it is easy to obtain 10mm. change in deflection for 1 per cent. change in the P.D. The second instrument exhibited was a very sensitive thermal galvanometer, called in the paper a "thermo-galvanometer." It consists of the combination of a radio-micrometer of the "Boys" type with a very small resistance, which is heated by the current to be measured, and which in turn heats the thermo-junction of the radio-micrometer by radiation and convection. The principle of its action is as follows: A loop of wire has its two ends fixed to the two bars of a single thermo-junction, a mirror is fixed to the loop, and the whole is suspended in a magnetic field by means of a quartz fibre. The heat from the resistance raises the temperature of the thermo-junction, and causes a current to flow round the loop which is deflected by the magnetic field. The sensibility of the instrument depends on the resistance of the heater. Using a heater having a resistance of 13,910 ohms, a deflection of 250mm. at a scale distance of 1m. is obtained with

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a current of 31 micro-amperes; a heater having 18 ohms resistance required 800 micro-amperes to give the same deflection. To illustrate the high sensibility of this instrument, the author showed the large deflections produced by the currents through a telephone receiver even when the source of sound was many feet distant from the microphone; he also showed that if the thermo-galvanometer was placed in series with the vertical receiving wire in spark telegraphy over a short distance, large deflections were produced. The third instrument described was a switchboard instrument which works on the same principle as the last, only that the moving part is pivoted in the usual way. The author exhibited one of these instruments, arranged to give the whole scale deflection for only 0·15 volt, which can be used in connection with shunts to measure large currents; for instance, to measure 1,000 amperes the power lost in the shunt would only be 150 watts. Transformers can also be used, as the power to produce the whole scale deflection is only 0·3 watt. A similar instrument with a high-resistance heater was also exhibited giving the whole scale deflection for 0·1 ampere, which can be used as a voltmeter by putting resistance in series with it.

**Prof. R. Threlfall,** in a letter to the secretary, congratulated the author on his instruments, and stated that we were not told the effect of change of relative position in the heater and thermo-junction during the operation of the thermo-galvanometer. This effect might make it possible to construct an instrument having either a scale of equal parts or of any desired form.

**Dr. P. E. Shaw,** in a letter to the secretary, said it was possible to measure the amplitude of vibration in the diaphragm of a telephone receiver, and Mr. Duddell's instruments would enable us to determine the currents producing these vibrations.

**Dr. D. K. Morris** pointed out that the working forces in an electrostatic instrument could be increased by limiting the angular range without increasing the moment of inertia of the moving system. For instance, this could be effected in a quadrant electrometer with a wide needle by subdividing the needle into narrow fingers and sub-dividing the quadrants in a similar manner. Dr. Morris showed an instrument constructed on this principle capable of measuring 0·1 volt when used idiostatically. The limit to this process of sub-division is decided by the practical working clearance—the clearance being determined by the tilting of the needle due to unbalanced electrostatic forces. Such an instrument may be called a "multipolar electrostatic instrument," and Dr. Morris has used the same idea in the construction of a "multipolar electrodynamic instrument." Both of these instruments were exhibited at the meeting, Dr. Morris said he was glad of the opportunity of Mr. Duddell's paper for bringing them forward, and although they were well suited for use as zero instruments as detectors, they were not nearly so sensitive as the instruments designed by the author of the paper.

**Prof. W. E. Ayrton** said we had another example of the ingenuity of Mr. Duddell, and drew attention to the fact that he had not only designed the instruments but had also constructed them himself. He was pleased to see that good results had been obtained by using an Ayrton-Perry twisted strip. The use of such strips had hitherto been limited by the absence of contrivances for compensating temperature-change effects. With such compensation it is possible by using a twisted strip to combine simplicity of construction with constancy of zero. In expressing especial interest in the experiment on spark telegraphy, Prof. Ayrton referred to the fact that Mr. Duddell had designed his thermo-galvanometer for use in an important investigation, being unable to purchase a suitable instrument. The author had spoken about an alternator with a frequency of 120,000, and he hoped we would soon have some account of it. Referring to the remarks of Dr. Morris, he said it was often difficult to calculate the sensibility of a quadrant electrometer with a divided needle. In order to do so, it was essential that the edges of the needles should never be near to the edges of the inductors. Any arrangement to increase the sensitiveness of an electrostatic instrument was desirable, and if Dr. Morris had obtained large deflecting forces without bringing the needles and inductors very near together, he was to be congratulated. He asked the author if it would not be better in his thermo-galvanometer to double the heater on itself, and thus obtain a greater heating effect with diminished self-induction.

**Mr. A. Campbell** expressed his interest in the instruments shown. Some years ago, in connection with the measurement of small alternating magnetic fluxes, he used a hot wire near a minute thermopile connected with an ordinary moving-coil galvanometer. One of the main difficulties with such arrangements was the slowness in reaching a steady deflection and in settling back to zero. For some relative positions of the thermopile and heater the deflection passes through its steady value and creeps back to it; for other positions the steady value is reached asymptotically. Even in Mr. Duddell's instruments the effect is quite noticeable, and it appears to want further elucidation. In order to render more uniform the calibration of the scale (which normally follows the square law), Mr. Campbell had sometimes mounted the heater, so that by its expansion (or that of another hot wire) a spring drew it further from the thermopile as the temperature of the heater rose.

**Mr. E. Edgcumbe** congratulated the author, and said that as far as small alternating currents were concerned the instruments shown would be very useful. He could not, however, follow the author when he said that his pivoted form of thermo-galvanometer would make a good switchboard instrument, because it was never necessary to measure small currents. In using Mr. Duddell's instruments it was necessary to have very good contacts. Mr. Duddell had spoken of the advantage of being able to remove one heater and put in another, but the speaker pointed out that it would be necessary to adjust the second heater with accuracy, or errors would be introduced. He was not a believer in hot-wire instruments, which were unsuitable for central-station work and gradually dying out in this country.

**Mr. W. A. Price** said he had recently been thinking of the possibilities of the instrument described by Dr. Watson in the discussion on Prof. Fleming's recent paper on a "Hot-Wire Ammeter." He thought that in many respects this instrument would be more practical than those brought forward, although it would probably not be so sensitive.

**Mr. W. Bennett** asked how far the temperature correction in the twisted strip was perfect. It might be slightly affected by the fact that the twisted strip, though of the same material as the side wires, had been treated rather roughly in the process of flattening and twisting, the coefficient of expansion being possibly lessened. The fact that the strip and wires were at different temperatures might also affect the correction adversely on account of the temperature variation of elasticity. The sensitiveness of the radio-micrometer form of instrument would be increased if the efficiency of heat-transference between the heater and the thermo-junction could be improved. If it were possible to make a heater that would nearly surround the junction this might be effected, and the variation of sensitiveness due to inaccurate replacement of the heater after removal would be lessened. He suggested using as a heater a thin film of platinum deposited on the inside of a small thin tube of glass or quartz.

**Mr. R. S. Whipple** said he would like to testify to the great patience of Mr. Duddell in overcoming the difficulties met with in the construction of his instruments. He was of the opinion that a good deal of the bad name of hot-wire instruments could be attributed to their inability to stand overload.

**Mr. H. Tinsley,** referring to Prof. Ayrton's remarks about the position of the needle in an electrostatic instrument, said he had recently tested the matter accurately. So long as the edges of the needle were well within the inductors it was easily possible to calculate the deflection which would be produced by any voltage to about 1 part in 500. Under such conditions the instrument accurately followed a square law, and its working constant could be obtained from one observation.

The **Chairman** said that a thermopile had been used many years ago in a similar way to that in which the thermo-junction had been used by Mr. Duddell, but the sensitiveness obtained was not nearly so great as that of the instruments exhibited. With regard to electrostatic instruments, he did not see any advantage in being able to predict the deflection produced by any voltage, according to a definite law, as it was always easy to calibrate such instruments. The shape of an instrument with an Ayrton-Perry twisted strip often rendered it unsuitable for many purposes.

**Mr. W. Duddell,** in reply, said that it was necessary that the heater and the thermo-junction should be very small, and this made it difficult to diminish the self-induction of the heater by doubling it on itself. It was also essential that the bars of the thermo-junction should be narrow, otherwise creeping effects were introduced. The deflection might also be too small, due to the increase in resistance of the whole circuit brought about by the heating effect of the current. Referring to Mr. Edgcumbe's remarks, he pointed out that his pivoted instrument used less watts than any instrument on the market, and could be used, if necessary, in connection with transformer instruments.

**Mr. F. E. Smith** exhibited and described the following instruments from the National Physical Laboratory: (1) a mercury-resistance standard; (2) a 10-ohm build-up resistance box; (3) an astatic galvanometer.

## LEGAL INTELLIGENCE.

### MACARTNEY, M'ELROY, AND CO., LIMITED v. THE CORPORATION OF BRIGHTON.

The plaintiffs sought to recover £16,000, the balance alleged to be due for work and labour done under a contract for laying down tramlines and roadmaking.

Mr. Lush, K.C., Mr. H. S. Cautley, and Mr. Moss-Blundell were for the plaintiffs; Mr. Moulton, K.C., Mr. Boxall, K.C., and Mr. C. C. Scott for the defendants.

The action was tried before Mr. Justice Grantham and a special jury in April last, when his Lordship deferred judgment pending the consideration of questions of law raised by the defendants. The point at issue was whether the plaintiffs, on a true construction of their contract with the Corporation, were entitled to charge some £14,600 for preparing the bed of the wood pavement, or whether this work was covered by the contract price for the paving of 19s. 7d. per yard. The jury had found that both parties had intended that the bed should be an extra charge, and the plaintiffs asked that if it should be held that the contract as drafted did not embody the intentions of the parties, it should be rectified. For the defendants it was contended that a contract of a corporation, being necessarily under seal, could not be subsequently rectified, and that the intention of the present contract was not open to question.

**His Lordship,** in giving judgment, reviewed the facts at considerable length, and criticised the conduct of the defendants in attempting to evade, by legal technicalities, a liability which, he held, they had undoubtedly meant to undertake. He held that, in order to carry out the intentions of the parties, the contract required rectification, and that he had power to rectify it, and he gave judgment, with costs, for the plaintiffs for an amount to be ascertained when certain items, including the sum due under a counterclaim, had been settled on a reference in accordance with the findings of the jury.

### THE LLANELLY TRAMWAYS.

In the Chancery Division last week Mr. Justice Joyce delivered a reserved judgment in the case of the Llanelly Tramways Company *v.* the Llanelly District Electric Light, etc., Company and the British Insulated and Helsby Cables, Limited (formerly the British Insulated

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Wire Company). The case was heard last term. The plaintiffs claimed specific performance of a contract to purchase the Llanelly tramways undertaking and certain premises in Robinson-street, Llanelly, etc., for £5,000. The plaintiffs' case was that they had agreed to sell to the Wire Company, for the sum named, the property in respect of which the action was brought; that for the convenience of the Wire Company a subsidiary company (the first defendants) was formed to take over the contract; that both defendants refused to carry out the contract; and that the Wire Company disputed having had any contract with the plaintiffs. The plaintiffs also claimed interest on the £5,000 and damages for non-completion of the contract.

In giving judgment, **His Lordship** said many things showed that the Wire Company always intended to perform any obligations undertaken by the other defendants. He thought the plaintiffs had shown great forbearance, and he found that the Llanelly District Company was but the creature of the Wire Company. No witnesses had been called by defendants, and on the whole he had come to the conclusion that there had been no discharge or release of the Wire Company from the absolute liability which they undertook by the original contract. There would be judgment for plaintiffs against the Wire Company, a decree for specific performance of the contract against the Wire Company, and plaintiffs must have costs. If they could not agree as to the form of the decree, they must apply to him again.

An application that the action against the Llanelly District Company be dismissed was refused.

**His Lordship** directed that an enquiry should be held as to the amount of the purchase-money and interest, and also as to damages.

# COMPANIES' MEETINGS AND REPORTS

## CALLENDER'S CABLE AND CONSTRUCTION.

The eighth annual meeting was held at Hamilton House, Victoria-embankment, last week. The report appeared in our issue of the 13th inst.

**Mr. Henry Drake,** who presided, remarked that during the year they had acquired as a going concern the Anchor Cable Company's works at Leigh, Lancashire, by the purchase of the whole of the shares in that company for £37,250, and they had advanced, for the purposes of making capital, £35,446, making a total outlay of £72,696. The profit and loss account showed a net income of £46,456, out of which it was proposed to pay a further dividend, making 10 per cent. for the year, with a bonus of 2s. 6d. per share. This would absorb £21,875, leaving £24,581 to be carried forward. The purchase of the Anchor Company's business had eliminated a big item of competition, and the result of the acquisition had been distinctly favourable.

**Mr. C. H. McEuen** having seconded the motion,

**Mr. T. O. Callender,** the managing director, said that their business was largely done with local authorities, and these bodies had found it to be improvident to continue their expenditure on the extension of works for the supply of electricity. The result was that the amount of business offering was very much less than before, and barely enough to go round the whole year. There was, besides, very keen competition for what work had to be placed. The storms of last year had cost them from £600 to £200 a day, and the total loss had reached £10,000.

The motion was carried and the dividend and bonus confirmed.

## TYPEWRITING TELEGRAPH CORPORATION.

The fourth ordinary general meeting was held on Wednesday at Winchester House, Mr. Arthur J. Parker presiding.

The **Chairman,** in moving the adoption of the report, said that the debit balance for the year amounted to the large sum of £2,555, but as a matter of fact, the net loss was only £259. The Corporation had to receive some royalties in respect of German sales, the amount of which was not yet ascertained. The patents stood in the balance-sheet at £50,245, an item which would have to be dealt with at some future period, but in the opinion of the Board that time had not yet arrived. He considered that in consequence of the terms of the agreement between the Exchange Telegraph Company, one of the vendors, and this Corporation, the real values of their patents for the United Kingdom, whatever those values might be, were reduced by that agreement by at least 75 per cent., and the real values of their foreign patents were, in a like way, also reduced by at least 50 per cent. Turning to the profit and loss account, he said that the sales, £3,936, and the royalties, £225, both showed increases. Although the sales during the year exhibited a material increase, they had no increase in the home trade to report, as practically the whole of the sales were to foreign countries. These sales included two good orders from the War Department of the United States of America. It would be remembered that in the prospectus they were told that the Corporation was formed to acquire, among other things, the business as "a going concern and the valuable contracts thereinafter mentioned," which were the agreements with the General Post Office, the National Telephone Company, and the Exchange Telegraph Company. Up to the end of the past financial year, the Corporation had not succeeded in inducing either of those companies to purchase or hire a single machine. Relations between the Corporation and the General Post Office officials were good, but the business with that department was far too limited in extent to satisfy the expectations held out in the prospectus. Referring to the foreign experiments which had been made during the year, the chairman remarked that the Italian Government had been testing their instruments, and had sent to the Board a printed message on the tape which had been received by one of the Corporation's instruments from another station over 1,500 km. distant. The Spanish war authorities had also sent them a like tape message, which had been sent over a military telegraph field wire of 56 km. in length. During the year the practical utility of their Steljes instrument was also successfully demonstrated by their staff in Austria, France, Sweden, and the United States. How far and how soon they would reap financial benefits therefrom remained to be seen; but they could report that negotiations, which were still in progress, had been opened up for the sale of several of their foreign patents. Further useful experiments have been made in the Steljes instrument by the inventor and others, which were now emerging from the experimental stage, and gave great promise of securing an increase in power and speed. Dealing with the future, he said that the Board found it was impossible by amicable means to induce the Exchange Telegraph Company to modify their agreement by a single letter, or to be otherwise than hostile to the Corporation. They were, therefore, of the opinion that unless that agreement was cancelled, or at least modified, it would not be possible for the Corporation to carry on a home trade of any considerable extent. They were satisfied that a home trade so limited not only prejudiced the selling value of the foreign patents, but their chance of disposing of them or their instruments abroad. Under those circumstances a considerable reduction of expenses had become a necessity. They were anxious to bring to a conclusion, one way or another, the most forward and promising of the negotiations on foot for the sale of their foreign patents before making serious alterations with regard to the offices and workshop, which might prove to be improvident should those sales be effected.

A lengthy discussion ensued as to the dismissal of Mr. E. Liebmann, the general manager.

Subsequently the motion for the adoption of the report was put, and declared carried.

**Mr. Chantrey** said that the Company had £1,100 or £1,200 at the bank and in hand. He did not seek re-election to the Board.

Mr. R. W. Nash was re-elected a director, and Messrs. Carnaby-Harrower Barham and Co. were reappointed auditors.

In answer to Mr. Ney, the **Chairman** said that the contract with the Exchange Telegraph Company ran throughout the lifetime of the patent.

At an extraordinary general meeting, which was subsequently held, resolutions to alter the articles were negatived.

## WILLANS AND ROBINSON.

A general meeting of holders of debenture stock of Willans and Robinson, Limited, was held on Wednesday at Cannon-street Hotel for the purpose of passing a resolution approving the appointment of Mr. John Frederick Robinson as trustee for the debenture-holders in the place of Mr. Frederick Gordon, deceased. Mr. Rhodes Cobb was appointed chairman by the stock-holders present.

**Mr. Mark Robinson** explained that it rested with the directors to appoint a trustee, but the matter was subject to the approval of the stockholders. The directors proposed that Mr. J. F. Robinson should fill the vacancy caused by the death of Mr. Frederick Gordon. Mr. J. F. Robinson was not a relation of his, but he was managing director of the North British Locomotive Company.

**Mr. Percy Hunter** asked if Mr. J. F. Robinson could enlighten the meeting on the subject of the reduction of the Queensferry Works, and whether he approved of a drastic course being taken in that matter.

**Mr. J. F. Robinson** said that the trustees were appointed for a special purpose, and had nothing to do with the management. The course, however, that had been taken of cutting down all unnecessary expenditure at Queensferry Works, and confining them solely to the manufacture of boilers until it could be found whether they could be manufactured at a profit, had received the approval of the advisory committee, of which he had been chairman.

The resolution was carried.

## REUTER'S TELEGRAM.

The directors report that the balance for distribution for the year ended Dec. 31 last amounts to £4,872, including £273 brought forward from the last account. An interim dividend of 2½ per cent. was paid in October last, and the directors now declare a dividend of 4s. per share, equal to 2½ per cent., making a total distribution, free of income tax, of 5 per cent. for the year. This will leave a balance of £137 to be carried forward. The dividend warrants will be payable on the 4th prox.

# NEW COMPANIES REGISTERED.

**Lambert Company, Limited.**—Capital, £8,000. Objects: to acquire such part of the undertaking and assets of the Lambert Company, of Chicago, U.S.A., relating to the business carried on in the United Kingdom, the Isle of Man, the Channel Islands, and any British colony or possession, except Canada; to adopt an agreement with the said company; to acquire any inventions and patents connected with the manufacture of phonographs, gramophones, telephones, etc. Registered office: 26, Euston-buildings, N.W.

**Bristol Rolling-Stock Company, Limited (80,965).**—Capital £7,000. Object: to carry on in the United Kingdom or elsewhere the business of builders, repairers, vendors, purchasers, lessors, and hirers of wagons and all kinds of railway rolling-stock, electrical and mechanical engineers, etc. Registered office: 17, Bridge-street, Bristol.

**Henry Wallwork and Co., Limited (80,995).**—Capital, £100,000. Object: to acquire as a going concern the business of engineers, iron, steel, and brass founders, oil merchants, and manufacturers of malleable

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cating heretofore carried on by R. Wallwork and C. H. Wallwork, at Manchester, as Henry Wallwork and Co., and to carry on the same and the business of brass finishers, metal workers, mechanical and electrical engineers.

**United Engineering Company, Limited.**—Capital, £25,000. Object: to carry on the business of machinery manufacturers, mechanical and electrical engineers, etc.

### Liens Registered.

**Evershed and Vignoles, Limited, London, W.**—Lien registered May 13 for £400 4½ per cent. debentures, part of £15,000; amount previously issued, £13,600; trustee: Law Guarantee and Trust Society, Limited; charged on the undertaking and all the property, including the uncalled capital.

**Woking Electric Supply Company, Limited.**—Lien registered May 12 for £600 4½ per cent. debentures, part of £25,000; no trustees; charged on the undertaking and all the property, including the uncalled capital.

## APPOINTMENTS VACANT.

**Electrical Engineer,** Weymouth and Melcombe Regis. Salary will be £250 per annum. Applications to Mr. R. N. Howard, town clerk, by June 8. See advertisement in last issue.

**Track Engineer,** Birmingham, for construction of 4½ miles of electrically-worked tramways. Salary £5 to £6 per week, according to experience. Also, an **Inspector.** Salary £4 per week. Applications to Mr. John Price, city engineer and surveyor, Council House, Birmingham, by 31st inst. See advertisement in last issue.

**Assistant Electrical Engineer,** Wakefield. Salary, £150 per annum. Applications to Mr. C. M. Shaw, Electricity Works, Wakefield, by 30th inst. See advertisement.

**Draughtsmen.** Apply, with copies of testimonials, stating age and salary expected, to the Fairfield Shipbuilding and Engineering Company, Limited, Govan. See advertisement.

**Charge Engineer,** Bristol. Salary, £2. 10s. per week, rising to £3. See advertisement.

**Assistant Lecturer in Engineering,** Swindon Education Committee. Salary, £150 a year. Applications by June 11. See advertisement.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Utrecht (Holland).**—The Municipality require tenders for supply and laying of electric cables by 31st inst.

**Amelia (Peruqia, Italy).**—The Municipality require tenders for an electric lighting installation by Aug. 18.

**Villanueva de la Serena.**—The Municipal Authorities require tenders for the electric lighting of the town by June 25.

**Handsworth.**—The Urban District Council invite tenders for the erection of generating station. Particulars may be obtained from the Town Clerk. Tenders by June 8.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao, including supply of material and rolling stock, by July 6.

**Lincoln.**—The Corporation invite tenders for eight electric tramcars. Specifications, etc., may be obtained from the Electrical Engineer after the 30th inst. Tenders by 10 a.m. on June 13.

**Edinburgh.**—The Council invite tenders for copper strip. Specifications, etc., can be obtained from the Resident Electrical Engineer, Dewar-place. Tenders by June 4. See advertisement.

**St. Annes-on-Sea.**—The Urban District Council invite tenders for the supply of leadless cable for laying solid. Particulars may be obtained from the Electrical Engineer. Tenders by May 30.

**Almeria.**—The Harbour Commissioners require a motor launch. The estimate is 29,000 pesetas, and the deposit required 1,450. Particulars from the Secretary of the above. Tenders by July 6.

**Portsmouth.**—The Town Council invite tenders for pump, pipes, etc. Specifications, etc., can be obtained on and after 31st inst. at the Town Hall, Portsmouth. Tenders by June 11. See advertisement.

**Batley.**—The Corporation invite tenders for a steam superheater, steam piping, valves, and accessories for the electricity works. Specifications may be obtained from the Borough Electrical Engineer. Tenders by June 2.

**Erith.**—The Urban District Council invite tenders for additions and alterations to the electric light station. Specifications, etc., may be obtained from the Quantity Surveyor, 12, Queen's-road, Erith. Tenders by June 15.

**Pontypridd.**—The Urban District Council invite tenders for supply of motors. Specifications, etc., may be obtained at the offices of Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on June 4.

**Southampton.**—The Corporation invite tenders for cast crossings and points and mates. Particulars may be obtained from Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders before 2 p.m. on June 6.

**Penrhiwceiber (Wales).**—The Penrikyber Navigation Colliery Company, Limited, Penrhiwceiber, R.S.O., Glam., invite tenders for 12 months' supply of various stores, including electric lamps and fittings. Tenders by June 2.

**Cheshire.**—The Committee of Visitors of the Parkside Asylum, Macclesfield, invite tenders for (1) electric light wiring and fittings, (2) electric light plant. Specifications, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 78, King's-street, Manchester, after the 30th inst. Tenders by June 20.

**Dewsbury.**—The Corporation invite tenders for supply and delivery of one Lancashire boiler at their electricity works. Specification may be obtained from Mr. R. H. Campion, borough electrical engineer, Bradford-road. Tenders by June 8.

**Rochester.**—The Corporation invite tenders for the construction of permanent way and overhead line. Specifications, etc., can be obtained at the office of Mr. E. Rotter, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders by June 3.

**Warrington.**—The Electricity Committee invite tenders for (1) four mechanical stokers, (2) water softener and purifier, for the electric light station. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by 30th inst.

**Glasgow.**—The Corporation invite tenders for supplying and erecting electric light installation, bells, etc., required at Kingston Halls, Paisley-road. Particulars may be obtained from the City Engineer, 64, Cochrane-street. Tenders by 31st inst.

**Madrid.**—The Public Works Department require tenders for the concession to construct (including supply of material and rolling stock) and work an electric tramway from Sarria to the foot of Mount Vallvidrera, in the province of Barcelona. Tenders by July 15.

**Suakim.**—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

**Bury.**—The Tramways Committee invite schemes and tenders for the heating required at the car depôt, Rochdale-road, Bury. Particulars may be obtained from Mr. Arthur W. Bradley, A.M.I.C.E., borough engineer and surveyor, Bury. Tenders by June 7.

**Norwich.**—The Corporation invite tenders for lighting the streets, roads, and public places of Norwich for one, two, or three years, at the option of the Corporation, from July 1. Particulars can be obtained from Mr. Arnold H. Miller, town clerk, Guildhall, Norwich. Tenders by June 4.

**Deptford.**—The Borough Council invite tenders for the supply, delivery, and erection of (1) two 25-kw. steam dynamos and a booster, (3) switchboard. Specifications, etc., may be obtained from Messrs. F. H. Medhurst and Lloyd, 13, Victoria-street, S.W. Tenders before 4 p.m. on June 21.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for the supply of various stores for year commencing July 1, including electrical stores. Specifications, etc., may be had on application to the Superintendent of Stores, 16, Robertson-street, Glasgow. Tenders by 10 a.m. on June 4.

**York.**—The North-Eastern Railway Company invite tenders for the supply of various stores, including arc lamp carbons, electric lamps, electric wires and cables, etc., for six months ending Dec. 31. Specifications, etc., may be obtained from Mr. F. H. Clark, Stores, Gateshead. Tenders by 9 a.m. on June 4.

**York.**—The North-Eastern Railway Company invite tenders for the supply of telegraph apparatus and telegraph wire and line stores for six months ending Dec. 31. Particulars may be obtained on application to Mr. C. H. Ellison, the company's telegraph superintendent, York. Tenders by 9 a.m. on June 4.

**Walthamstow.**—The Urban District Council invite tenders for the following stores for the electricity works: incandescent lamps, switches, cut-outs, cables, enamelled steel conduits, arc lamp carbons, carbon brushes, white cotton waste, asbestos packing, etc. Particulars may be obtained from the Electrical Engineer. Tenders by June 3.

**Coventry.**—The Corporation invite tenders for the works required to be executed and materials supplied in the erection of an extension of engine-house at the electric light works, Sandy-lane. Specifications may be obtained from Mr. J. E. Swindlehurst, city engineer and surveyor, St. Mary's Hall, Coventry. Tenders by 10 a.m. on May 28.

**Southampton.**—The Corporation invite tenders for the supply of 150 tons of rolled-steel rails and the necessary fishplates, anchor joints, soleplates, bolts, nuts, and tiebars, according to particulars to be obtained upon application to Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders before 2 p.m. on June 6.

**Shanghai (China).**—The Municipal Council of Shanghai invite tenders for a concession for constructing and working about 24 miles of electric tramways on the trolley system in the streets of Shanghai. Particulars may be had upon applicatien to Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Tenders by 12 noon on July 30.

**Stepney.**—The Borough Council invite tenders for laying on a complete electric light installation at their public baths in Goulston-street, Whitechapel, E. Specifications, etc., may be obtained from the Borough Engineer, 15, Great Alie-street, Whitechapel, E., on and after June 6, between the hours of 10 a.m. and 12 noon. Tenders by June 20.

**London, S.W.**—The Fulham Guardians invite tenders for wiring, electric bells, steam-hooter, etc. in connection with fire-alarm systems ot the workhouse and infirmary, Fulham Palace-road, Hammersmith, W. Specifications, etc., may be obtained on application at the office of Mr. E. J. Mott, clerk Fulham Palace-road. Tenders by 4 p.m. on 30th inst.

**Johannesburg.**—The Municipal Tramways and Electric Supply invite tenders for insulated cables and bare overhead conductors and certain accessories. Specifications, etc., may be obtained from the Town Clerk, Johannesburg, and from Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., on and after the 30th inst. Tenders by noon on July 4.

**Paisley.**—The Scottish Office of the May-Oatway Fire Appliances, Limited, 49, Queen-street, Glasgow, invite tenders for wiring auto-

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matic fire-alarms for Messrs. J. and P. Coats, Limited, Paisley. Specifications can be inspected up to 29th inst. at the Scottish Office, and also at the London Office of the Company, 92-4, Paul-street, Finsbury. Tenders by 31st inst.

**Greenwich.**—The London County Council invite tenders for the supply and erection of two continuous coal and ash conveyors of the gravity bucket type, at the electricity generating station, Greenwich, and for the maintenance of the same for 12 calendar months. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on June 14.

**Rotherham.**—The Corporation invite tenders for single vulcanised-bitumen (covered) cables of various sizes; electricity meters of sizes for maximum currents of 2½, 5, 10, 25, and 50 amperes (the supply pressure is 230 and 460 volts continuous current), for 12 months from July 1. Particulars can be obtained from the Borough Electrical Engineer. Tenders by 31st inst. See advertisement in last issue.

**Canterbury.**—The Lighting Committee invite tenders for the following: One Lancashire or dry-back marine boiler, superheater, steam-pipes, a 300-kw. steam dynamo, switchboard and connections and extensions to economiser. Specifications, etc., may be obtained from Mr. Hammond, 64, Victoria-street, Westminster, S.W. Tenders before 10.30 a.m. on June 1. See advertisement in former issue.

**Hornsey.**—The Town Council invite tenders for the following: (Section D) condensing plant; (E) water-cooling apparatus; (F) pipe-work and valves; (G) water softener and purifier; (H) switchboards and connections. Specifications, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by 30th inst. See advertisement in former issue.

**Erith.**—The Urban District Council invite tenders for a steel trough-floored road bridge, with brick and concrete abutments, etc., over the South-Eastern and Chatham Railway at the Lower-road level crossing, Erith, together with making up the approaches, fencing, kerbing, etc. Specifications, etc., may be obtained from Mr. Charles H. Fry, clerk of the Council, District Council Offices, Erith, Kent. Tenders by June 13.

**Kilmarnock.**—The Corporation invite tenders for the supply, delivery, and erection of the following plant in connection with electric lighting and tramways for the burgh: (Specification No. 11) overhead equipment, trolley wires, poles, and brackets, etc.; (12) rolling-stock; (13) wiring of generating station and car-shed. Specifications, etc., can be obtained on and after 10th inst. from the Town Clerk. Tenders by 12 noon on the 28th inst. See advertisement in former issue.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Exeter.**—The Corporation invite tenders for (1) construction of permanent way and paving (including copper bonding) of about four miles of route length line, single line, with passing places; (2) overhead electrical equipment of the above lines and of car-shed; (3) supplying and laying of insulated cables and stoneware ducts for the same length of tramway in connection with the above; (4) supply and delivery of 12 double-decked single-truck motorcars. Specifications, etc., can be obtained for Contracts Nos. 1 and 4 at the office of Mr. Thomas Moulding, Municipal Offices, Southernhay West, Exeter, and for Contracts 2, 3, and 4 at the office of Mr. H. J. Munro, city electrical engineer, New North-road, Exeter. Tenders by June 9.

**Madrid.**—Tenders are required for construction of a telephone system between Madrid and Cordoba, Malaga, Sevilla, and Cadiz, with stations in Madrid, Ciudad Real, Cordoba, Sevilla, Cadiz, and Malaga. The estimate per kilometre is 1,800 pesetas for an underground line and 14,700 per aerial line, and the adjudication will turn upon whatever reduced prices are offered. Similar tenders are also required for a system connecting Madrid, Santander, Asturias, and Galicia, with stations in Madrid, Valladolid, Palencia, Santander, Leon, Oviedo, Gijon, Monforte, Corufia, and Vigo. The deposit for each of these two contracts is 10,000 pesetas, and particulars may be obtained from the Post and Telegraph Department, Madrid. Tenders by June 8.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Reichenberg (Austria-Hungary).**—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

## RESULTS OF TENDERS.

**Erith.**—The Town Council have accepted the tender of McDowall, Steven, and Co., Limited, at £155. 10s., for the erection of transformer house at Erith-road, Belvedere.

**Gainsborough.**—The Urban District Council have accepted the General Post Office terms, at an annual rental of £46. 5s., for the installation of an electric fire-alarm system.

**Stafford.**—The Town Council have accepted the tender of the Callender Cable and Construction Company, at £1,483, for extensions of electric cable in Rowley-street, Gaol-road, and Rowley-park.

**Grimsby.**—The Town Council have accepted the following tenders: Johnson and Phillips, at £235, distribution cable; Ferranti Limited, at £328. 19s., meters; Rumney and Rumney, at £24, smaller meters.

**Watford.**—The Urban District Council have accepted the following tenders for plant for the electricity station: C. A. Parsons and Co., at £3,945, one 500-kw. turbo-alternator and exciter complete with surface condenser, also motor-driven air and circulating pumps for same; Babcock and Wilcox, at £2,705, two boilers, complete with chain-grate stokers and superheaters.

**Dublin.**—The Corporation have accepted the tender of the General Electric Company, Limited, at £19,227, with deferred payment for two years, for one 1,500-kw. steam generating three-phase extra-high-pressure plant, consisting of Belliss engine and condensing plant combined with General Electric Company's alternators, steam and exhaust piping, and extension to switchboard.

**West Hartlepool.**—The Central Marine Engineering Company have placed an order for the whole of their present requirements of motors for driving their machine shops, comprising 28 direct-current motors ranging from 8 h.p. to 62 h.p., and aggregating over 900 h.p., with the British Electric Plant Company, Limited, Alloa, N.B. The contractors for installing this plant are Messrs. Selby Bigge and Co., of Newcastle.

**Heckmondwike.**—The District Council have accepted the following tenders for additions to plant at the electricity station: Thornton and Crebbin, pipework; Dick, Kerr, and Co., engine and generator (without bedplate); Stirling Boiler Company, Limited, boiler and stoker; J. E. Statter, switchboard; Sturtevant Engineering Company, induced draught; W. T. Henley's Telegraph Works Company, Limited, cables. The tenders totalled £4,586.

**Canterbury.**—The Lighting Committee have received the following tenders for the supply of about 1,800 yards of cable:—

| | | | |
|---|---|---|---|
| Western Electric Company, North Woolwich (accepted) | £902 | 0 | 0 |
| Johnson and Phillips, Old Charlton, Kent | 907 | 0 | 0 |
| Siemens Bros. and Co., York-mansions, York-street, Westminster, London, S.W. | 910 | 0 | 0 |
| W. T. Dennis and Co., 49, Queen Victoria-street, E.C. | 912 | 15 | 0 |
| Electrical Company, Limited, Charing Cross-road, W.C. | 959 | 15 | 0 |
| Anchor Cable Company, Limited, Leigh, Lancs. | 979 | 4 | 0 |
| W. T. Henley's, Blomfield-street, London-wall, E.C. | 984 | 0 | 0 |
| Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, E.C. | 992 | 2 | 0 |
| W. T. Glover's, Trafford Park, Manchester | 1,003 | 17 | 5 |
| British Insulated Wire Company, Prescot, Lancs. | 1,005 | 0 | 0 |
| General Electric Company, 71, Queen Victoria-street, E.C. | 1,095 | 0 | 0 |
| St. Helens Cable Company, Limited, Warrington | 1,074 | 12 | 6 |
| Verity's Limited, King-street, Covent Garden, W.C. | 1,137 | 2 | 0 |

**London, E.**—The Poplar Borough Council have received the following tenders for supply of cables, etc.:—High-tension cables—Western Electric Company, eight miles cables £2,496, four miles telephone cables £256 (accepted); British Insulated and Helsby Cables, Limited, £2,760 and £288; W. T. Henley's Telegraph Works, £2,800 and £288; Siemens Bros., £2,930 and £280; St. Helens Cable Company, £3,116 and £293; Callender's Cable Company, £3,232 and £300; Glover's Telegraph Works Company, £3,280 and £320; Johnson and Phillips, £3,289 and £304. Additional cables pro rata. Provision and maintenance of battery—Electrical Power Storage Company, Millwall, erected complete and including maintenance for one year £1,860, annual charge for maintenance second, third, fourth, and fifth years £114 (accepted); Hart Battery Company, £1,937. 12s. and £88. 18s.; Tudor Battery Company, £1,972 and £99; A.B.P. Accumulator Company, £2,081. 13s. and £180; D.P. Battery Company, £2,275. 14s. and £146. 15s.; Chloride Battery Company, £2,771 and £152. 4s.; British Battery Company, £1,790, annual charge for maintenance—first year £90, second year £95, third year £100, fourth year £105; Northampton Battery Company, £2,528. 14s., charge for maintenance—first year £50, second £70, third £80, fourth £90.

**Govan (Scotland).**—The Town Council have accepted the following tenders for supply of stores for 12 months from 15th inst.:—Dempster, Moore, and Co., engine packing and gauge glasses; Ferguson and Timpson, Klingerit jointing and graphite; British Insulated and Helsby Cables, lead-covered and armoured cables and rubber-covered cables; Callender's Cable and Construction Company, mica sheets, binding and fuse wire, leadless cables; General Electric Company, Limited, rubber solution, strip, and prepared tape and solder; Callender's, bitumen for solid system; Craig Sharp, Limited, bituminous compound; Chamberlain and Hookham, meters, all sizes; Keighley Electrical Engineering Company, Limited, house fuse boxes; T. and A. Paul, iron castings; M'Dowall, Steven, and Co., iron pipes; Wilson's and Union Tube

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Company, wrought-iron tubes; Kelvinside Brick Company, Limited, bricks; Scott and Rae, cement; Dempster, Moore, and Co., ironmongery; W. Morier and Co., brushes; J. Storer and Co., paints; Robinson, Dunn, and Co., timber; General Electric Company, carbons; Cruikshank and Co., joint-boxes; British Thomson-Houston Company, motors, 1 h.p. to 3 h.p.; Lancashire Dynamo and Motor Company, motors, 4 h.p., 5 h.p., 7 h.p., 15 h.p., and 30 h.p.; Mavor and Coulson, motors, 10 h.p., 20 h.p., and 25 h.p.; British Thomson-Houston Company, motor starters up to 5 h.p.; Sturtevant Engineering Company, motor starters above 5 h.p.; Veritys, Limited, switches of 30 and 50 amperes; Bray, Markham, and Reiss, switches of 75, 100, and 200 amperes.

# BUSINESS NOTES.

## TRACTION.

**Derby.**—The cars are arriving for the new tramways.

**Ashton.**—The Cavendish-street tramway has been completed.

**Stockton.**—The Rural Council are pressing the company to commence the new line at Norton.

**Berlin.**—It is reported that 1,200 employés at the workshops of the Berlin Tramways Company are on strike.

**Kirkby Malzeard.**—The inhabitants have unanimously decided to support the proposed light railway scheme.

**Airdrie.**—The company's receipts for April amounted to £964, against £750 in March and £521 in February.

**Leeds.**—The receipts for the holidays (Saturday to Tuesday inclusive) amounted to £4,821 against £5,284 last year.

**Dundee.**—The tramway accounts, which were closed on Saturday, are expected to show receipts considerably in excess of the estimate of £44,670.

**Huddersfield.**—The tramway receipts for April amounted to £5,585. 1s. 7½d. The miles run were 137,447, and the passengers carried 1,077,868.

**Aberdeen.**—The Tramways Committee have informed the company that they will adjust the Corporation time-table to suit the requirements of the company.

**Elland.**—The Halifax Corporation will come to a decision at their next meeting as to obtaining powers for extending their terminus at Salterhebble-hill to Elland.

**Kidderminster.**—The proposed light railway to Bewdley looks like falling through, as the Town Council and the company cannot come to terms upon widening expenses.

**Belfast.**—The tramway employés have made representations to the Lord Mayor for a consideration of the rates of pay after the electrification scheme has been completed.

**Glossop.**—As the result of a ratepayers' petition the District Council are making representations to the company as to running ½d. fares from Old Glossop to the town hall.

**King's Norton.**—The Urban District Council have published in the *London Gazette* formal notice of their intention to lease their new lines to the Birmingham Tramway Company.

**Bath.**—The difficulty with the Midland Railway Company in regard to the new bridge has been overcome. The construction of the new tramways *vid* James-street is to be put in hand at once.

**Dewsbury.**—A car descending a steep gradient last Friday gained such impetus that the brakes failed to act. The car collided with other vehicles, but none of the passengers were injured.

**Leicester.**—The new electric cars were freely patronised during the holidays. On Monday the total number of passengers carried by the Corporation trams was 123,000, chiefly on the electric cars.

**Bishop Auckland.**—The Bill to authorise a tramway from Bishop Auckland to Spennymoor has complied with the Standing Orders of the House of Lords, and will be reported for second reading.

**Vancouver.**—The tramway between Vancouver and New Westminster and the suburban railway lines of the latter city are now operated by electricity generated from the waters of Lake Beautiful.

**Stirling.**—The Town Council propose to hold conferences with the County Council and the Stirling and Bridge of Allan Tramways Company with reference to a tramway between Stirling and Bannockburn.

**Stalybridge-Hyde.**—The electric trams connecting the boroughs of Stalybridge, Dukinfield, Mossley, and Hyde commenced running on Monday. The line is about 20 miles long, and has cost £400,000.

**Hull.**—The receipts on Bank Holiday amounted to £528, the number of passengers carried being 126,902. This is a considerable increase over last year, when the figures were £471 and 113,242 passengers.

**Belfast and co. Down Railway.**—It is stated that, as an experiment, the company have ordered two electric cars, which will be constructed in such a way that they can be run on the present rails.

**Darlington.**—The Board of Trade have inspected the electric tramway system. Everything went smoothly. To-day the electrical equipment is to be examined. Certificates are expected to be given in another fortnight or less.

**Cambridge.**—The Town Council have approved the Tramways Committee's recommendation that approval be given to the company's scheme of electrification and extension of the borough tramways provided terms can be arranged.

**Wellington (New Zealand).**—The electrical tramway system, it is expected, will do away with the necessity for the Te Aro railway system. It is anticipated that the tramways will be faster, cheaper, and further reaching than the railway service.

**Havre.**—The electric tramways company have given an order for a car to be fitted with a Raworth automatic regenerative control, making the eighth company that has decided to introduce the system. The Havre Company works a gradient of 1 in 10.

**Preston.**—Two sections were due to be inspected on Wednesday, and it was expected that the Board of Trade's approval would be given. It may be a month before the Fishergate and Ashton routes are ready. The Deepdale section will be the last to be finished.

**Bristol.**—A committee of the House of Lords has been appointed to consider the Bristol Tramways Extension Bill. There are seven Bills before the committee, the Bristol Tramways Extension being the first, and it has been arranged that the proceedings shall commence on June 9.

**London United Tramways Co.**—The extension to Uxbridge is ready for the Board of Trade inspection which is to be held next Tuesday. The Twickenham District Council are communicating with the company as to reduced fares for children attending the Isleworth Polytechnic.

**Blackpool.**—As compared with the corresponding period of last year, the returns to the 12th inst. show an increase of £392. 8s. 3d. The double line on the promenade accounts for £301. 7s. 1d. The Marton route shows an increase of £86. 19s. 8d., and the New-road route £4. 1s. 6d.

**Sunderland.**—The number of passengers carried on the Sunderland tramways on Monday was some 116,000, the receipts being £442. 14s. 5½d. The takings are £40 less than last Whit Monday. For the week end—Saturday to Monday, inclusive—the receipts were £886, being £2 more than last year.

**Centre Poles.**—The Roads Improvement Association has started an agitation against the centre-pole system. The association has asked the President of the Board of Trade to receive a deputation, the object being to secure that in future systems centre poles shall not be authorised unless the roads are of ample width.

**Liverpool.**—It was stated at the last meeting of the Tramways Committee that arrangements with the South Lancashire Tramways Company for through tickets to Prescot and St. Helens had been completed and would be in force in a few days. There would be a reduction in the fare from Pierhead to Knotty Ash from 3d. to 2d.

**Light Railways Act.**—The Board of Trade have just issued a regulation directing that where promoters desire to extend or alter their scheme after the application has been lodged, they may, with the consent of the Light Railway Commissioners, include same in their original application instead of applying for an amending order.

**Ipswich.**—The returns for last week amounted to £461, the sum taken on Saturday being £91. On Sunday the receipts exceeded £100. With the 10 new cars starting—making a total of 36—the receipts on Monday reached £238—some 57,500 passengers being carried. The highest receipts on any previous day were £158 on Easter Monday.

**Bury.**—The reconstruction of the tramways is proceeding rapidly, the Limefield section being opened on Friday last. Other sections are in hand, and will be completed by the end of September. The whole of the permanent-way construction is being done by direct labour under the supervision of Mr. A. W. Bradley, the borough engineer, 500 to 600 men being employed.

**Poole.**—The arbitration proceedings in connection with the tramways have been fixed to commence on Friday, May 27, in London. The town clerk has been instructed to open negotiations with the owners of the various strips of land adjoining the main road at Parkstone proposed to be acquired for widening the road in view of the extension of the system through Parkstone.

**Cleckheaton.**—A sub-committee has been appointed by the District Council to draw up a representation to the Board of Trade, setting forth strong disapproval of the action of the British Electric Traction Company in applying that their powers should cease as regards the portion of the unconstructed railways under the Spen Valley Light Railways Extension Order, 1901.

**Plymouth.**—The following figures relate to the tramway returns for the past two years: car miles run in 1903—electrical cars 608,146, horse cars 32,900; in 1904—electrical cars 656,071, horse cars 33,025. Number of cars in use 1903, 21; 1904, 20. Units used, 762,570; units per car mile, 1·16; average units per day per car, 104; average miles per car per annum, 32,803; average miles per car per day, 90.

**Erith.**—The District Council have instructed the clerk to issue the advertisement for tenders for the bridge over the railway at the Lower-road level crossing. The Board of Trade have approved the plans of the rail and substructure proposed to be used. Plans have been submitted to the railway company showing the proposed method of construction of the tramway track over the Bexley and Britannia bridges.

**Brighouse.**—The Halifax Corporation are said to be favourably disposed towards constructing a section to Rastrick as well as from Brighouse to Bailiffe Bridge. The Huddersfield Corporation holds parliamentary powers for the former route, but have declined to extend their tramway system to Rastrick, and the Brighouse Corporation have decided to ask the Huddersfield Corporation to relinquish such of the powers as affect the Rastrick district.

**North-Eastern Railway.**—Alongside of a large portion of the recently electrified track the Post Office telegraph wires run, and it is stated that the current for the trains has been seriously affecting the transmission of messages. It is reported that, as the result of a conference between the company and the Post Office authorities, the telegraph lines running parallel with the railway wires are to be duplicated. It now appears that the electric service from Newcastle to Tynemouth will not be opened until a rather later date than was expected.

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**Christchurch (New Zealand).**—The contract for the construction of the electric tramways has been awarded to the New Zealand Electrical Construction Company. The price is £249,876. Forty-three tenders were received, eight of which were for the full work and 35 for various sections. The lowest was £244,502, and the highest £368.700. The Tramway Board's engineer estimated the amount at within £1,000 of the accepted tender. The Board's loan amounts to £305,000, and a balance will be needed for buying out the existing companies and paying the first year's interest on the loan and expenses.

**Compagnie du Chemin de Fer Metropolitan de Paris.**—The balance-sheet for last year shows on the credit side: amount carried forward, 489,481fr.; interest, etc., 154,089fr.; receipts, 17,626,682fr. On the debit side we find: royalty to the city of Paris on 17,290,739 = 5,693,654fr.; expenses, 7,577,060fr. This gives a profit of 4,999,537fr., or about £200,000. From this must be deducted cost of a lawsuit with certain companies with which the railway company had contracted for the supply of current, and 1,150,000fr. cost of the accident, not covered by insurance. This leaves a net profit of 3,785,850fr.—*i.e.*, 489,481·16fr. from 1902, and 3,296,368fr. from 1903.

**London County Council.**—The County Council have made an initial vote of £25,000 for the Hammersmith-to-Harlesden scheme. The Brixton section was reopened on Saturday. Mr. Graham Harris, the umpire in the arbitration between the London, Deptford, and Greenwich Tramway Company and the County Council in regard to the structural value of the company's tramway, has published his award at £91,363. The expert valuations handed in on behalf of the claimants ranged between £105,000 and £106,000, while those for the County Council were slightly over £53,000. The Board of Trade have approved the conduit system for the lines through Finsbury.

**Scarborough.**—The Board of Trade certificate for the aquarium top having arrived on Saturday, the complete service of tramways was opened on Sunday for the first time. Experience having proved that the two short routes from the station to the sands and the North Side respectively were not sufficiently appreciated, a rearrangement has been made, so that there are now two long routes covering the whole system. Eleven thousand passengers were carried on Saturday, which is a record up to date. The directors have already decided to increase the number of cars from 15 to 18. The return for May 14 to May 6 gives the total number of passengers as 70,289. The agitation against Sunday running continues.

**Torquay.**—In addition to the petitions against the Dolter Company's Bill by the Corporation and the committee of residents, the Torquay Gas Company are also asking to be heard by counsel before the House of Lords Committee. The petition of the gas company, after setting forth the circumstances with regard to the insertion of the protective clause in respect of the electrolysis clause—which clause was inserted by the House of Commons Committee on the application of the gas company, but which has since been struck out by the chairman of the House of Lords Committee—submits that in the working of the tramways by electrical power very serious damage would be caused to their mains by electrolytic action and fusion of the pipes and apparatus which lie under the roads along which the tramways are intended to be laid. The Bill is expected to be reached on June 9.

**Rowley Regis.**—The order made by the Light Railway Commissioners authorising the construction of light railways in the urban districts of Quarry Bank, Brierley Hill, and Rowley Regis, in the county of Stafford, has been issued by the Board of Trade. The undertakings for the construction of which authority is given are a railway 2 miles 2·55 chains or thereabouts in length, situate partly in the district of Brierley Hill, partly in the district of Quarry Bank, and partly in Rowley Regis, commencing by a junction with the Dudley, Stourbridge, and Kingswinford tramways in Brierley Hill High-street at a point near its intersection with Mill-street, and terminating in Cradley Heath High-street by a junction with the Dudley and district light railways at Five Ways; also a short section of line to connect the preceding with the Dudley, Stourbridge, and Kingswinford tramways.

**Newcastle.**—The report on the past year's working shows that the total receipts were £185,027, and the total expenditure £121,545. The car mileage was 4,059,907. The passengers numbered 39,715,120. Interest on redemption cost £51,534, and the balance carried to appropriation account is £8,991, as compared with £18,000 last year. The manager recommends the abolition of ½d. workmen's fares, as without such alteration it will be impossible to realise the income per car mile that has been assumed in making up the estimates for next year. The Tyneside Tramways Bill will come before a committee of the House of Commons on Tuesday, June 7. The following are particulars of the traffic for the week ending March 21, with the corresponding figures for last year: passengers, 809,800, against 714,453; miles run, 82,329, against 72,724; receipts, £3,635, against £3,228; receipts per car mile, 10·59d., against 10·65d.

**Liverpool to Manchester.**—It will be possible shortly to travel between these towns by tramcar, and except for a few miles the tramway systems between Liverpool and Leeds will then be linked up The difficulty in the way of the acquisition by the Bury Corporation of the length of line in the Council's district, which is owned by the Bury, Rochdale, and Oldham Tramway Company, has been removed, and the Salford Corporation will now be asked, in accordance with their agreement with Whitefield, to commence electrification at once, in order that their work may be finished by the time the Bury lines have been completed to the Whitefield boundary. Bury will then approach Salford for running powers as far as Whitefield railway station. With the completion of this route and the whole of the Bury system connecting up with Bolton, it will be possible to run cars from the centre of Manchester, through Bury and Bolton, to Liverpool. The settling of differences between Whitefield and the company will also facilitate the coupling-up of Radcliffe with Manchester and Salford.

**Blackburn.**—The following is a statement of the tramway accounts for the year ended March 25 last. The expenditure comprised £17,160. 14s. for electric current; £9,326. 12s. 4d. for traffic expenses, including wages, insurance and compensation, uniforms, etc.; £4,190. 7s. 3d. for maintenance of rolling-stock, etc.; £1,812. 11s. 7d. for overhead line and depôt repairs; and £2,879. 3s. 5d. for general expenses—the total being £29,369. 8s. 7d. The income included £43,374. 6s. 7d. as traffic receipts, £448. 5s. 7d. for parcels, £266. 12s. for rents, and £593. 6s. 10d. for advertising on cars, or a total of £44,682. 11s., thus leaving a balance to net revenue account of £15,313. 2s. 5d. The expenditure of the net revenue account for the repayments of loans, sinking fund, and interest on loans was £20,451. 10s. 3d., thus showing a loss on the year's working of the undertaking of £5,138. 7s. 10d. The mileage covered was 951,484 miles, the passengers carried numbered 7,742,692, the receipts were £2,250 more than last year, and the working expenses were 7·4d. per car mile this year against 7·45d. per car mile last year, but the receipts per car mile fell from 11·89d. to 10·89d.

**Middlesbrough.**—In regard to the Middlesbrough, Stockton, and Thornaby Tramways Bill, the town clerk of Thornaby has issued the following letter: "The conflicting reports as to the proceedings in the committee of the House of Commons upon the above Bill render it desirable that the members of the Corporation should be informed officially that the result of the Thornaby Corporation's petition against any alteration in the clauses agreed upon between the Corporation and the tramway company was quite successful, all the clauses being inserted in the Bill except the clause relating to the postponement of purchase, upon which evidence was given on our behalf showing that it was immaterial whether it was inserted or not, as it had already been agreed upon. The committee, therefore, in declaring the preamble proved decided that this clause should be struck out. All the other clauses, including the one as to the annual payment of £200 per route mile, were included without alteration. The power as to purchase, therefore, remains as given by the Act of 1897, but it can only be carried out by the 'combined authorities,' and Thornaby has agreed with the company not to exercise its power of purchase until the year 1918, in consideration of the expenditure by the tramway company of upwards of £15,000 for tramway improvements within the borough of Thornaby. The Thornaby Corporation has, therefore, obtained all that is required."

**Penarth.**—A special meeting of the Urban District Council was held last week to further consider the proposed tramway to Cardiff. Deputations of ratepayers and the company attended. On behalf of the promoters, Mr. Robert Lewis stated that they were prepared to meet the Council in any fair way. With regard to the bridge over the Ely, they were ready to strengthen it sufficiently to carry the tramlines. As to Cogan-hill, Mr. Lewis stated that the syndicate were prepared to widen the road from 23ft. to 50ft., and had already come to terms with the owners. If the Council insisted upon the hill being lowered by 7ft. 6in., the syndicate could not possibly entertain the idea. They were, however, ready, provided the Council could agree with the road owners, to lower the crest of the hill from 2ft. to 3ft. With regard to a double track, Mr. Lewis remarked that the Corporation of Cardiff had constructed a single line, with passing places, between the Western Mail-buildings and Grangetown. If the Council were afraid of the traffic being congested within their area, the syndicate were prepared to take the line up Windsor-road, through Glebe-street, and back again through Plassey-street. The syndicate were also ready to subscribe £6,000 towards the freeing of the toll on Penarth-road, if the councils interested decided to buy the road from the Marquis of Bute and Lord Windsor. After a discussion in private the Council decided to appoint a small committee to inspect the road between the turnpike gate and Penarth, and report to a future meeting.

## LIGHTING AND GENERAL.

**Lancaster.**—The price for motor power has been reduced from 3d. to 2½d. per unit.

**West African Telegraph Co.**—The directors have declared a dividend of 6s. per share.

**Whitehaven.**—The Town Council have resolved to extend the public lighting mains to Kells.

**Hull.**—The price of electricity is still being discussed in a number of letters appearing in the daily Press.

**Llandrindod.**—The Urban District Council have reduced the annual charge for meter hire from 14s. to 10s.

**Torquay.**—The electric lighting for the Imperial Hotel has been placed in the hands of Mr. T. L. Harding, Torquay.

**City of London.**—At the last Court of Common Council authority was given for the spending of £200 on rewiring the art gallery.

**Gillingham.**—The Admiralty have agreed to take electric current from the Council for three years from May 25 of the present year.

**Tynemouth.**—An enquiry has been held into the Corporation's application to borrow £15,000 for extension to the electric supply.

**Rickmansworth.**—The Urban District Council are asking the Board of Trade to cancel the Rickmansworth electric lighting order.

**Abram.**—The Lancashire Electric Power Company will shortly be able to supply electrical energy for power and lighting purposes in the district.

**Change of Address.**—Messrs. Bruce Peebles and Co., Limited, have removed their London office to more commodious premises at 25 Victoria-street, S.W.

**Pangbourne.**—An offer of the Whitchurch and Pangbourne Electric Supply Company for lighting street lamps will come before the next Parish Council meeting.

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**Benwell and Fenham.**—The Urban District Council intend to apply for sanction to a loan of £5,000 for the purpose of laying electric cables in the district.

**Heavitree.**—Representatives of the Urban District Council and of the Exeter Town Council are conferring with reference to the supply of electric light in the district by the latter body.

**Westmorland.**—The County Council last week agreed to a resolution of the Cumberland County Council that the consideration of the expenditure of £8,000 for electric lighting be deferred.

**Hempstead.**—The Hemel Hempstead Motorcar Company have under contemplation a scheme for the electric lighting of this district, but the Corporation have not consented to the proposal.

**Wigan.**—It has been decided to lay auxiliary feeder cables in Chapel-lane, to at once insulate the whole of the cables in the section boxes, and also to purchase a ventilating fan for the engine-room.

**Larne.**—A canvass is being made in view of the early extension of the telephone system to Limavady and the opening of a post office telephone exchange in connection with the general telephone system.

**Kirkmichael.**—Steps are being taken in regard to the installation of the Post Office trunk telephone here. When extended to Kirkmichael a new line of wires will be constructed *via* Dundee or Perth.

**Chichester.**—At the last meeting of the City Council, the town clerk was instructed to ask the Board of Trade for particulars as to the position with respect to the proposed transfer of the electric lighting order.

**Weybridge.**—The Urban District Council have decided to apply for an injunction restraining the Urban Supply Company from supplying energy to Walton from Weybridge, and from breaking up the roads to relay cables for that purpose.

**Epsom.**—The Leatherhead and District Electricity Company proposes to appeal to the Board of Trade with reference to the requirements of the Rural District Council that 6in. of new material should be put in when refilling the trenches.

**Dundee.**—Mr. H. Richardson has recommended a new system of charging for power, under which the rate charged will vary with the power factor, instead of the present flat rate of 2d. per unit. His report on the matter is to be circulated.

**Onchan.**—The Village Commissioners have received £137. 10s. from the liquidator of the Isle of Man Tramways as compensation for the electric light in the village which was cut off. The Board's original claim against the liquidator was £5,050.

**Deptford.**—The Borough Council's consulting electrical engineers estimate the cost of the installation of the electric light at the new municipal buildings at £2,800, which, with 10 per cent. for engineering expenses and contingencies, brings the amount up to £3,080.

**Basingstoke.**—The Town Council have entered into a contract with the National Electric Construction Company, Limited, for the leasing of the Council's electric lighting order, and will apply for sanction to borrow £16,000, the capital expenditure involved.

**Fulham.**—The Guardians have decided to spend £669 for the provision of increased boiler accommodation and the erection of works, and the provision of machinery and apparatus for the purpose of lighting by electricity the workhouse infirmary and offices, in addition to the £11,100 already sanctioned.

**Colwyn Bay.**—The Lighting Committee in their last report stated that they estimated a surplus of revenue over expenditure in the current year of £385. Their recommendation that the charge for current to the public lamps be reduced from 4½d. to 4d. per unit, and that the provision in the estimates for public lighting be £430, has been adopted.

**Hastings.**—At the last Town Council's meeting it was agreed to rescind the order made at the previous meeting of the Council on the subject of suggested alterations of and extensions to the existing plant at the electric light works, noted in our previous issue, and to adopt the report of the Council in committee, which contained a proposal to borrow £3,416. 10s.

**Ormskirk.**—The Guardians will apply for power to borrow £5,000 for the various works in hand and in contemplation to carry out an installation of electricity for the workhouse buildings. This includes £3,049 for the electricity plant, £320 for economisers, £750 for new boilers, £210 for the fence wall on the west side of the workhouse premises, and £200 for boiler seating.

**Poplar.**—It has been decided to adopt raising and lowering gear for use in trimming arc lamps in substitution of the present method by the use of tower ladders. The gear required is estimated to cost 60s. per lamp, amounting to £960 for the existing arc lamps, and the net saving on public lighting account, after meeting interest and repayments of capital, is estimated at £364 per annum.

**Greenock.**—Mr. Robertson, electrical engineer, in his last report states that for the five weeks ending May 7 the units generated for public and private supply amounted to 63,694, an increase of 14 634 compared with the corresponding five weeks of 1903. The units generated for traction supply totalled 69,827, a decrease of 4,570 units in comparison with the corresponding period of 1903.

**Sunderland.**—The Electricity and Lighting Committee have decided to recommend the Town Council to oppose the Electric Lighting Bill, which will give private companies and other authorities outside municipal authorities power to apply for land inside the borough, to go to the Board of Trade and apply for leave to supply the town and district with electricity, not only for power but for lighting.

**Stafford.**—The accounts of the electricity department for last year show a total revenue of £2,879. 7s. 10d. and an expenditure of £1,332. 2s. 5d., leaving a gross profit of £1,547. 4s. 5d. Interest charges and loans repaid amounted to £1,852. 2s., and in addition the committee had decided to place £400 to a depreciation fund for the renewal of cables, and £211. 17s. 11d. to the same fund for the renewals to the battery.

**Bristol.**—In his last report the electrical engineer refers to the disastrous fire at Christmas, and to the consequent alterations since completed or now in hand. The cost of the undertaking had, however, been reduced, in spite of that disaster involving extra running expenses. The coal bill per unit sold was 10 per cent. less, and although the revenue fell from 3·44d. per unit to 3·18d. per unit, the net profit increased from ·413d. per unit in 1903 to ·46d. per unit in 1904.

**Louth.**—The Town Council have sealed an agreement with the National Electric Construction Company, Limited, under which the Corporation will borrow £17,000, and with this sum as capital the company will instal electricity within the borough at a price to be fixed by a subsequent construction agreement. The agreement is for 20 years, during which period the company agree to make yearly payments to the Corporation sufficient to the payment of interest on and repayment of loan.

**Watford.**—The electrical engineer in his last report quotes the number of persons whose supply is connected as 330. He has been instructed to ascertain what towns on the Continent pump their water by electricity, and to make a report on the subject for the next meeting of the committee. A comparative statement of the three months ending Lady Day shows that in 1900 the receipts from the electric light were £1,298, £1,499 in 1901, £1,673 in 1902, £2,023 in 1903, and £2,490 in 1904.

**Erith.**—Various additions and alterations to the proposed extensions of the electric light station, rendered necessary by changing the position of the high-tension switchboard, are being carried out. Tenders are required for the extensions to the electric light station, and the surveyor has been directed to submit at the same time a tender for the construction of the works by direct labour. The cable for the supply to the sewage-disposal works has been laid. The transformers are fixed, and we understand that the work is completed.

**Southampton.**—The following resolutions were before the Council on Wednesday night: "That the Commerce of the Port Committee be requested to take into consideration (1) the subject of the National Telephone Company's high charges to subscribers in the county borough, and, if thought advisable, to ask the directors to receive a deputation on the subject; (2) the desirability of establishing a municipal telephone exchange in the county borough." The motions were, however, not reached when the Council adjourned for a fortnight.

**West Ham.**—The London and County Banking Company, Limited, is authorised by the Corporation of West Ham to receive applications for £500,000 West Ham Corporation redeemable stock, bearing interest at 3 per cent. per annum. The present issue is for the extension of the electric tramway system, the electric lighting undertaking, and for repayment of temporary borrowings in connection with the above and sundry small works of a permanent nature. The issue price has been fixed at £84 for every £100 of stock. The list of applications will be closed on or before Monday next.

**Stock Exchange.**—The Stock Exchange Committee have ordered London Electric Supply Corporation, Limited, further issue of £121,895 4 per cent. first mortgage debenture stock (redeemable) to be quoted in the official list. Application has been made to the committee to allow Edmundson's Electricity Corporation, Limited, further issue of £31.467 4½ per cent. first mortgage debenture stock (redeemable) to be quoted in the official list. May 26 is the special settling day for Charing Cross and Strand Electricity Supply 10,000 4½ per cent. cumulative preference fully-paid shares.

**Tynemouth.**—An enquiry has been held into an application by the Corporation for sanction to borrow £15,000 to develop the electricity works. Mr. Turnbull, the borough electrical engineer, said that during the first year they sold 482,000 units, in the second year 820,000, and in the third year, which has just finished, 1,103,000. In addition they had connected up 525 h.p. for motors, and applications were coming in rapidly. Therefore, to meet the ordinary expansion of demand, it was necessary to extend the plant. One particular item for which the Corporation wished to borrow was mains and services in Cullercoats.

**Nernst Electric Light.**—An extraordinary general meeting of the Nernst Electric Light, Limited, will be held on the 31st inst. to consider resolutions to reduce the share capital, at present amounting to £320,000 (divided into 140,000 preference shares of £1 each, and 180.000 ordinary shares of £1 each), to £90,000, divided into 90,000 ordinary shares of £1 each, and that such reduction be effected by cancelling 260 preference shares numbered 9,741 to 10,000 inclusive, which have been duly forfeited and never reissued by the company, and by writing off capital which has been lost or is unrepresented by available assets to the extent of £229,740 in manner following—that is to say: (*a*) by cancelling 69,740 fully-paid preference shares of £1 each; and (*b*) by cancelling 160,000 fully-paid ordinary shares of £1 each. When the scheme has been confirmed by the Court each holder of preference shares in the present capital shall surrender one-half of his holding for cancellation, and shall retain the other half as ordinary shares in the reduced capital, and each holder of ordinary shares in the present capital shall surrender eight-ninths of his holding for cancellation, and shall retain the remaining one-ninth as ordinary shares in the reduced capital. None of the shares in the reduced capital shall have any right to priority in the return of capital upon a winding-up or otherwise, but all the said shares shall rank *pari passu* in all respects, and in the case of profits as from Sept. 30, 1903, being the close of the last financial year.

**Stockton.**—The Sanitary Committee of the Urban District Council are considering the question of the extension of the refuse destructor, in connection with which the engineer has reported that an addition of two cells to the present plant would cost £2,796, and of four cells £4,389. The cost of new plant in another part of the town, exclusive

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of site, would be £3,867 for two cells and £5,138 for four cells. They have appointed a sub-committee to confer with the Electricity Committee with a view to ascertaining whether it would be worth while to utilise the spare steam from the destructor for electricity purposes.

**North Wales Telephones.**—A largely attended deputation, including representatives from Chester, Denbigh, Ruthin, Flint, Holywell, Colwyn Bay, and other districts in North Wales, had a private interview on Wednesday week at the House of Commons with Lord Stanley, Postmaster-General, in order to lay before him the grievances of local telephone subscribers and to point out how inconveniently the districts were grouped. The Postmaster-General promised to bear in mind the suggested alteration of grouping with a view to affording further facilities, and expressed his willingness to receive and consider any suggestion on the point.

**London Gazette.**—The first meeting in the estate of William Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, will be held on June 3 at 11.30 a.m. at 24, Railway-approach, London Bridge, S.E. The partnership between Samuel Haynes and Albert Edward Favell, carrying on business as electrical and gas fittings merchants, Dilks-yard, Long-row, Nottingham, under the style or firm of S. Haynes and Co., has been dissolved by mutual consent. The final meeting of the Hiram Maxim Lamp Company, Limited, will be held at 3, Lothbury, London, at 11 a.m. on June 30. The final meeting of the Electrical Copper Company, Limited, will be held at Winchester House, Old Broad-street, London, at 11.30 a.m. on June 29.

**Newcastle Telephones.**—The following letter from the Postmaster-General to Mr. Plummer, M.P., will be read with interest by all telephone subscribers in the Newcastle district: "Dear Mr. Plummer,—I am glad to be able to tell you, with reference to your correspondent's letter, and your interview with me thereon, that the National Telephone Company have recently agreed to intercommunication between the telephone systems of the Post Office and the company in the Newcastle area, subject to the payment of a fee of 1d. for each call between the two systems. The working details of the arrangement are now being settled with the company, and I hope that the service will be available as soon as the necessary junction lines between the exchanges of the two systems have been completed.—Yours sincerely, STANLEY."

**Timaru (N.Z.).**—The Corporation are considering an offer made by Mr. J. S. Maben, engineer and manager of the Pioneer Electric Lighting Company, to light Timaru by electricity. The company would provide a lighting power of 7,000 c.p. in the main street and 1,780 c.p. in the suburbs. This would give a total candle-power of 8,780, as compared with 1,114 now existing, and the cost would be £624. 10s. per annum to the borough. The company would supply power at 3d. per horse-power per hour instead of 4d., the local price for gas or water, and the 3d. would be reduced as the company progressed. The price proposed to be charged to private consumers is 9d. per unit for lighting and 5d. for power. The Corporation is to have the right of purchase of the company's installation at the expiry of 14 years after the date of the completion of the installation.

**Stirling.**—With regard to the proposed loan of £4,300, noted in our last issue, we find it is distributed over the following items: Cost of connecting private consumers, including material and wages, £1,310; probable extensions of public lighting, £450; probable extensions of distributor, £600; motors for hire, £450; machinery, instruments, etc., £500—total estimated cost for three years, £3,310. Capital cost for year ending May 15, 1904, £1,476; cash in hand at commencement of year, £484—overdrawn to date, £992. Amount to be provided for next three years: estimated cost for next three years, £3,310; overdrawn, £992—£4,302. Mr. A. C. Hanson, electrical engineer, in his report for the four weeks ending April 16 shows that during that time 15,582 units of electricity were generated, as compared with 12,447 for the same period of 1903. The total number of equivalent 8-c.p. lamps connected for all purposes was 14,128.

**Cardiff.**—Mr. A. Ellis, borough electrical engineer, has informed the Cardiff Lighting Committee that early next month he expected to be in a position to announce that Sir William Thomas Lewis had accepted the offer of the Corporation to supply electrical current to the Cardiff Railway Company's premises at the Bute Docks. The amount of electrical energy would be equal to 5,000 h.p., and the extra revenue to the Corporation would be between £25,000 and £30,000 per annum. There were now 1,012 consumers connected to the mains, with a total equivalent to 110,341 8-c.p. lamps, being over 20 per cent. over the corresponding period of last year. The output was now 168,684 units. The revenue from street-lighting was £503, and from private supply £1,627, making a total of £2,130, as against £1,542 in the corresponding period of last year. Premises are to be acquired at a cost of £750 for providing a sub-station. The question of lighting the Cardiff Workhouse by electricity has again been deferred for an indefinite period.

**Southwark.**—At the last meeting of the Guardians a letter was read from the London Electric Supply Corporation, Limited, stating that their charge for electric lighting at the new relief station would be 4½d. per Board of Trade unit, and taking into consideration the character of the buildings, they would allow a discount of 5 per cent. for prompt quarterly settlement of accounts. Another letter was read from the County of London Electric Supply Company stating they were prepared to supply on their maximum demand system on a sliding scale of 7d. to 3d. per unit, and that they would guarantee that the average price did not exceed 4½d. per unit, and at the same time credit the Guardians with any further reduction they might obtain on this figure. Also that they understood the hours of lighting were above the average per day, and it was therefore probable that the average price would work out at something between 3d. and 4½d. per unit. It was agreed to make an offer to the two companies of a fixed rate of 4d. per unit.

**Bermondsey.**—The borough surveyor has compiled a statement showing that the cost of lighting Bermondsey Town Hall when the whole of the electroliers are lighted is 6s. 4d. per hour, and when only half of the electroliers are used 4s. 10½d. per hour, the footlights costing about 3½d. per hour. The cost of lighting the Rotherhithe Town Hall is about 3s. 8½d. per hour, and the cost of the footlights per hour 4d. The number of lights in Bermondsey Town Hall is about 289, and in the Rotherhithe Town Hall 126, the footlights at Bermondsey comprising 15 and those at Rotherhithe 14. The charges at present in force for the use of light at the Bermondsey Town Hall are 6s. per hour when the whole of the electroliers are used and 4s. per hour when only half are required. The scale of charges for the Rotherhithe Town Hall are inclusive of lighting. The committee's recommendation that in future the charges for light at the Bermondsey Town Hall be 6s. 6d. per hour when the whole of the electroliers are used and 5s. per hour when half of the electroliers are used, has been agreed to.

**Shrewsbury.**—The last report of the Lighting Committee states that the electric current sold shows an increase of 16,175 units compared with the corresponding quarter last year. The following figures show the continued satisfactory financial progress of the electric light undertaking during the past year, the result being a credit balance of £353: Revenue account for the year ended March 31, 1904—Expenditure—General expenditure for the year, £3,032; interest on loan, £1,300; sinking fund transfer, £1,730; due to sundry creditors, £320; reserve fund (1902-3), £500—£6,883; balance due to treasurer, April 1, 1903, £1,654; credit balance, March 31, 1904, £353—total, £8 891. Receipts—Received during the year, £6,514; value of stock in hand, March 31, 1904, £277; sundry debtors for current to March 31, 1904, £2,100—total, £8,891. The work of extending the electric light main so that the existing public gas lamps on the whole of the Kingsland Estate may be converted into electric light lamps is in progress. It is also proposed to extend the main along College-hill both for public and private supply.

**Mussoorie (India).**—A scheme for the supply of electric power for Mussoorie and Landour has been drawn up by Mr. Billinghurst, late State engineer, Bikanir, *Indian Engineering* says. The electricity is to be generated by the power obtained from the Kampti Falls, about 2½ miles from Mussoorie. These falls are 821ft. high, and the minimum power available from them is sufficient for 434 effective horse-power. The water of certain springs will be pumped up to the top of Blutcher's Hill, and thence distributed by gravitation over the greater part of the station. It, however, only provides eight gallons per head for a population of 15,000, leaving a small surplus for municipal use. The scheme also provides for the lighting of 13½ miles of public roads, with a surplus for private lighting. The total cost of the scheme is six lakhs of rupees, but it needs careful technical scrutiny before measures for giving it practical effect could be sanctioned. Sanction has been accorded for providing telephonic communication along the line between Howrah and Burdwan, arrangements having been made for the supply of some 124 telegraph and 192 telephonic instruments.

**Barking.**—The accounts of the electric lighting undertaking for the last year show a profit of between £240 and £290. In the first year of working—1899-1900—the number of units sold was 127,626 at 2·88d. per unit, resulting in a net deficit for the year of £943. 15s. 8d. In the following year nearly 100,000 more units were sold, but while the price per unit was raised to an average of 4·2d., the net result was an adverse balance of £1,005. 18s. 4½d., partly because the works cost more than doubled. In the third year Mr. A. H. Seabrook, the present engineer, was appointed, and since then the position entirely altered. In his first year 60 000 units were added at a lower selling price per unit. The total revenue rose to £4,650, the works costs decreased, and the deficit came down to £273. In the year 1902-3 the number of consumers rose to 532, and the maximum load was more than double that of the first year. Now a net surplus was shown of £19. During the past year the total cost of production and working was only £3,893, while the total units sold have been more than trebled, and approached 500,000. The total number of consumers has risen to 640, and fresh applications, for motor power chiefly, are being received almost every day. Current is supplied for power purposes down to 1d. per unit according to demand. We are informed that a new power station is to be erected on a riverside site, generating three-phase current at 6,000 volts.

**Canada.**—Upon the turning on of the water-generated electric power on the interurban and New Westminster street railway circuits, says the *British Columbia Review*, the Vancouver Power Company is supplying power for all the works of the British Columbia Electric Railway Company with the exception of the arc lighting and the street railway system in the city of Vancouver and the municipal lighting of the city of New Westminster. With the Vancouver incandescent lighting system, the interurban and the New Westminster street railway circuits in operation by power from Lake Beautiful, the British Columbia Electric Railway Company will be utilising a maximum of 2,500 h.p. from that source, and the average for the 24 hours will be about 1,000 h.p., the difference up to 2,500 h.p being called into requisition at times of great stress on the various circuits. By next August the British Columbia Electric Railway Company expects to supply power to the city of New Westminster for the lighting of that town. The power will be sold to the city, which will operate its own system as it does at present, except that it will purchase the outside generated power. A year from next May it is expected that the tunnel under the mountain separating Lakes Beautiful and Coquitlam will be completed, and then there will be available for use no less than 9,000 h.p., which amount may be increased at short notice to more than double.

**Blackburn.**—Mr. A. S. Giles, electrical engineer of the Corporation, in his report upon the year's working of the electricity department, gives the following abstract of accounts: Receipts, £28,549. 16s. 6d.; working expenses, £13,892. 16s. 7d.—gross profit, £14,656. 19s. 11d.

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This sum is available for the payment of interest, £6,195. 10s. 1d., and sinking fund, £7,028. 5s.—total, £13,223. 15s. 1d.; less bank interest, £201. 4s. 2d.; net profit, £1,634. 9s. The profit enables the committee to clear off the previous adverse balance of £657. 19s. 2d., leaving a surplus of £976. 9s. 10d., which it is suggested should form the nucleus of a reserve fund. The output of the generating station for the year was 2,895,181 units sold, being an increase of 15 per cent. over last year. The number of consumers on March 25, 1904, was 990, being an increase of 100 during the year. The total present connections to the mains are equivalent to 138,485 lamps of 8 c.p., as compared with 106,866 lamps at the corresponding period last year. The cost of working the undertaking has been very considerably reduced, the works cost of generation being ·65d. per unit 1904 (·79d. per unit 1903). The total cost including management and distribution to the consumer being 1·05d. per unit in 1904 against 1·2d. per unit in 1903. Mr. Giles compares the present rates, which are as follows: Lighting—6d. and 3d. per unit, rebate indicator system (one hour); power—2½d. and 1½d. per unit (the lower rate for power consumers using 100 units per quarter per horse-power installed, less 5 per cent. for early payment); tramways—1½d. per unit net, with the revised rates which come into force July 1 next—viz.: for lighting—one uniform rate of 4d. per unit, with the option for consumers to pay on the existing rebate system; for power—first 1,500 units per quarter 1½d. per unit, all consumption above 1,500 1d. per unit; all accounts subject to 5 per cent. discount for early payment. He says until the output of the electricity department reaches a point which will materially lower the cost of generation, it is not possible without loss to reduce the rate for power supply to the tramway department, and advocates the abolition of meter rents.

**Kingston.**—The tenth annual report of the borough electrical engineer, Mr. J. E. Edgcome, shows that preparations are in hand for carrying out extensions to the engine-house required for the new generating plant which will be installed to meet next winter's load. The report then states: "A day-load condensing plant, consisting of horizontal combined air and circulating pumps coupled to the existing condenser shell, has been erected and is now at work. A single-phase alternating-current motor of 8 h.p. has been put down for driving the mechanical stokers of the boilers and the scraper gear of the economisers. Mechanical stokers with patent self-cleaning compressed-air furnaces have been fitted to one of the multitubular Lancashire boilers, and tests with these stokers are being carried out. The generating plant, which has been ordered for next winter's work, consists of a three-crank, triple-expansion, high-speed, enclosed engine of 350 h.p., direct coupled to a single-phase alternator of 200-kw. capacity. Extensions of the distributing mains have been made in the following roads for the purpose of connecting up consumers: Lower Ham-road, Eastbury-road, St. George's-road, Dagmar-road, Park-road, Herbert-road, Upper Park-road, High-street, Ceres-road, Burton-road, Grove-lane, Maple-road, Fairfield South, Old Mill-lane, Cambridge-road, Chesham-road, Clevedon-road, Chatham-road, Gloucester-road, Denmark-road, Portland-road, and Mill-street. Arrangements have been made for installing transformer pillars, in place of underground sub-stations in various parts of the borough where distributing centres are required. High-tension feeders will be laid to these pillars, to which the low-tension distributing mains will also be connected, and these transformer pillars, in conjunction with section pillars, will divide up the borough into districts, controlling the supply from various points. These pillars will prove easier of access than the underground sub-stations originally laid down, and will not, like these, be subject to trouble from water during floods. A number of motors of various sizes have been connected to the circuit, and are used for driving printing, cutting, and folding machines, aerated water machinery, dentists' drills, ventilating fans, hair-brushing machinery, for organ blowing, boot stitching, and other similar purposes. Small motors for driving sewing machines are very convenient, this type of motor taking an amount of current about equal to that taken by a 16-c.p. lamp. These small motors are becoming more popular as their adaptability, simplicity, and absolute cleanliness become known, and, particularly for intermittent work, electric motors are the cheapest means for obtaining mechanical power, whereas the floor space taken by an electric motor is about one-tenth that required by steam or gas engines of equal power. Current for motors is supplied through a separate meter at the reduced rate of 3d. per unit. Small ventilating fans which can be connected to an existing lampholder will be found of the greatest benefit in the sick room, where it is of importance that the air should be kept pure and fresh. The extension of the public arc lighting has proved very satisfactory, the automatic change-over switches have worked well, and the automatic lighting of the side lights has proved useful on those few occasions when an arc lamp has been temporarily extinguished. The committee will be gratified to note that during this year, for the first time since the inauguration of the undertaking, a net profit has been made after paying all charges, including payment of interest and repayment of capital, and after payment of certain special charges amounting to £399. 18s. 4d., these payments including that amount of the cost of installing chain-grate stokers to Nos. 4 and 5 boilers chargeable to revenue account. The total capital expenditure to March 31, 1904, amounted to £86,468. 7s. 1d. The amount of capital expended during the year being £3,684. 4s. 1d., the amount of capital repaid being £2,711. 12s. 9d., leaving a balance of outstanding capital expenditure to March 31, 1904, of £72,782. 17s. 5d., a total sum of £13,685. 9s. 8d. having been paid off the capital account. The number of consumers has increased from 530 to 630, an increase of 100. The number of 8-c.p. lamps connected has increased from 25,767 to 28,603, an increase of 2,836. This increase in the number of consumers is very satisfactory, and is the largest increase during any 12 months since the works commenced running. The number of lamps connected per consumer is not so large as in previous years. This, however, is not an unsatisfactory feature, as it indicates that the class of consumer now being connected to the mains is one installing a comparatively small number of lamps, and experience shows that this class of consumer burns daily a larger proportion of lamps installed, and for longer hours, and is consequently more profitable than the consumer who, having a large number of lights installed, usually burns only a small proportion of his lamps, and then often for a comparatively short period daily. The adoption of the demand indicator system, with charges of 7d. and 3d. per unit, will considerably lessen the average cost of current to private house consumers, and especially to hotels and public-houses, where lamps are in use for a number of hours daily. Business houses, where the light is also installed in the living-rooms, passages and basements, will likewise obtain a considerable advantage by adopting this system. Our system of deferred payment wiring now more widely known, I find that consumers are availing themselves of this method of wiring their premises. The Corporation pay the contractor the cost of the work, such amount being refunded by the householder by means of deferred payments over a period not exceeding five years. A fee of 5 per cent. is charged by the Corporation for preparing the specification and superintending the work, interest at the rate of 5 per cent. being charged each quarter on the outstanding balance. A number of consumers, although not wishing to avail themselves of this opportunity of spreading the payment over a number of years, have had their houses wired under this system in order that the work might be carried out to the specification and under the superintendence of the Corporation, and upon completion of the installation have paid the whole cost of the same, together with the Corporation's fee of 5 per cent. for superintendence, instead of dividing the payments over a period of years. Tenders lately received show that 10 lamps with simple fittings can be installed for from £7 to £8. A further reduction in the cost of coal has been carried out, the amount paid for coal being £203. 8s. 7d. less than during the previous year, although the units sold have increased by 67,666. This increase in efficiency is, in my opinion, greatly due to the satisfactory working of the chain-grate stokers and of the large condensing plant with its adequate supply of cooling water. The average cost for fuel per unit sold has been reduced from 1·536d. to 1·157d. The total works cost expenditure has been increased by £116. 13s. 5d.—from £4,930. 4s. 10d. to £5,046. 18s. 3d.—but the total revenue has increased by £1,661. 11s. 7d.—from £8,341. 1s. 6d. to £10,002. 13s. 1d.—a net increase of revenue over expenditure of £1,544. 18s. 2d. The gross profit on the works after paying all charges, exclusive of payment of interest and repayment of capital, has increased from £3,410. 16s. 8d. to £4,955. 14s. 10d. The amount of interest has increased by £118. 16s. 3d.—from £2,022. 10s. to £2,141. 6s. 3d.—and the amount for repayment of capital has increased by £386. 15s. 9d.—from £2,324. 18s. to £2,711. 12s. 9d. There is a surplus after payment of interest amounting to £2,814. 8s. 7d., and after repayment of capital there is still a surplus of £102. 15s. 10d., which I trust the committee will consider a satisfactory result as indicating the commencement of an era of prosperity for the undertaking."

## PROVISIONAL PATENTS, 1904.

MAY 12.

**10939. Electric tramways point and frog mover.** Robert Peck, 75, Elaine-street, Toxteth Park, Liverpool.

**10957. Means to facilitate placing the poles or arms of electric cars in contact with the overhead wire.** Alexander Pringle, 97, Withington-road, Whalley Range, Manchester.

**10962. Improvements in electric signalling on railways.** Edgar William Timmis, 2, Great George-street, Westminster, London.

**10986. Improvements in printing telegraphs.** Robert James Sheehy, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 13.

**11040. Improvements in electric fire-alarms.** Johannes Franz August Lueckert, Fife House, Kingston-on-Thames.

**11041. Improvements in automatic electric circuit breakers.** August Eckstein and David Barclay Mellis, Peel Works, Adelphi, Salford, Manchester.

**11056. Improvements in ceiling or wall rosettes for electric lighting and heating.** Andreas Peter Lundberg and Gustaf Charles Lundberg, 477, Liverpool-road, London.

**11072. Improvements in electric resistances.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**11073. Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**11089. Improvements in electrostatic instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11090. Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11093. Improvements in and relating to electric meters.** Claude William Atkinson, 1, Queen Victoria-street, London.

**11111. A new or improved electrically-operated hoisting winch.** Auguste Jules Gustin, 18, Buckingham-street, Strand, London. (Complete specification.)

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**11107. Improvements in and relating to electric lighting and heating apparatus.** Cornelis Hendrik van Aspern, Carey Burt Robinson, and Herman William van Raden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**11116. Electrical signalling.** Leo Arthur Hards, 6, Southfield-gardens, Strawberry-hill, Twickenham.

MAY 14.

**11141. Improved method of winding armatures of dynamo-electric machines.** William Arthur Ker and Paterson, Cooper, and Co., Limited, 65, Chancery-lane, London.

**11156. Improvements in the manufacture of electric cables.** Charles James Beaver and Ernest Alexander Claremont, 4, Bloomsbury-square, London.

**11168. Improvements in safety devices for protecting dynamo-electric machinery and the like against the excessive voltage occurring when they are switched in or out.** The Elektrizitäts Actien-Gesellschaft vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 23, 1903, being date of application in Germany.) (Complete specification.)

**11177. An improvement in electricity meters** Isaac Revilliod, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MAY 16.

**8876a/03. Improvements in methods and apparatus employed in wireless signalling.** Lee de Forest, 19, Holborn-viaduct, London. (Date applied for under Patents Rule 9, Feb. 18, 1903.) (Complete specification.)

**11219. Switch for electric signs.** Ferdinand Nusch, 81, High Holborn, London. (Ludgerus Hölscher, Germany.) (Complete specification.)

**11233. Improvements in electric meters for three-phase alternating electric circuits.** The Union Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, May 15, 1903, being date of application in Germany.) (Complete specification.)

**11251. Improvements in voltmeters used in connection with distributing mains or feeders for systems of electric current supply.** Guy Marquis Newbury, 1, Queen Victoria-street, London.

**11262. Method for the transmission of sound to long distances and telephonic apparatus therefor.** Victorien Tardieu, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11264. Improvements in or relating to electrically-propelled vehicles.** Russell Thayer, 111, Hatton-garden, London.

**11272. Improvements in electrical safety apparatus for signalling on and controlling trains independently of driver.** John William Mackenzie, 40, Chancery-lane, London. (The Société Cousin and Co., France.) (Complete specification.)

**11274. Improvements in telephone selecting systems.** William David Watkins, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 9, 1904.*

1903.

**3876. Methods and apparatus employed in wireless signalling.** De Forest.

**3876a. Methods and apparatus employed in wireless signalling.** De Forest. (Date applied for under Patents Rule 9, Feb. 18, 1903.)

**11145. Accumulator electrodes.** Calandri.

**11299. Alternating-current motors.** Schüler and Ferranti Limited.

**11378. Electric testing apparatus and dynamos therefor.** Evershed and Vignoles, Limited, and Evershed.

**11730. Systems of electric motor control.** Carolan. (General Electric Company.)

**11909. Electric arc lamps.** Ridings.

**12311. Electric steering gear.** Carolan. (General Electric Company.)

**13074. Coin-freed electric shocking machines.** Heinze.

**14295. Electromagnetic separators.** Edison Ore-Milling Syndicate, Limited. (Edison.)

**15591. Means for preventing arcing between commutator brushes.** Carolan. (General Electric Company.)

**15595. Electric arc lamp hanger and switch.** Carolan. (General Electric Company.)

**17073. Electric arc lamps.** Hamilton-Adams.

**21493. Apparatus for perforating the type bands for automatic telegraph transmitting apparatus and the like.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

**21793. Valve and brake controlling mechanism for steam or electric winding or hoisting engines.** Futers.

**28780. Electric furnaces or ovens.** Eimer. (Date applied for under International Convention, May 22, 1903.)

1904.

**8234. Electric telegraphic signalling apparatus.** Bloxam. (Goffin.)

**3912. Apparatus for regulating the intensity and the heating effect of electric currents.** Soc. Anon. L'Industrie Verrière et ses Dérivés. (Date applied for under International Convention, Feb. 18, 1903.)

**8608. Commutators for dynamo-electric machines.** Young. (Date applied for under International Convention, May 22, 1903.)

**8715. Electric circuit cut-outs or switches.** Thompson. (Johnston and Johnston.)

**8826. Safety appliances for electric circuits.** Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅜-½ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ¼-⅜ |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 5½-5⅝ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3¼-4 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 88-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | .. | ¾-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1-1⅛ xd |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 5 | .. | 1⅞-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 96-99 |
| Edison and Swan United, "A" Shares, 1-89,261 | 3 | .. | ¼-⅜ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¾-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9⅛-9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 11½-12½ |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 18½-19½ |
| —— 4 per cent. Debentures | 100 | .. | 99-102 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 14½-15½ |
| Telegraph Construction and Maintenance | 12 | .. | 35-38 |
| —— 6 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 120-125 |
| Bournemouth and Poole, Ordinary | 10 | .. | 11½-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 9½-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10½-11½ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10¾-11¼ |
| —— 7 per cent. Preference | 5 | .. | 10½-10⅝ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 7-7¼ xd |
| —— Nos. 20,001-30,000 | 5 | .. | 7-7¼ xd |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 107-110 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5-5¼ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 103-105 |
| Chelsea Electricity Supply | 5 | .. | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | .. | 107-110 |
| City of London, Ordinary | 10 | .. | 10¾-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 7⅛-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5¾-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5¾-6 |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | .. | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 11½-12½ |
| —— per cent. Debenture Stock Red | 100 | .. | 102-105 |
| Kensington and Knightsbridge and Notting Hill | 100 | .. | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | .. | 9¾-10¼ |
| London Electric, Ordinary | 5 | .. | 1¼-1½ |
| —— 6 per cent. Pref. | 5 | .. | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | .. | 19⅛-20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 12½-13½ |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | .. | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 | .. | 98-101 |
| Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures | 100 | .. | 98-101 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | .. | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | .. | 85-90 |
| South London, Ordinary | .. | .. | 3¾-4¼ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | .. | 14-15 |
| —— 7 per cent. Pref. | 5 | .. | 8-9 |
| —— 3½ per cent. Deb. | 100 | .. | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | .. | 4⅜-4⅞ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4⅜-4⅞ |
| Westminster, Ordinary | 5 | .. | 12½-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | .. | 6¼-6⅜ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 91-94 |
| —— 4 per cent. Pref. | 100 – | 99-102 |
| —— ,, ,, deferred | 100 – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 50-52 |
| —— 4 per cent. Debenture Stock | 100 – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 123-126 |
| —— ,, ,, ,, '96 | 100 – | 120-123 |
| —— ,, ,, ,, '01 | 100 – | 118-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 – | 4-4¼ |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 99-101 |
| Waterloo and City, Ordinary | 100 – | 90-93 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 5⅛-5⅜ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 – | 130-135 |
| Blackpool and Fleetwood Tramroad | 10 – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1¼-2¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 97-102 |
| British Columbia Electric Railway Co., Ord. Def. | 100 – | 100-103 |
| —— Ord Pref. | 100 – | 99-102 |
| —— Non-Cum. 5 per cent. Pref. | 10 – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | – – | 102-104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 – | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 – | 9¼-10 |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10¼-10⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 115-118 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅜-2½ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 5-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 106-109 |
| —— Prov. Cert., all paid | 100 – | 100-103 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 99-102 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18 19 |
| —— 6 per cent. Cum. Pref. | all – | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 50,001-60,000 | 5 .. | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8 8¼ xd |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 .. | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 .. | ⅛-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 .. | ¾-1 |
| New General Traction, Ordinary | 5 .. | ¼ |
| —— 6 per cent. Cum. Pref. | 5 .. | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.). | 100 .. | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12-12½ |
| —— 5 per cent. Cum. Pref. | 10 – | 9¼ 9½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 .. | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 101-104 xd |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,132 6 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 104-106 |
| —— Deferred Stock | 100 – | 87-90 |
| —— 6 per cent. Cum. First Pref. | 10 – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5¼ |
| —— 5½ per cent. Deb. Stock, Red. | 100 – | 98 100 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 103-105 |
| Oriental Telephone and Electric Company | 1 – | 15/16 1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 21 | 1,318 | 1,082 | + 236 | +12,548*h* | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 14 | 213 | 211 | + 2 | + 83 | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 21 | 38 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 22 | 1,051 | 1,038 | – 47 | + 14 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | April 23 | 268 | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | May 20 | 923 | 791 | + 132 | + 550 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 19 | 512 | 444 | + 68 | + 479 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 21 | 334 | 330 | + 4 | + 252 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 22 | 1.752 | 2,089 | – 337 | – 223 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 18 | 983 | 965 | + 23 | + 420 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 14 | 4,055 | 3,271 | + 784 | + 4,911 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 22 | 910 | 921 | – 11 | + 27*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 20 | 5,105 | 4,875 | + 230 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 21 | 1,011 | 784 | + 227 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 23 | 316 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 21 | 1,937 | 1,879 | + 113 | + 717 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 30 | 178 | 186 | – 8 | + 264 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | May 21 | 6,549 | 6,981 | – 432 | – 1,908*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6 *a* |
| City & South London Railway | ,, 22 | 2,65[illegible] | 2,911 | – 255 | – 2,318*h* | 6⅝ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 19 | 482 | 512 | – 30 | – 326 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 20 | 266 | 229 | + 37 | – 67 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 21 | 201 | 216 | – 15 | – 201 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 22 | 121 | 113 | + 8 | + 135*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 20 | 4,064 | 3,957 | + 107 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 20 | 920 | 1,206 | – 285 | } | | | | | | | | | | |
| Dundee City Tramways | ,, 18 | 880 | 836 | + 44 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 22 | 771 | 659 | + 122 | + 712 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 21 | 14,855 | 13,978 | + 877 | +60,128*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Gloucester Corporation | ,, 18 | 272 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 18 | 2,624 | 2,231 | + 403 | + 842 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 21 | 1,266 | 1,207 | + 59 | + 647 | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 21 | 2,095 | 1,783 | + 307 | + 1,154 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 14 | 432 | 367 | + 65 | + 460 | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 19 | 138 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 18 | 216 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 21 | 5,580 | 5,393 | + 187 | + 3,643 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Liverpool Corporation | ,, 14 | 9,976 | 9,816 | + 160 | + 4,535 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 22 | 1,643 | 1,649 | – 6 | + 138*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 7 | 10,728 | 8,483 | +2,245 | +22,034 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 14 | 145 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 21 | 11,991 | 11,811 | + 180 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 21 | 107 | 65 | + 42 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 21 | 3,635 | 3,228 | + 407 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 21 | 481 | 308 | + 173 | + 1,040 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 21 | 1,731 | 1,639 | + 92 | — | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 16 | 126 | 117 | + 9 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 19 | 459 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 16 | 3,974 | 3,051 | + 923 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Corporation | ,, 21 | 165 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 22 | 4,629 | 4,547 | + 82 | + 1,056 | 53½ | 53½ | Mar. | 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 19 | 953 | 938 | + 15 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 18 | 307 | 267 | + 40 | + 170 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 20 | 571 | 273 | + 298 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 22 | 1,260 | 1,223 | + 37 | + 257 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 21 | 682 | 661 | + 21 | + 216 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·05 |
| West Ham Corporation | ,, 19 | 788 | — | — | — | 1⅞ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 18 | 600 | 399 | + 201 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Presentation to Mr. A. R. Bennett.**—The staff of the Glasgow Corporation Telephone Department presented on Tuesday an illuminated address to Mr. A. R. Bennett on the occasion of his retirement from the general managership of that department. The address pays a warm tribute to Mr. Bennett's strenuous efforts as a pioneer of municipal telephony, and to his scientific and literary abilities.

**Single-Phase Electric Traction.**—In order to make an extended trial of single-phase alternating-current motors for railway traction, the General Electric Company (of America) is equipping the entire Ballston division of the Schenectady line on this system. The alternating-current equipment will be in addition to the present direct-current equipment, which is the standard for operation of the Schenectady railway. It is thought that by placing a car in regular service the real value of the alternating-current apparatus will be developed.

**Society of Engineers.**—At next Monday's meeting a paper will be read by Mr. Percy G. Scott, entitled "Notes on Railway Surveys and Design in New Countries," of which the following is a synopsis: Preliminary survey—Equipment—Camps—Obligatory points—Survey for Gold Coast Railway—Contoured plan—Detailed survey—Drainage—General plans and sections—Railway gauges (with table)—Railway gradients (with table)—Setting out curves—Staking out plans and sections and their details—Calculations for river bridges—Plans and sections of rivers, etc.—List of drawings and special designs required—Specifications—Estimates—Conclusion.

**Society of Arts.**—The conversazione will take place at the Royal Botanic Gardens, Regents Park, on Monday, June 27, from 9 to 12 p.m. Each member will receive in due course a card for himself and one for a lady companion. In addition, a limited number of tickets will be sold to members of the society, or to persons introduced by a member, at 5s. each if purchased before the day, or 7s. 6d. on the day. These tickets can be purchased on personal application, or by letter enclosing remittance. Tickets will also be supplied to non-members on presentation of a letter of introduction from a member. The programme will be announced later.

**Electric Lighting Conference.**—A conference of local authorities and companies owning electrical undertakings is to be held at the St. Pancras Town Hall to-morrow at noon, when the principal business will be to discuss the advisability of petitioning the Board of Trade to promote legislation repealing or modifying those clauses in the Electric Lighting Act of 1882 and in electric lighting orders which render undertakers liable for any damage or nuisance caused in the exercise of their powers. It is proposed that they shall be relieved of such liability unless serious damage or nuisance is occasioned, in which event they are to have power for the compulsory acquisition of the interests affected.

**Curious Lighting Incident.**—The explanation given at the recent meeting of the South African Lighting Association, reported in the *Journal of Gas Lighting*, of a little shrinkage in the gas consumption during the latter part of last year is surely a unique one. It appears that the Government of Cape Colony has adopted a standard time which brings the day forward by setting the clocks to indicate one hour in advance of the old time. The result is that, as they still regulate their life by the hour shown on the clock, their offices and shops are closed an hour earlier than formerly, and the people retire to bed that much earlier, so that they save an hour's consumption of gas at night, which in South Africa is not counterbalanced, even in winter, by the people rising proportionately earlier.

**New Books.**—"Constructive Geometry," by J. G. Kerr. (London: Blackie and Son, Limited. 1s. 6d.) The author, with sympathetic consideration for the young mind, has compiled an elementary treatise on geometry, introducing the pupil to mathematics in a practical way, so that he may be prepared for the mazes of Euclid. Messrs. Whittaker and Co. inform us that they will publish shortly a new work by Mr. H. M. Hobart, entitled "Electric Motors: Their Theory and Construction." This will deal fully with the design of induction and continuous-current motors, and will be characterised by considerable departure from conventional methods, by which means it is believed that new light will be thrown on the subject.

**Telephone Purchase.**—There have been a number of statements published in the daily papers to the effect that an agreement has been come to between the Post Office authorities and the National Telephone Company, by which the purchase of the company's undertaking may be completed within the next few weeks. These statements are obviously incorrect, as no such agreement can be completed until the terms have been discussed in Parliament. It is interesting, however, to recall the fact that under the provision of the company's license, which expires on Dec. 31, 1911, the Postmaster-General is enabled by giving six months' notice to acquire the undertaking compulsorily at septennial periods, the last of which is Dec. 31 next. To do this Lord Stanley must give notice on the 30th inst. It would involve a long arbitration which an amicable agreement may avoid.

**Wireless Telegraphy in Chicago.**—We gather from the *Western Electrician* that wireless telegraphy has not been commercially successful in the Chicago district. Last year two stations were equipped in Chicago which were supposed to form part of a large system to transmit messages to the principal points on the great lakes and also to the steamers trading on them. The first of these was laid down by the Marconi Company, and the other by the De Forest Company. The Marconi station was in operation last June, and messages were successfully exchanged over a distance of 81 miles to Milwaukee. The station is now said to be closed down and the apparatus for sale. The station of the De Forest Company has been abandoned in an incomplete condition. It will be interesting to know some time the reason of these enterprises having been allowed to fall through.

**Obituary.**—With the death of Mr. Friedrich Siemens at the age of 78, another of the noted family which founded the firm of Siemens Bros. has passed away. This firm, so closely allied to the firm of a somewhat similar name on the Continent, has taken the lead in this country in every branch of electrical manufacturing. The late Mr. Friedrich Siemens came to England in 1848 for the purpose of introducing the telegraphic apparatus invented by Mr. Werner Siemens. Owing to the patents held by Wheatstone and Cook, he was not successful in this respect; but he assisted the late Sir William Siemens in the development of the regenerative principle as applied to furnaces, which practically revolutionised the steel industry by rendering possible the open-hearth process. The latter part of his career was mainly devoted to the glass industry, in connection with which he invented many economic devices. To inventions in other fields of industry, also, he was a fertile contributor. His decease removes a notable figure from the world of engineering and science.

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**The Light Railways Act.**—A Bill has been introduced in the Upper Chamber by Lord Wolverton "to continue and amend" the Act of 1896. In substance it provides that (1) if any order under the principal Act is not confirmed by the Board of Trade on the ground that the proposals of the promoters ought to be submitted to Parliament in pursuance of Sub-Section 3 of Section 9 of the principal Act, the Board may, if they think fit, submit the proposals to Parliament by bringing in a Bill for the confirmation of the order; (2) if, while a Bill confirming any such order is pending in either House of Parliament, a petition is presented against the order, the Bill, so far as it relates to the order, may be referred to a Select Committee, or, if the two Houses of Parliament think fit so to order, to a joint committee of both Houses, and the petitioner shall be allowed to appear and oppose as in the case of private Bills; and (3) on bringing in a Bill under this section for the confirmation of an order, the Board of Trade shall make a special report to Parliament with respect to the order.

**Wireless Telegraphy.** — The long-deferred daily newspaper on board Transatlantic liners to be produced by means of wireless telegraphy, is, according to statements in the daily Press, to be inaugurated to-morrow, when the "Campania" leaves Liverpool for New York. Simultaneous arrangements, it is stated, have been made for all the Cunard liners and those of other Transatlantic companies to publish the paper. Mr. Marconi returned from America last week, and when interviewed he stated that his latest experiments had been very successful, as he had exchanged messages with both sides of the Atlantic throughout the passage, besides communicating with other vessels. It has even been settled that the paper will be devoted purely to Press purposes, and will not contain any advertisements; possibly this feature will be developed later. Apart from the journalistic novelty, however, the electrical world will during the next few days watch with exceeding interest how far Mr. Marconi's optimism is justified by the regular supply of wireless telegraphic messages over long distances.

**Electric Lighting Charges.**—The following information, which we have received from Mr. W. C. P. Tapper, electrical engineer to the borough of Stepney, is of interest to all London inhabitants as establishing a new record for low charges for electrical energy. The charges now adopted by the Council are as follows: (*a*) for lighting (from June 1), 8d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and 1d. per unit for all further consumption in each month; (*b*) for motive power at 480 volts and for all purposes other than lighting (as and from July 1), 1d. per unit. It will be seen from this that, acting on the advice of Mr. Arthur Wright, the Council are still rigidly adhering to the charge of 8d. per unit for the first period on the maximum demand system, but that they are reducing the charge for subsequent hours. For motive power, on the other hand, a uniform rate of 1d. per unit has now been established, which must be of very great value to manufacturers within the borough. The electrical undertaking at Stepney is one of which the inhabitants may well be proud.

**North-East Coast Engineers' Institution.**—The closing meeting of the twentieth session of the North-East Coast Institution of Engineers and Shipbuilders was held last week in the lecture hall of the Literary and Philosophical Society, Newcastle, Prof. Weighton presiding. The chairman announced that the following awards had been made to graduates for papers read before the graduates' section during the nineteenth session of the institution: £2 to Mr. H. Bocler for his paper on "Rudders," £2 to Mr. T. C. Fortune for his paper on "The Stresses Produced in the Working Parts of a Marine Engine," £1 to Mr. P. F. Allan for his paper on "A Short Description of Street Railway Work," £1 to Mr. A. E. Berriman for his paper on "The Growth of Automobilism in Public Highways," and £1 to Mr. R. Robson for his paper on "The Comparison between Different Systems of Charging for Electricity." A discussion took place on Engineer-Lieut. E F. Baker's paper on "The Management of Belleville Boilers at Sea," to which Lieut. Baker replied. Thanks were tendered to Mr. Jno. Tweedy, the retiring president, and the retiring members of the council.

**Paris Metropolitan Railway.**—The annual general meeting of this company was held last week in Paris, and the returns show a total income of £704,700, against working expenses of £303,100. The amount paid as compensation for the catastrophe last August was £46,000. The balance available for dividend and reserves was £174,200. The company is now working 20½ miles of the 26 miles of line which will complete the first portion of the Paris Electric Metropolitan Railway. It has almost completed the construction of the Bercy power station, which will ultimately supply sufficient electric power for the whole of the line. The capacity of this station will be 14,440 kw.—say 20,000 h.p. In conformity with the requirements of the authorities, the company is renewing the whole of its rolling-stock, and is adopting an improved system of traction, whereby short-circuits will be made innocuous. The complete isolation of all electric machinery on the trains will be effected by the adoption of a system of multiple units, so as to render harmless the current circulating in the channels under the trains. The new rolling-stock now being built will comprise 167 bogie auto-motors, 28 bogie first-class cars, and 28 bogie second-class cars.

**Patent Returns.**—The report of the Comptroller-General of Patents, Designs, and Trade Marks for last year shows that the number of applications received was 28,832, a slight decrease over the previous year. This is exclusive of applications for complete patents after grant of provisional, which numbered 9,187, as compared with 8,510 in 1902. Of the applications, 17,820 came from England and Wales, 1,309 from Scotland, and 419 from Ireland, whilst of those received from abroad the applications from the United States and Germany were in a large majority, though both show decreases. There was a marked increase in the applications from Japan. The fair sex have, of course, invaded the field of invention, 583 applications having been made by women inventors. The total receipts amounted to £248,924, against an expenditure of £124,055. Although the applications for provisional outnumbered those for complete patents, the former diminished, whilst the latter continue to show an increase, the record number of 6,634 being received during 1903. The electrical classes show the most conspicuous growth in accepted complete specifications; regulating appliances, dynamo generators and motors, and measuring apparatus having increased by 42, 34, and 33 per cent. respectively. The number of inventions relating to means for signalling, or for controlling or actuating apparatus, by electromagnetic and other radiators (including wireless telegraphy), is more than double that in the previous year. On the other hand, galvanic batteries and electrolysis show a slight diminution. The subject of electric traction on rails, which showed such immense progress the previous year, underwent only a slight further development in 1902, although the number of inventions relating generally to

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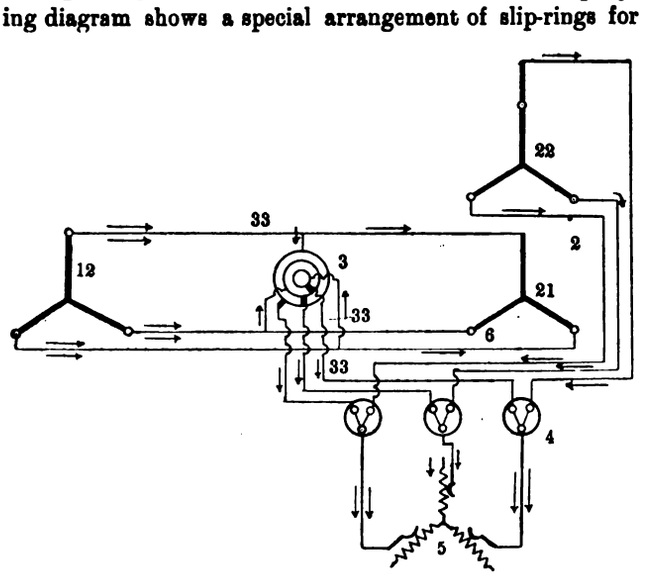
railway and tramway vehicles went up 9 per cent. There was a large increase in the number of inventions relating to steam-turbines.

**Radium.**—Lord Kelvin delivered some observations the other day to a representative of the *Westminster Gazette*, who interviewed his lordship upon the theory advanced by Prof. Rutherford in his recent lecture, that radium as a new source of energy might account for the antiquity attributed to the earth by geologists. In regard to this, his lordship quoted the following remarks, lately published by him: "But this leaves the mystery of radium untouched—Curie's discovery that it (perpetually?) emits heat at a ratio of about 90 centigrade calories per gramme per hour. If emission of heat at this rate goes on for little more than a year, or, say, 10,000 hours (13½ months), we get as much heat as would raise the temperature of 900,000 grm. of water by 1deg. C. It seems to me utterly impossible that this can come from a store of energy lost out of the gramme of radium in 10,000 hours. It seems to me, therefore, absolutely certain that if emission of heat at the rate of 90 calories per gramme per hour found by Curie at ordinary temperature, or even at the lower rate of 38 found by Dewar and Curie from a specimen of radium at the temperature of liquid oxygen, can go on month after month, energy must somehow be supplied from without to give the heat which gets into the material of the calometric apparatus." His lordship suggested that ethereal waves might in some manner supply energy to the radium while it was emitting heat to the ponderable matter around it. He referred to the original discovery of radioactivity by Henry Becquerel, and paid a tribute to the Becquerel family for their research into its mystery, and also eulogised Prof. Rutherford's new work on "Radioactivity," in glowing terms.

**Electro-Chemical Behaviour of Radium.**—A paper on this subject by Mr. A. Coehn appears in the *Journal* of the Chemical Society. The author remarks that radium cannot be deposited on a platinum electrode by electrolysis of solutions in alcohol, acetone, or pyridine, as the cathode shows only a temporary induced activity. With aqueous solutions, cathodes of different metals acquire only a temporary activity in presence of radium bromide solutions; a mercury cathode, however, becomes permanently active, and when extracted with hydrogen bromide gives a permanently active bromide. The D.P. required for the separation of metal (calculated from heats of formation) increases in the series Ca, Sr, Ba, but proceeds in the reverse direction when amalgams are produced, so that the separation of strontium on mercury requires 0·2 volt more than barium, and calcium 0·25 volt more than strontium; the latter difference is sufficient for the electrolytic separation of these metals. These values are, however, for saturated solutions, and although the difference between radium and barium should be greater than between barium and strontium, it is not possible to separate these metals except with extraordinarily small current densities; metallic radium is, however, precipitated by barium amalgam. Neither barium nor radium can be separated from aqueous solution on fused Wood's metal. Metallic radium cannot be satisfactorily deposited on amalgamated platinum, but can be obtained on amalgamated zinc, the upper part of the rod being protected from oxidation by means of paraffin wax. By precipitation on a pure mercury cathode and dissolution in hydrogen bromide, a considerable increase of activity is obtained in the bromide. A silver anode was used to absorb the bromide; this at first showed a greater activity than the cathode, but this was due only to induced activity, and disappeared at the end of 24 hours. The redissolving of the metallic radium in the solution from which it is being deposited can be greatly checked by using methyl alcohol as the solvent in place of water. Metallic radium in the form of amalgam behaves like its compounds, in that the activity increases during several days to a maximum value.

**St. Marylebone Lighting.**—When the Bill authorising the Borough Council to raise the purchase money for the electric lighting undertaking and to erect a generating station was before the House of Commons Committee, the Gaslight and Coke Company made abortive efforts to obtain an enlargement of the modified form of the Bermondsey clause included in the measure. As the result of the proceedings before Lord Brougham's Committee, however, some material alterations have been introduced. On behalf of the gas company the usual plea, that they might be liable to contribute to any deficiency arising out of a rival undertaking, was urged, and they were allowed a *locus standi*. Negotiations were then entered into, and alterations made to Clause 34. The first of these deals with the fixing of the charges for supplying energy. The clause originally provided that the Council should annually fix the charges at such rates that, "so far as is reasonably practicable (having regard to any steps which the Council may decide to take to decrease the expenses or increase the revenue of the undertaking), the revenue for that year shall not be less than the estimated amount of the charges on revenue account and of the charges for interest and sinking fund for that year." The words in parentheses have been deleted, the company contending that their elasticity would practically defeat the provision. The next section of the clause, which makes exception to the one just quoted in the case of contracts entered into "under special circumstances with particular consumers to supply electricity at prices fixed by the contracts," has been altered so as to render it applicable only to contracts entered into for periods exceeding a year. The most drastic alteration, however, is the introduction of a provision, supplementary to the Bermondsey clause, directing that the general borough rate shall not be debited with any higher rate of charge for street-lighting or other purpose using electrical energy than that charged to consumers. This, of course, prevents any deficit arising out of the supply to private consumers being met out of the public lighting rate. Gas interests are naturally elated at this result, which they regard as a valuable precedent; but it is to be feared that such stringent provisions will seriously hamper the St. Marylebone undertaking.

**Slip-Rings for Cascade Motors.**—The accompanying diagram shows a special arrangement of slip-rings for




cascade motors introduced by Koloman V. Hando, and described by Josef Löwz in the *Zeitschrift für Elektrotechnik*.

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The two motors are mounted on a common shaft, and have but one set, 3, of three slip-rings. Both the rotor, 12, of the primary motor and the rotor, 21, of the secondary machine are connected to the three slip-rings by means of the conductors, 33, while the stator winding, 22, of the secondary motor is connected with the three brushes resting on the slip-rings through the switches, 4, to which latter resistances, 5, are attached. At starting the switches, 4, are set so that the current in the rotor winding, 12, flows directly through the rotor winding 21, while that induced in the rotor winding 22 passes through the resistances. Hereupon the switches, 4, are reversed, when nearly the whole current from the rotor 12 is diverted through the resistance, 5, only the magnetising current of the secondary motor flowing in the rotor 21. Finally, the resistance, 5, is gradually reduced, the current in the rotor 21 being ultimately decreased to zero with the resistance short-circuited. The arrangement described dispenses with the necessity for a second set of slip-rings, thus economising room, reducing contact resistance, and minimising attention.

**Heating Effect of the Radium Emanation.**—A paper on this subject is contributed to the *Phil. Mag.* by Messrs. Ernest Rutherford and H. T. Barnes. The authors conducted experiments in order to determine how the heat emission of radium is connected with its radioactivity. For the measurement of the heat a differential air calorimeter and platinium thermometers were employed, diagrams and descriptions of which are given in the *Magazine*. The emanation was driven off the radium bromide by heating, and was condensed in a tube surrounded by liquid air. The heating effect of the radium, when first tested, had fallen and continued to fall for about three hours, when it reached a minimum of about 30 per cent., after which it gradually increased, reaching its original value in about a month. Complementary changes were observed in the case of the emanation tube, so that the sum of the heating effects of the radium and the emanation tube during the whole course of the experiments was always equal to that of the original radium. The authors therefore conclude that about 75 per cent. of the heat is not due to radium directly, but to the emanation and the active matter it produces (termed emanation X). It was found that the curve of diminution of the heating effect of the emanation is nearly identical with the curve for the loss of radioactivity, and hence supports the view that the heat emission is an accompaniment of the expulsion of the $\alpha$-rays. About 10 minutes after the removal of the emanation, the heating effect of radium is about 45 per cent. of the original; the gradual decay from this point to the minimum is due to the decay of activity of the "emanation X" left behind, and the curve was found to be similar to the decay to zero of the emanation tube after the removal of the emanation itself. The decay curves indicate three well-marked changes in the emanation X. In the first, half the matter is transformed in three minutes; in the second, half in 34 minutes; and in the third, half in 28 minutes. These changes will be discussed in a later paper, but the authors now state that the first is accompanied by $\alpha$-rays, the second is not, and the third is accompanied by $\alpha$, $\beta$, and $\gamma$ rays. The proportion of the heat effect due to the radium is about 25 per cent.; that due to emanation and first change to emanation X, about 41 per cent.; and that due to the second and third change, about 34 per cent. The energy stirred up in the emanation is enormous, and the authors calculate that one cubic centimetre would liberate per hour from $1{\cdot}25 \times 10^5$ to $1{\cdot}25 \times 10^6$ gramme-calories, and that 1 grm. can radiate an amount of energy lying between $2 \times 10^9$ and $2 \times 10^{10}$ gramme-calories.

**London Chamber of Commerce.**—At the last meeting of the Electrical Trades' Section several matters of interest to the electrical industry were dealt with. The section considered and generally approved the provisions of the Supply of Electricity Bill—subject to slight modifications on points of detail—as being a necessary measure, which will have the effect of removing the difficulties which have arisen in the past in the development of the electrical supply industry. The council of the Chamber subsequently endorsed the views of the section, and resolved to address the President of the Board of Trade, expressing the hope that, in view of the urgency of legislation on the lines of the Bill, the Government might see its way to grant facilities for its passage during the present session of Parliament. A discussion also took place with regard to certain draft regulations arising out of the report of the Departmental Committee on Electricity in Mines which it was suggested would affect the electrical industry generally as well as the mining industry in particular, and might also become the basis of future regulations affecting the whole electrical industry. A resolution was passed (and has since been confirmed by the council of the Chamber) to the effect that the attention of the Home Office should be called to the matter with a request that any draft proposed regulations which may be under consideration may be submitted to the Chamber in order that the electrical section may have an opportunity of considering the same and submitting their remarks to the Home Office before the regulations are put into force. The Valuation Bill as affecting electrical and other large industrial undertakings was also considered. Certain general objections were made to the Bill, more especially (*a*) that it is unsound in principle, that a great spending authority such as a county council should itself be the valuation authority; (*b*) that the bodies which will control the assessments are themselves competing with traders; (*c*) that the valuation authorities will appoint expert valuers, and that there is no security under the Bill that the system of payment according to the amount of the assessment secured by their efforts will be discontinued; (*d*) that there is no machinery by which a ratepayer can appeal to a competent independent court. It was agreed to co-operate with other sections of the Chamber in giving effect to the views of the section and bringing them before members of Parliament. The council of the Chamber subsequently referred the matter to its General Purposes Committee for early action.

**Alternating-Current Motors.**—We referred recently to a serial article by Josef Löwz, appearing in the *Zeitschrift für Elektrotechnik*. A further instalment deals with multiphase induction motors, strenuous efforts to perfect which have been made, the author points out, notwithstanding the attention given to alternate-current commutator motors, with the result that improvements have been effected, especially in regard to starting up and speed regulation. The author incidentally describes several rotors expressly designed to enable starting with high resistance in the armature circuit, whereby this resistance is gradually or suddenly reduced when the normal speed has been attained. The Maschinenfabrik Oerlikon connect all armature conductors (see Fig. 1) to form a cage winding, through short-circuiting rings of high resistance. At the same time these conductors form a multiphase winding having the special end connectors, *g*. At starting, this multiphase winding is open, being short-circuited through the ring, *k*, and contact arms, *h*, only after the normal speed has been reached. Steinmetz provides the rotor (Fig. 2) both with a cage winding, *i*, and a special multiphase winding. While the beginnings of the

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phase windings are connected through a closed ring, *m*, the end of each phase and a corresponding number of intermediate points in the windings are connected separately to

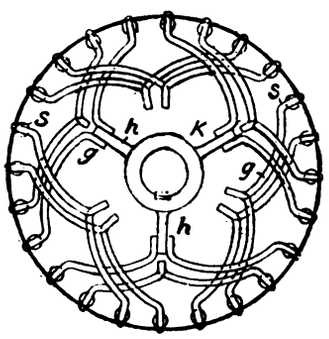


FIG. 1.

special contacts, *j*, *k*, *l*, etc. At starting the multiphase winding is open, while as the normal speed is gradually attained it is short circuited through the ring, *s*, by

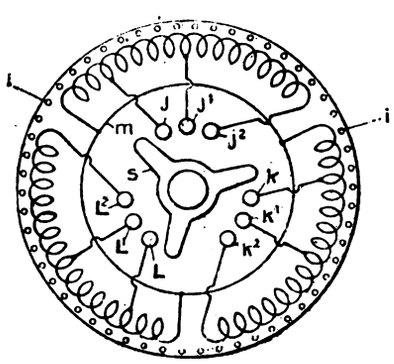


FIG. 2.

successive steps. No special starting resistances are required with these motors, the resistance offered by the rotor winding serving instead.

**Compounding Three-Wire Machines.**—In a recent issue of the *Zeitschrift für Elektrotechnik* there appeared a short article from the pen of E Rosenberg dealing with the above question. When machines designed to supply current to a three-wire network are provided with compound winding, it is generally necessary for the current carried by both outer conductors to pass through the main winding. The machine shown diagrammatically in Fig. 1 has

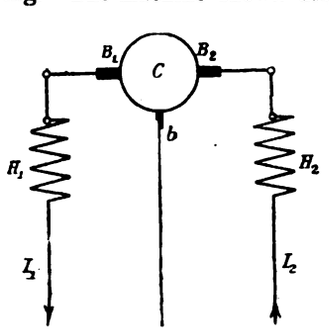


FIG. 1.

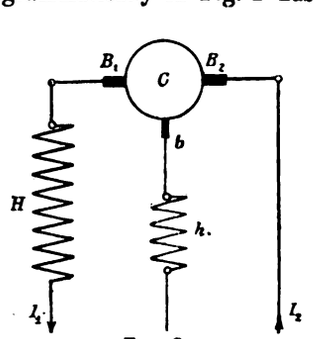


FIG. 2.

an auxiliary brush, *b*, mounted on the commutator, C, between the main brushes, $B_1$ and $B_2$. It is usual, as here shown, to split the main winding into two parts, each connected to an outer conductor. If the current in the first outer conductor be $J_1$ and that in the second $J_2$, the number of turns in each coil being $\frac{N}{2}$, then the magnetisation in ampere-turns produced by the main winding is

$$\frac{N}{2} \cdot J_1 + \frac{N}{2} \cdot J_2.$$

The division of the main winding is, however, not always convenient. For instance, if it were desired to parallel an ordinary compound machine with one arranged to supply to a three-wire network, it would be necessary, in order to connect the balancing wires, to couple the series windings of both machines in circuit with the same outer conductors. Moreover, the divisions of the windings frequently presents difficulties, especially when it is a case of adapting a machine for the three-wire system. If, for instance, all series coils be connected in parallel, as is usual for heavy currents, the division can only be effected with a considerable reduction of the efficiency. And since, after the division, only half the number of coils is connected in parallel, it follows that in order to prevent twice the former volume of current from passing, a resistance must be connected in parallel designed to carry an equal share of the current. In this case the loss due to the main winding will amount to double the normal, while by dispensing with the resistance or over-compound winding the fourfold loss would be incurred. The author proceeds to describe how the main winding may be connected unaltered in circuit with one of the outer conductors, the balancing being effected by a second main winding being in circuit with the middle wire. Fig. 2 shows the arrangement when the division of the voltage is effected by means of an auxiliary brush resting on the commutator, while Fig. 3 represents that patented by the Allgemeine

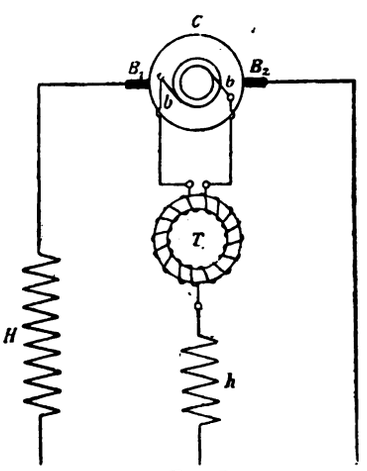


FIG. 3.

Elektricitäts-Gesellschaft, in which case this division is made by an external choking coil whose ends are connected through slip-rings, with two diametrically opposite points of the armature winding, while its centre is connected to the neutral conductor. To obtain the same effect as previously, this winding is provided with half the number of turns contained in the main winding and connected in a similar manner. Its section is determined by the estimated amount of current required to balance. Assuming the current, $J_1$, which flows through the main winding, exceeds the current, $J_2$, in the second outer conductor, then an out-of-balance current, $J_1 - J_2$, will flow through the middle wire, its direction being opposed to that of $J_1$. Further, if the main winding has N and the auxiliary winding $\frac{N}{2}$ turns, the resultant ampere-turns will be

$$N \cdot J_1 - \frac{N}{2}(J_1 - J_2) = \frac{N}{2} \cdot J_1 + \frac{N}{2} \cdot J_2.$$

Hence a precisely similar effect is obtained as by halving the main winding. The efficiency is not reduced by the auxiliary winding so long as the machine has a balanced load. Even with the outer conductor unequally loaded, the loss of potential caused by the auxiliary winding may be reduced to a very small amount by correctly proportioning this winding.

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## LEICESTER CORPORATION ELECTRIC TRAMWAYS.

*(Continued from page 819.)*

### Overhead Electrical Equipment.

The overhead equipment has been designed and arranged with a view to obtaining the greatest possible immunity

FIG. 24.—Centre-Pole Construction opposite Midland Railway Station.

from breakdown, also that the fittings should appear as artistic as possible. The design of the centre, span, and side bracket pole ornamentation is original, and was prepared by Mr. Mawbey in conjunction with the Leicester

FIG. 25.—Laying Conduits on Power Station Site.

Art School. Span-wire construction has been adopted generally, but where streets and roads are wide enough centre poles (Fig. 24) have been introduced. In the centre of the town where suitable attachments could be obtained poles have given way to rosettes, except at junctions, these being erected on poles throughout. Each centre pole has been fitted with two incandescent gas lamps, and the base is protected by a neat elliptical guard kerb, this work being carried out by the Corporation staff. Side bracket arms

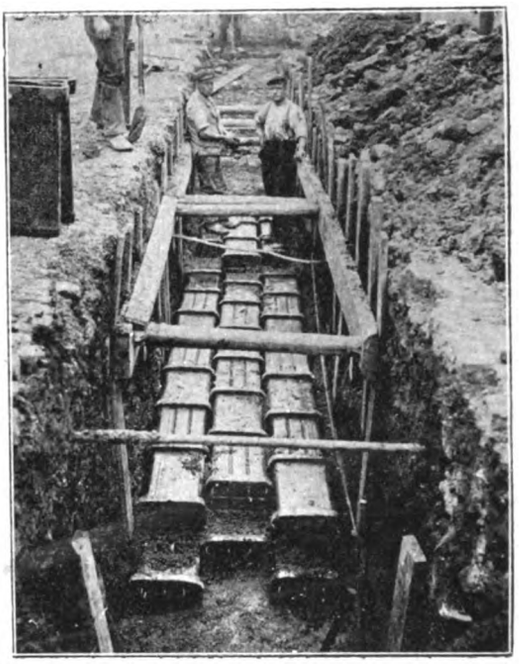
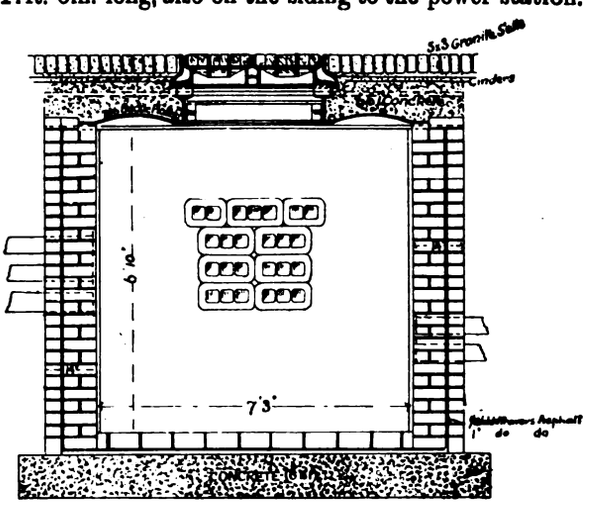
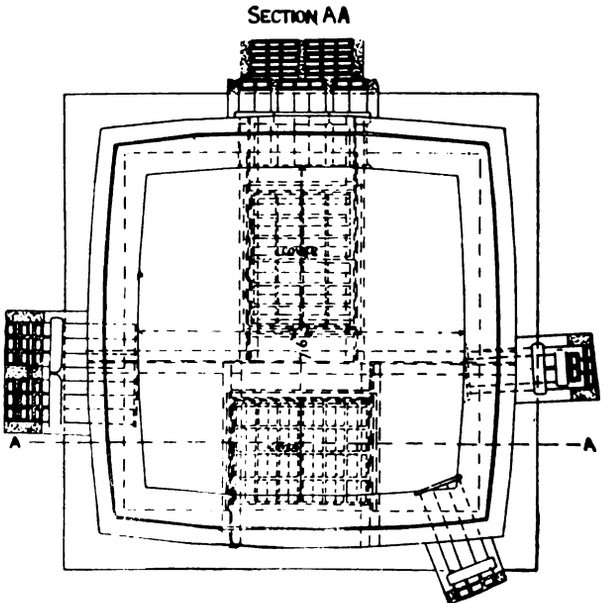


FIG. 26.—Laying Conduits in Painter Street at entrance to Power Station.

have been used on one short length to the number of nine, each 17ft. 6in. long, also on the siding to the power station.




SECTION AA




PLAN

FIG. 27.—Drawing-in Chamber for Cables, Painter Street.

The poles are of two grades, A and B, the former being used on the straight, and the latter on the curves, at junc-

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tions and for anchorage. The respective weights of the poles are 840lb. and 1,180lb. The total length is 31ft., made up of three sections shrunk together. The poles are planted 6ft. in the ground, the foot resting on a concrete template 6in. thick, which in turn is bedded on 6in. of cement concrete, the space around the pole being filled in with cement concrete of suitable thickness to suit the nature of the ground. The pole bases, which are of a very neat and truly artistic design, are 6ft. 6in. high, the greatest diameters being 16in. and 18in. respectively for the two sizes.

The trolley wire is 3/0 B. & S. gauge throughout, except at the car depôts, which are wired with 1/0; and the span and guard wire are of galvanised steel $^{7}/_{12}$ and $^{7}/_{16}$ respectively. Flexible bowstring suspensions and double insulation have been adopted throughout. One important feature and advantage is that the trolley wire is with a few exceptions suspended over the centre of the track, a deviation of 3ft. only being allowed. "Aetna" insulation and line fittings of extra strong design have been used throughout, the insulator bolts being of drop-forged mild steel, screwed ¾in. Eighteen-inch ears have been used on the straight and 24in. on the curves throughout, and special double and single pull-offs on all junctions and curve work, the distance between the bolt and the eye being 5in. Galvanised iron thimbles are employed wherever eyes have been spliced in either span, pull-off, anchor, or guard wires, and straight under-running section insulators are fitted at each half-mile section, the feeders being connected to the line at these points. The connecting cable between the section and feeder pillars and the line is $^{61}/_{20}$'s, insulated with pure and vulcanised rubber, lead covered and double braided, and is carried from the pillar to special drawing-in boxes at the foot of each of the section poles, and thence up the inside of the pole, the pole being bushed with gunmetal bushes top and bottom. From the top bushes of the pole the cables are carried out to the trolleys along the span or bracket, as the case may be, and served with P. and B. tape, a copper ferrule being sweated to the end of each cable and clamped into the section insulator. In the car depôts the trolley wire is carried in a neat pitch-pine troughing, running the entire length of the shed, and suspended from the roof trusses by wrought-iron clips.

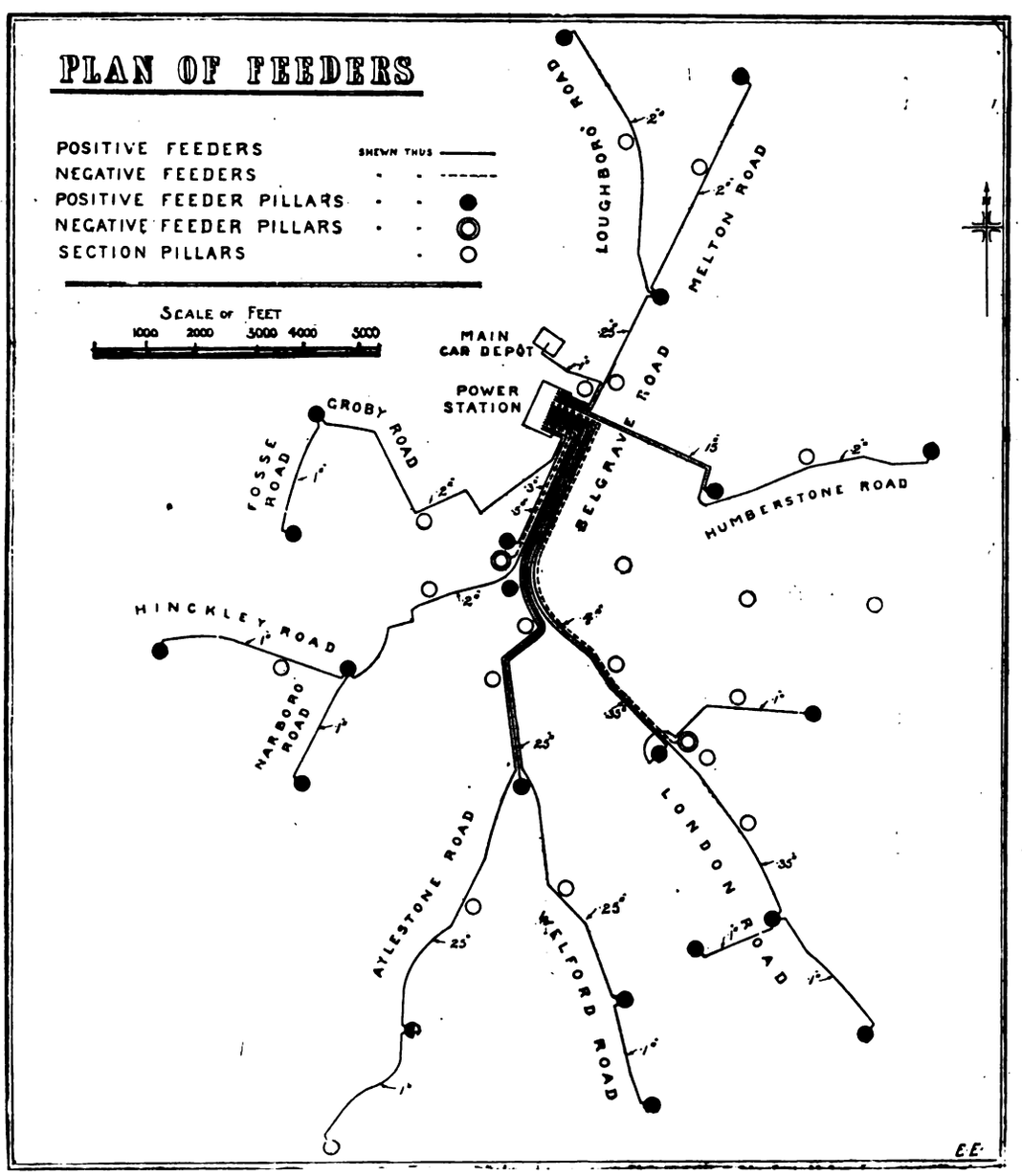


FIG. 28.—Distribution to Lines, Leicester Tramways.

The main car depôt is supplied by a separate feeder direct from the power station, arranged so that when the rest of the system is shut down the depôt may be run off the battery. Where the lines pass under railway bridges, the trolleys are carried in troughing suspended from the underside of the bridges in such a manner that it is impossible for a passenger even by leaning over the car rail to touch the "live" wire. The danger arising from telephone and other wires crossing over the routes has been thoroughly appreciated, and the engineer has adopted the course of having these removed wherever practicable, so that very little guard wire has been erected, this only occurring at some few points where the Post Office wires could not be dealt with in any other manner. Special arrangements were made with the Post Office authorities and the National Telephone Company, whereby the

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Telephone Company have placed the whole, and the Post Office the bulk, of their wires underground. Several stacks of Post Office wires have been dealt with in this manner, including one of 21 wires on the London road, which ran parallel to the track for a distance of approximately 1½ miles; another also of 21 wires on the Loughborough road, which extended for a distance of approximately one mile; and a similar stack of seven wires on the Hinckley road, approximately 1½ miles long.

Four sizes of section and feeder pillars are used. These are fitted with white marble panels, which carry the various quick-break switches, kicking coils, and safety fuses for automatically disconnecting the overhead line in case of failure. The feeders are connected up to the main switchboard at the power station through automatic circuit breakers, which are set to cut out any one of the feeders should a short-circuit occur on any of the sections supplied by that feeder, thus ensuring that should a trolley wire break on any portion of the line, either the fuses in the nearest section pillars would "blow," or the circuit breaker at the station would open, rendering that portion of the line dead. Each pillar is also fitted with a Garton lightning arrester, and an ebonite panel carrying the test and telephone terminals. All holes in the panels are fitted with ebonite bushes and washers. A specially designed telephone shutter, operated by a separate key, has been fitted to each piliar, arranged so that it is unnecessary to open the pillars in order to use the telephone, the jack being inserted from the outside, thus obviating the danger of anyone accidentally coming in contact with the "live" fittings in the pillar when using the telephone. The telephone instruments are carried on the cars, one being supplied to each car. Two negative feeder pillars are erected to meet the present requirements, one at the clock tower and the other at Highfield-street, approximately 1,100 and 2,700 yards respectively from the power station. All section and feeder pillars, and the poles up which the feeder cables have been carried, are bonded direct to the rails by a 4/0 copper bond to prevent the possibility of their becoming "alive" owing to breakdown of the insulation at these points.

The whole of the equipment, including poles, wires, section and feeder pillars, etc., has been supplied and erected by Messrs. R. W. Blackwell and Co., Limited, London; Messrs. Cort, Paul, and Cormick, a local firm, having, we understand, manufactured the cast-iron bases and collars for the poles to the order of Messrs. Blackwell.

### Feeder Cables, etc.

The whole of the cables in connection with this work have been supplied and drawn in by Messrs. W. T. Glover and Co., Limited, of Manchester. The stoneware conduits for the feeders and pilots are of the patent self-centreing type, with composition joints, and were supplied by Messrs. T. Wragg and Sons, Limited, of Swadlincote, the total quantity of conduits supplied being equivalent to about 80,000 yards of single way. During the time that the principal routes were being laid a very large number of these conduits were required daily, and notwithstanding the stress placed upon them, this firm were always able to cope with the demand. The contractors for the cables state that throughout the whole of the work none of the cables have been damaged whilst being drawn through the conduits owing to any roughness of the same. The chambers are built of brindled bricks in cement, and made as water-tight and gas-tight as practicable. The work of laying the conduits (Figs. 25 and 26) and the construction of the drawing-in chambers was carried out by the Corporation workmen. The drawing-in chambers, arranged about 80 yards apart, have been fitted with ventilating covers (Fig. 27), and designed with a view to securing ample room for inspection and work, and also to provide for future extensions. Bellmouths are built into the walls where the conduits enter and leave the chambers. Throughout the entire system the conduits are laid at the side of the track. The cables are single conductors, insulated with diatrine impregnated paper and lead-covered, jointed by means of lead sleeves wiped on to the lead of the cables. At intervals of approximately a quarter of a mile the lead covering of the cables is earthed to the rails by means of bare copper bonds, as a preventive against electrolysis.

Two negative feeders have been carried out to different points of the system (Fig. 28), and are connected to the rails through special feeder boxes, having the necessary Board of Trade instruments mounted therein. Each cable bears a brass label in every box, denoting its size, voltage, and termination. The sizes of the feeders range from ·1 square inch to ·5 square inch, the total length being over 20 miles. A complete system of telephone and pilot cables is also drawn into separate ducts along each feeder route, and connected up in every feeder and section box. All lead-covered cables terminate in the basement of the power station, connection being made to the switchboard with fire-resisting cable of Messrs. Glover's latest type, as previously mentioned. The whole of the feeders and pilots were submitted to a pressure test of 1,000 volts alternating current for one hour, which proved in every way satisfactory. They were then tested for insulation resistance, and in each case gave infinity.

*(To be continued.)*

## CORPORATION OF LEICESTER TRAMWAYS STAFF DINNER.

The Leicester Corporation electric tramways staff celebrated the inauguration of the town's new system of

traction, reported in a previous issue, by entertaining Mr. E. George Mawbey, M.I.C.E., borough and tramways engineer, and Mr. Frank W. Allen, A.M.I.C.E., assistant borough surveyor, at dinner at the Turkey Café on Thursday evening, May 19. Mr. T. Robert Smith, A.M.I.E.E., resident electrical engineer, presided, and was supported by Mr. W. Plant, resident engineer for the permanent way and buildings, and Mr. A. F. Lucas, the tramways manager.

The menu card was chiefly remarkable for the humorous picture which ornamented its front cover. Accompanying is a reproduction of the design, which, we understand, was executed by Mr. J. A. Diamond, architectural assistant on the staff.

After dinner a framed photographic group of the tramways staff, suitably inscribed, was presented to Mr. Mawbey

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as a mark of the esteem in which he is held by his co-workers. The enthusiasm which characterised the subsequent proceedings reflected in a high degree the mutual feeling of good fellowship and esteem which has prevailed among the staff throughout, thereby adding to their efficiency as a body in the public service.

## TYPES OF DIRECT-CURRENT LOW-TENSION SWITCHGEARS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Concluded from page 821.*)

When required for Colonial use the cellular gear is constructed for immediate service directly after unpacking and mounting in the station. Skilled erection is thereby obviated entirely, as the gear is practically complete on leaving the maker's works. The general design is similar to that described above, the method of supporting the main slabs presenting the only change. Fig. 20 indicates the manner in which the supporting slabs, forming the gear, are tied together. Steel bolts, with large distance nuts and washers, securely clamp the horizontal slates up solid, and are then in correct register for sliding the division pieces into position. All contacts, switches, cut-outs, 'bus bars, etc., are mounted in position before packing, and the entire gear, or its sections, are designed to rest on brick piers, built on the switch platform. The packing and slinging of a single section are illustrated in Fig. 21. When it is difficult to obtain skilled labour abroad, or undesirable to send out fitters acquainted with the work, the advantages of this form of board become at once apparent. The engineer of the station, or his assistants, can easily supervise so simple an operation as the unpacking of the various sections and mounting of them in position. When the loose instruments are connected up, the panels can be coupled by cables to their respective dynamos and feeders, and the board is ready for immediate use.

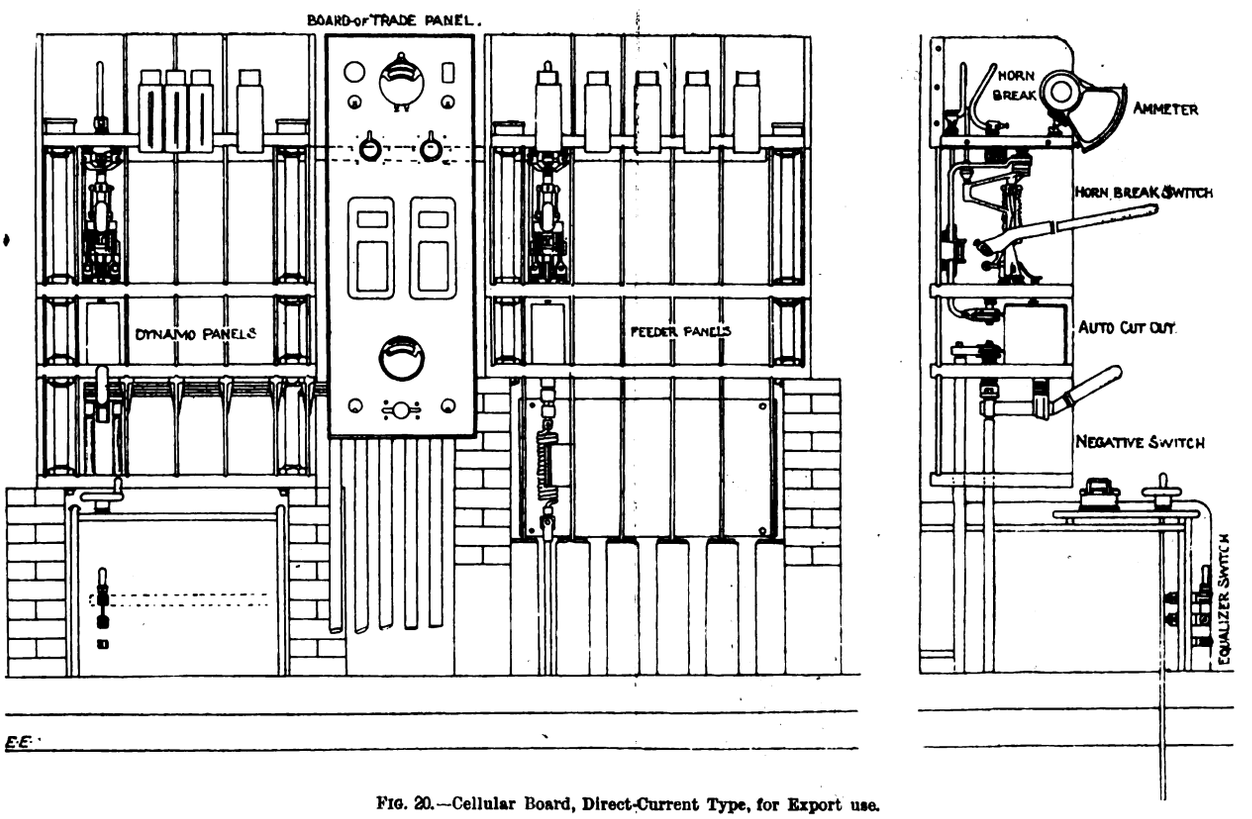


FIG. 20.—Cellular Board, Direct-Current Type, for Export use.

There are many other types of low-tension switchboards employed for rotary converters, sub-stations, and distributing networks, but the author has been unable to obtain a representative selection of these. The foregoing examples, however, may be regarded as characteristic of the types of low-tension boards now commonly used. Unlike its high-tension colleague, the low-tension switchboard has not received the attention which its importance merits. Comparing the developments of the two types, the danger in the early forms of high-tension gear necessitated immediate and radical alterations in its design. The successful operation of high-tension stations to-day is mainly due to the improvements effected in such switching apparatus. With the low-tension gear, however, no such powerful stimulant has been evident. The nature of the pressures controlled makes it a comparatively easy matter for work of poor character to pass muster. The connections behind the board can be made almost without regard to safety, as conductors of opposite potentials can be brought much closer together than in high-tension boards. The raising of pressures to 600 or 700 volts is certainly doing much towards improving the design of low-tension gears, both in the assembly of the panels and the construction of the fittings themselves. The persistence of a direct-current arc almost enforces the fixing of circuit breakers, etc., at the top of the gear, placed beyond all possibility of doing damage to the rest of the board. Circuit-rupturing devices operating in a magnetic field, with carbon points, or with flare horns, are now in general use, and each type fulfils a distinct function on the majority of switchgears.

At the present time any marked alteration in the design of low-tension gears will be very doubtful, because engineers are of opinion that this section of power-house equipment should be installed at low cost. This statement is not meant to convey the idea of cheapness or shoddy work, but rather that manufacturers are guided by the designs and estimates of consulting engineers in constructing such boards. Considerable sums will be expended upon generating plant, as efficiencies in this direction are regarded of great importance. The switchgear, on the contrary, is almost looked upon as a necessary evil, and the less spent upon it the better. This indictment is hardly applicable so much to the switching apparatus as the manner in which the various fittings are assembled to form the complete gear. A light framing, with insulating panels of a minimum thickness, is considered a suitable medium upon which to mount the most costly switching and registering appliances. In many cases, of course, the method of support controls the design of the apparatus, which is arranged to bolt on the face of the panels with connecting lugs for the rear couplings. In attempting to elaborate on this arrangement, and thus produce a type of board of more solid construction, and without rear cable couplings, the difficulty of cost is at first apparent. Engineers think such a gear is an expensive luxury, and in comparing its design and

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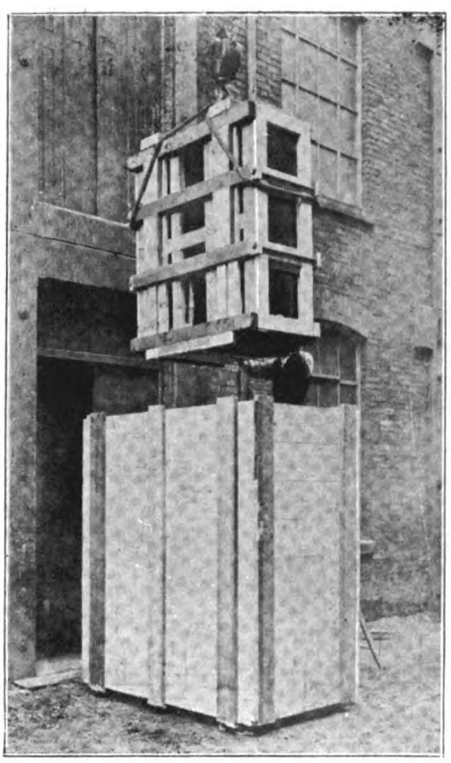
efficacy with boards of other makes they are apt to overlook the advantages conferred by the use of such a board. In any industry a good thing is worth paying for, and generally commands a fair market price; but inferior goods, although they may answer the purpose, cannot convey the same benefits as the first-class article.

The design of low-tension gear now commonly used has had a successful career, and, excepting a few isolated instances, no notable burn-outs have occurred. Severe



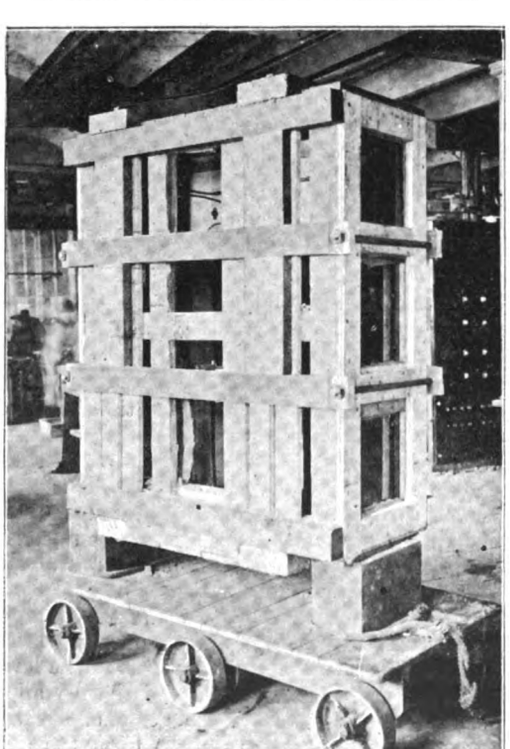


FIG. 21.—Packing Arrangement for Exporting Cellular Gear.

burns and heavy shocks have doubtless been received in their manipulation, but no really criminal evidence is forthcoming to shake the present confidence of the industry in them. Improvements in insulating materials have considerably lessened the chances of fire behind the board, though the starting of an arc amidst exposed connections would probably lead to disaster. The cheap nature of boards with backs has occasioned a good deal of competition in their manufacture. This circumstance has done much to lower the standard of low-tension boards, as their construction has drifted into the hands of firms who do little else than assemble the fittings of other makers on a framework of their own building. Gears can be run up in this manner at a very low price, and, in addition to delaying standardisation, they stem the tide of any movement which has the raising of the level of such switchgears for its object. Until the voltages of supply are put up, and until engineers are prepared to recognise a more substantial construction for this type of apparatus, the present state of affairs will doubtless continue. The raising of pressures in high-tension circles has quite debarred the introduction of inferior switching apparatus, while electricians are also avowed supporters of an efficient and expensive gear. It is to be hoped that some such change and support will also bring about marked improvements in the method of assembly of direct-current controlling appliances.

## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

*(Continued from page 790.)*

### 4. AUXILIARY MACHINERY.

*Importance of Auxiliaries.*—A careful analysis of the repair and labour accounts of any power station, especially one where steam-turbines are installed, shows that a very large percentage of the items are accounted for by the auxiliary machinery and apparatus. When we also consider that they represent about 10 per cent. of the total power installed in the station, it is evident that in order to fulfil the essential conditions we have laid down it is worth while devoting considerable attention to the choice and arrangement of this apparatus. When a main unit is running the whole of the corresponding auxiliary plant is operating at practically full load, whatever be the load on the main unit. As a consequence, the auxiliaries are responsible for about 15 per cent. of the total coal bill of the station—due regard, therefore, should be paid to their economy. On the other hand, the factors governing the design of auxiliaries are the same as those controlling the choice of the main plant—that is to say, they must provide as effectively as possible, firstly for the reliability, and secondly for the economy of the *main* supply. It is necessary to bear the relative importance of reliability and economy in mind when considering which system to adopt, and to face the sacrifice of running economy of the auxiliary plant to a material extent if by so doing additional reliability is secured. Auxiliary apparatus generally may be divided into (*a*) steam-driven auxiliaries, (*b*) electrically-driven auxiliaries.

*Different Means of Driving Auxiliaries.*—After making a careful balance-sheet of the respective merits of steam and electrically-driven auxiliaries, it will be found that it is impossible to lay down any hard-and-fast rule which will apply to all cases or to all classes of auxiliary machinery, partly on account of the widely different conditions under which the machinery has to operate, and partly on account of the effect which the general design of the station has on this question. For instance, the American practice of omitting economisers leads to the adoption of steam-driven auxiliaries exhausting into feed-water heaters, while as economisers are almost universally installed in English and Continental practice, it follows that there is less gain to be derived from exhaust steam feed heaters.† To adopt electrically-driven auxiliaries either involves that the capacity of the main generating units be increased by 10 per cent., or, as an alternative, that this amount of special generating plant be installed. In either case the cost of the additional generating plant must be debited against electrical auxiliaries, as steam-driven apparatus merely requires the provision of the additional boiler capacity.

The running account will be made up of the capital charges resulting from first cost, of the repairs and attendance charges, and of the actual cost of fuel. In considering these along with the question of reliability,‡ it is convenient to arrange the auxiliaries in a steam station under the following heads: (1) boiler-house drives—*i.e.*, stokers, coal and ash conveyors, economisers, and fans; (2) circulating and air pumps; (3) feed pumps; (4) exciters.

* Paper read before the Institution of Electrical Engineers.

† In this connection it may be noted that the installation of economisers offers more attractions with mechanical draught than with natural draught; in the former case the temperature of the flue gases at the base of the chimney need not be considered, and as a consequence they may be deprived of more heat.

‡ This, in the case of all electrical auxiliaries, is more a question of reliability of the supply of electrical energy to the motors driving the auxiliary plant than of the plant itself.

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*Electricity v. Steam for Driving Auxiliaries.*—Dealing with these *seriatim* : (1) It will almost invariably be found that, even apart from the question of reliability, it is best to adopt electrical driving for the machinery in the boiler. The units are small, and if steam driven wasteful of steam and expensive in repairs and attendance. (2) As to the circulating and air pumps, we are of opinion that here also electrical driving is preferable, save only in the case of stations having slow-speed reciprocating main engines, where the air-pumps may with advantage be driven direct from the main sets. The circulating pumps have occasionally to be situated some distance from the station, in which

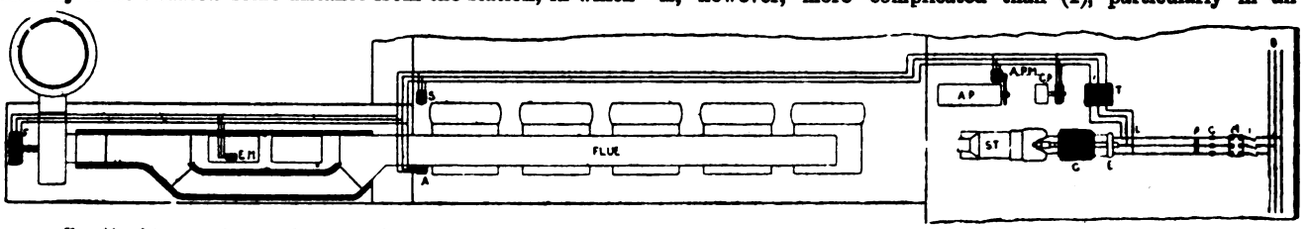


FIG. 11.—Diagram showing Complete Unit System for Operating Auxiliaries. A, ash-handling motor; A P, air pump; A P M, air pump motor; B, bus bar; C, current transformers; C P, circulating pump and motor; D, disconnecting link; E, exciter; E M, economiser motor; F, fan motor; G, main generator; L, link fuses; M, main oil switch; P, potential transformer; S, stoker motor; S T, steam turbine; T, transformer.

case electrical operation is especially advantageous. (3) The feed pumps are a more difficult problem. They operate at variable speed, whereas all other auxiliary plant in the station operates at constant speed. In addition to this, steam feed pumps have for years been standardised—their first cost is low and their reliability high. They are needed even when the boiler fires are banked, and when no plant is running in the station; and though this last argument is admittedly not a weighty one, it would appear desirable to put down steam-driven fesd pumps for, at any rate, the first instalment of plant. That this system of having steam-driven feed pumps at the commencements and electrically-driven feed pumps for extensions

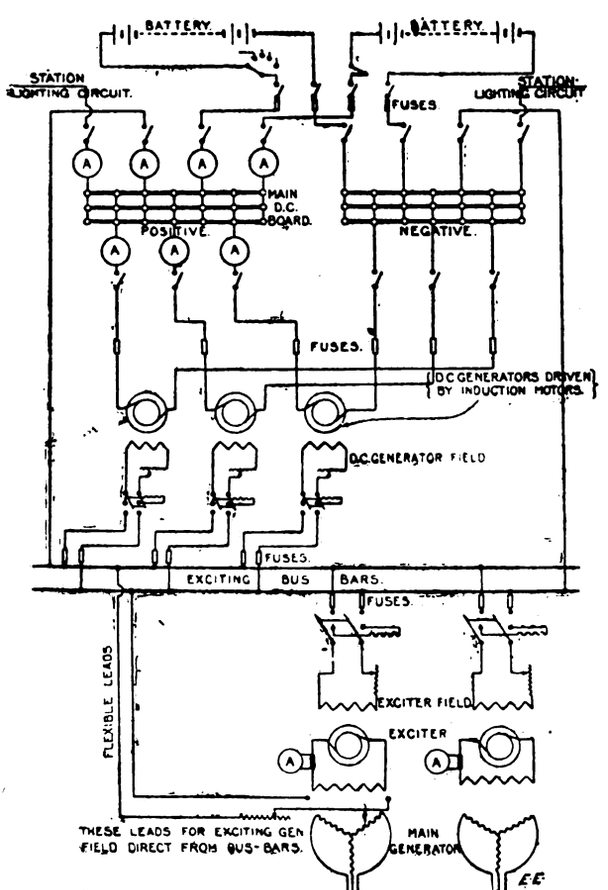


FIG. 12.—Exciting Circuit Diagram, Carville Power Station.

has much to commend it, is evidenced by the fact that it has been adopted in many cases both in this country and abroad.

*Methods of Electrically Driving the Auxiliaries.*—From the above it would appear that at any rate the major portion of the auxiliary plant under the first three heads should be electrically driven,* and before proceeding to discuss the question of exciters, it may be as well to consider the best way of obtaining and applying electricity for operating the auxiliaries already discussed. There are four obvious methods of driving electrically the auxiliary machinery : (1) from the main 'bus bars ; (2) from the main 'bus bars with a reserve battery ; (3) from separate generating sets ; (4) from separate generating sets, with the addition of a connection to the main 'bus bars to meet emergency conditions. Of these (1) is the simplest method, the objection being that a total failure of supply stops not only the main units but the auxiliaries—thus extending the duration of the failure owing to the necessity of again starting up the auxiliaries before the main units can be got under way. The second alternative has the advantage that the auxiliaries can always be kept running even though the main plant be shut down. It is, however, more complicated than (1), particularly in an alternate-current station, as it involves the interposition of a motor-generator between the 'bus bars and the battery. The most flexible system is (3) especially when the station is of sufficient capacity to justify the erection of auxiliary generating units of reasonable size. There still exists the possible danger due to failure ; this can either be met by the instalment of a battery or by taking current in emergency from the main 'bus bars on the lines of (4). This latter method offers many advantages, as it is preferable that the motors installed should be of the polyphase type. If polyphase motors be adopted, and if, as would appear desirable, steam feed pumps are installed in the first instance, then as continuous current is required for excitation both the feed pumps and exciters may be left out of consideration, and it is of less importance than it otherwise would be to guard against failure of the polyphase auxiliaries. It is, therefore, justifiable, with the ultimate adoption of (4) in view, to start the first instalment of a power station with polyphase auxiliaries operated through stationary transformers from the main 'bus bars, without, for the time being, providing any alternative source of supply, the separate generating unit for operating auxiliary plant alone would not be installed until justified by the load. In other words, method (1) may be adopted in the first instance with the idea of ultimately arranging for (4).

*The Complete Unit System as Applied to Auxiliaries.*—There is a further possible method—an extension of the complete unit system—which possesses many attractions, though, so far as we know, it has not been used anywhere. It consists in driving the whole of the auxiliaries from the particular main unit which they serve by connecting stationary transformers direct to the alternator terminals, these transformers being of sufficient capacity to operate air-pumps, centrifugal pumps, stoker, induced-draught fan, and even, if desired, feed pumps—all in permanent connection through a switch with the main unit. In starting up, the switches controlling air-pumps and centrifugal pumps may be left in and the field of the main generator excited. These auxiliaries would then start up with the main machine, just as if they were mechanically coupled or geared to it. Flexible connections would be provided so that motors, feed pumps, or induced-draught fans could be used as spares for other sets, but normally each main unit would deal with its own auxiliaries and would be independent of all others. The chief advantages offered are simplification and consequent saving in switchgear, and also, we think, increased reliability. It will be seen that the 'bus bars are protected from any failure of the stationary transformer by the main machine switch. (See Fig. 11.)

*Exciting Circuits.*—We come now to the question of excitation—one which has always attracted considerable attention. Numerous attempts have been made to run each exciter from the main shaft of its own alternator, but this method has not been generally adopted, chiefly due to the fact that in any variation of speed this variation and the variation of the exciting current have a cumulative effect on the 'bus bar voltage, and this effect is heightened by the unstable nature of a small low-speed, direct-current machine. The authors are, however, of opinion that with high-speed engines, and more particularly with steam-turbines, any difficulties there are may be readily overcome, and that the simple arrangement of coupling the exciter to the end of the alternator shaft may be safely adopted. The modern practice of operating all switchgear electrically almost necessarily involves the use of a small battery. It is convenient to utilise this battery to excite the fields of the direct-coupled exciters—it may also be used as a spare to meet the possible failure of one of the exciters. Such an arrangement carried out is shown in Fig. 12. Here two batteries are installed, from one or other of which the exciter field current is normally supplied, but should an exciter break down the

* The balance of advantages would still further lie with electrically-driven auxiliaries if it were possible to obtain efficient rotary feed and air pumps. There is no inherent difficulty in designing the former, and they have been installed in various places.

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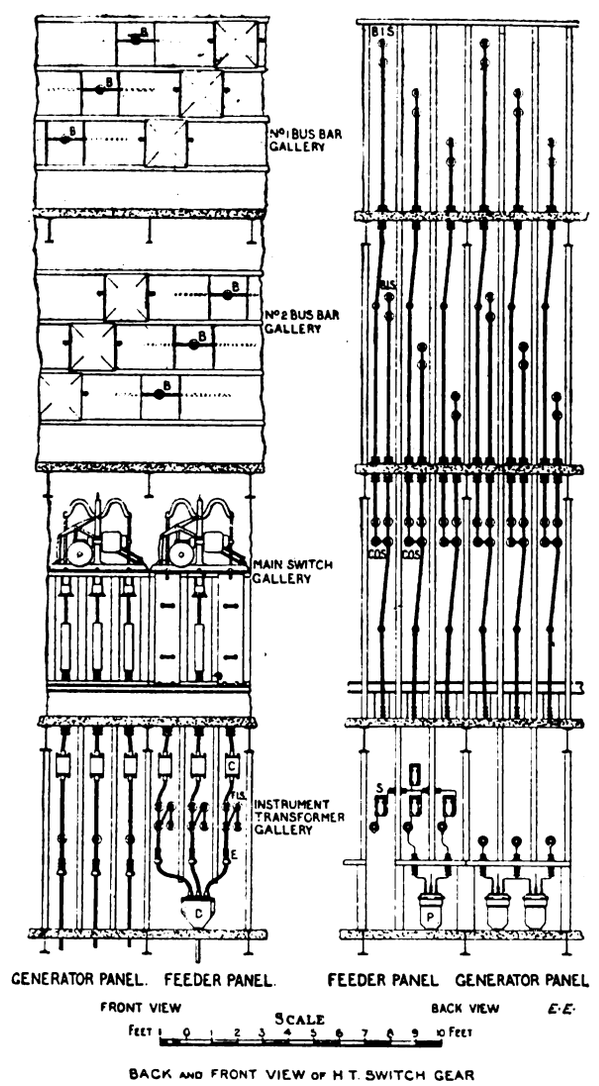
battery may be used for exciting the alternator direct. Two batteries are installed, so that there may be no variation of exciting voltage while one is being charged, and the batteries, in addition to supplying current for excitation and for operating the electrical switches, can feed the emergency lighting circuits throughout the station.

### 5. Switchgear.

*Importance of Reliability of Switchgear.*—Every engineer who has had experience in the operation of a large station appreciates of what vital importance it is that the switchgear should be efficient and reliable under all conditions. We have already pointed out that the main 'bus bars is one of the three places in the station where a junction must be made between the various units which, from the boiler-house to the switchgear, may be kept completely independent of one another. Switchgear suitable for large power stations has only been recently developed, and on this account reliability of operation must be secured by a relatively heavy capital outlay. As the manufacture of high-tension switches and automatic protective devices

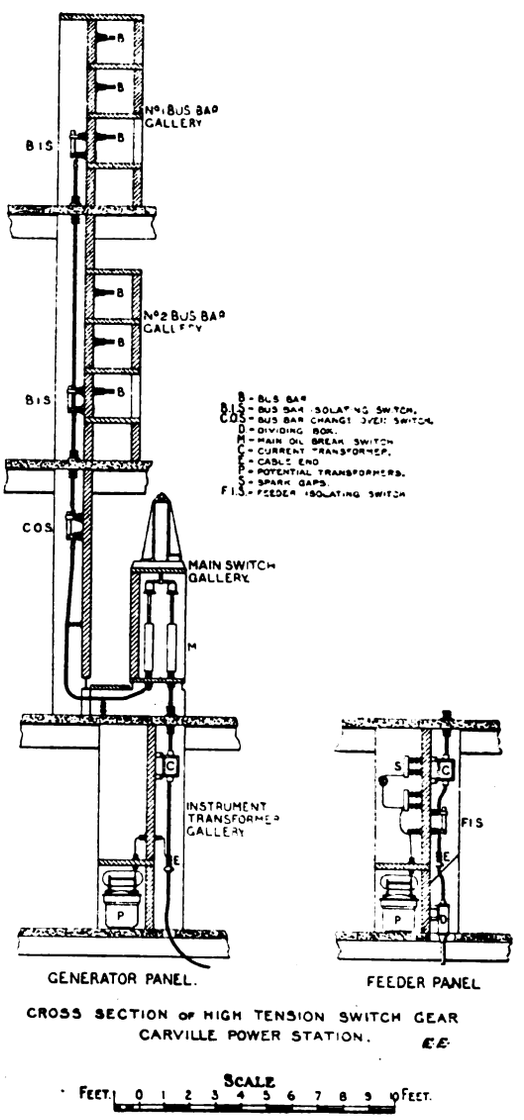



BACK AND FRONT VIEW OF H.T. SWITCH GEAR
CARVILLE POWER STATION

Fig. 13

becomes standardised and better understood we may look for a reduction in first cost. In the case of switchgear it is capital expenditure only which affects economy of production, the actual charges for maintenance should not be high, and as for cost of attendance this does not vary much for different types, though, of course, undue complication increases the running cost. On account of the absolute crippling of the power station which takes place if there be any serious failure of the switchgear, it is certainly justifiable to take every precaution to secure reliability even at the expense of capital expenditure. Under the section "Switchgear" we include not only the switchgear itself, but all electrical connections from the machine terminals to the main 'bus bars, and from these to the outgoing feeders. As in other sections of a power station, reliability of supply is best met by adopting a systematic and simple design and by properly subdividing all apparatus. Proper attention to the former will also tend considerably towards the reduction of capital cost, both in the first instance, and more particularly as the station grows—systematic design necessarily implying that due regard be paid to possible extensions.

*Features of Modern Switchgear.*—The simplicity of the Ferranti single-phase board probably first directed the attention of engineers to the necessity for subdividing high-tension switchgear from the machine to the 'bus bars, at the 'bus bars themselves, and from the 'bus bars to the outgoing feeder. Recent tendency in switchboard design* seems at first sight a retrograde step in the way of complication. The extra complication, however, is due rather to the fact that the system is a three-phase one† than that complication has been introduced. In fact, a modern board is practically a large Ferranti board controlled from a distance. Reference to the drawings of two switchboards which have recently been installed will facilitate discussion of the essential points. Figs. 13 and 14 show the arrangement of switchgear designed and adopted by the authors at Carville where B.T.H. switches are utilised, and Fig. 15 shows that for the five North-Eastern Railway sub-stations where Westinghouse switches are used. Where large powers have to be dealt with—that is to say, where one switch may have to open 10,000 kw. or more—the serious effect of the


No 1 BUS BAR GALLERY
No 2 BUS BAR GALLERY
B - BUS BAR
BIS - BUS BAR ISOLATING SWITCH.
COS - BUS BAR CHANGE OVER SWITCH.
D - DIVIDING BOX.
M - MAIN OIL BREAK SWITCH
C - CURRENT TRANSFORMER.
E - CABLE END
P - POTENTIAL TRANSFORMERS.
S - SPARK GAPS.
FIS - FEEDER ISOLATING SWITCH
MAIN SWITCH GALLERY
INSTRUMENT TRANSFORMER GALLERY
GENERATOR PANEL.
FEEDER PANEL
SCALE
FEET 0 1 2 3 4 5 6 7 8 9 10 FEET.

CROSS SECTION OF HIGH TENSION SWITCH GEAR
CARVILLE POWER STATION.

Fig. 14.

failure of a switch and the consequent necessity for completely subdivided apparatus will be readily realised. In both of the above designs this sub-division is provided for not only between the various pieces of apparatus and connections, but, as may be seen from the drawings, also between the different phases of the main switch itself—in fact, the only place where two phases come together is in the potential transformer chamber. The whole board in each case is made of concrete* from 3in. to 6in. thick. In designing the switch-house building it is necessary that all material should be fireproof, and this applies not only to the building itself, but as far as possible to all apparatus installed therein. The exigencies of space

* See *Transactions American Institution of Electrical Engineers*, vol. xviii., "The Control of High-Potential Systems of Large Power," by E. W. Rice, jun. See also "Three-Phase Switchgear," by A. C. Eborall, *Engineering*, Sept. 25, 1903, *et seq.*

† Even if single-phase motors are largely introduced for traction or other purposes, it seems probable that three-phase generation and distribution will still be resorted to, on account of (*a*) cheaper machines, (*b*) cheaper and more easily insulated cables.

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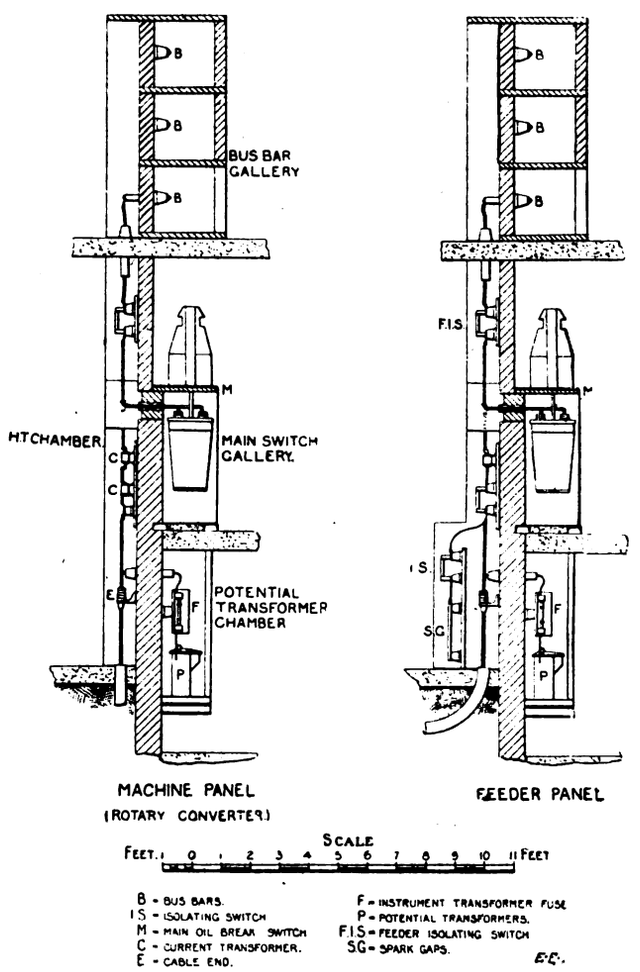
forbid a discussion of the details of each individual piece of apparatus, and as this paper deals more particularly with the assembling of apparatus rather than its design, we can only consider the requirements to be met, merely referring to apparatus without attempting to describe it.

*Main Switches.*—In designing the station buildings it was necessary to first decide upon the apparatus to be installed—in the case of the switchgear it is similarly necessary to decide upon the main switch, as the position of the terminals and the method of operation both affect the general lay-out of the gear. It is now recognised that oil switches are essential, and all high-tension circuits should be broken in this way, if only for the reason that opening the circuit under oil puts so much less stress on the cables and on insulation generally.† The switch chosen should be capable of breaking any current which may be met with in practice. This practically means, in emergency, breaking the whole short-circuit capacity of the station. It is only, however, within very recent years that it has been possible to secure switchgear which will meet such a contingency.




SECTIONS THROUGH H.T SWITCHGEAR
N.E. Rly SUBSTATIONS

FIG. 15.

*Main 'Bus Bars.*—The 'bus bars, in common with other parts of the switchgear, should not depend on fibrous or other combustible insulation. They may with advantage be of bare copper mounted on insulators, each 'bus bar being separately enclosed in an independent chamber. The object of complete sub-division here, as in other cases, is to as far as possible avoid any serious trouble spreading and damaging the switchgear as a whole should the switch by any chance fail to break a short-circuit.

*(To be continued.)*

* In America brickwork has been used for similar boards, but in the cases under consideration it was found that the adoption of concrete construction resulted in securing not only a cheaper, but, certainly, in many ways, a better job. The first board of this type was, so far as we know, erected in the power station of the Metropolitan Street Railway Company, New York, but there the complete sub-division referred to has been carried out in the case of the 'bus bars and the switches only, the connections themselves are not dealt with in the same way. Obviously the cost involved forbids that similar precautions be taken in small sub-stations. It is therefore necessary to so arrange these small sub-stations with regard to the rest of the system that if a serious fault should occur in any one it is dealt with, not by switches in the sub-station itself, but by the gear in the power station or in some large sub-station.

† Oil switches were first used for high-tension currents by Ferranti in this country, and by Messrs. Brown-Boveri in Switzerland. Lately they have been developed (especially for large powers) by the General Electric Company of America, and also by the Westinghouse Company.

## THE TUITION (?) OF ELECTRICAL ENGINEERING.*

BY JAMES PIGG, ASSOC.MEMBER.

As the ordinary session of this Local Section closed some time ago, this is not a "paper" in the ordinary accepted meaning of the term. The writer prefers to leave the characterisation to those who do him the honour to listen to it.

Probably no subject has been debated so keenly as education, and, especially of late, the subject has been raised to the front rank of the questions of the day. Pessimists tell us that our educational system is less efficient than those of our competitors for the trade of the world, and that as a nation we are being handicapped by the inferior quality of the finished article turned out of our educational workshops. However this may be as a national result—and the conclusions offered are, in many cases, debatable—the members of this Local Section of the Institution of Electrical Engineers, and especially those who have had the advantage of receiving their technical training in this building or that which preceded it, know and appreciate the good work that is being done in the North of England by the Durham College of Science, and how thorough is the training given.

But alarmists are apt to forget that the training of the engineer, whilst itself of the utmost importance, is not the only factor in the problem put before us by modern international competition. Cheap power has been termed the "key of wealth," and a review of the history of the world, and particularly of that of our own country since the opening of the nineteenth century, shows the truth of the aphorism. The development of the railway system during the last century, in which this district played so prominent a part, rendered possible the utilisation of our wide-spread coal deposits for manufacturing purposes to an extent altogether incomparable with previous use, with the result that our manufactures and over-sea commerce increased by leaps and bounds until we stood pre-eminent in this respect. At the very time, however, when railway transportation was beginning to effect such large changes in our industrial position, the discoveries of Michael Faraday were laying the foundations of most serious competition for us. These discoveries have rendered the use of what has been euphemistically termed "white coal" possible for industrial purposes, and systems of electrical transmission enable the power so developed to be conveyed to the centres of industrial activity. To the writer it seems as if the real contest will shortly be between rival systems for the transmission of energy. At present we seem to prefer to transmit our energy in a potential form, and provide means for transformation and retransformation to the forms in which it is required at the points of use, and there is no doubt whatever that enormous losses of energy result in the various processes incidental to this course of operation, besides the immediate expense attendant thereon. Such a system will, there is no doubt, have to compete with power obtained in other countries from more easily utilised sources of energy than we possess, and transmitted by means involving far less cost and waste than obtains in this country at present. The subject is one deserving the closest attention of all, and particularly of those engaged in transport.

My object, however, in appearing before you to-night is not to offer so large a subject for your consideration, but to bring to your notice some of the *advantages* of other methods of tuition than those in use in this and similar colleges. I refer more particularly to the method of tuition by post, which, if it precludes that intimate connection between teacher and student that the personal method of tuition permits, yet allows the former to prepare his theses in a calmer atmosphere than that of the lecture theatre or classroom, and is, or should be, conducive to that accuracy of statement which is so essential to the student,

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, May 9.

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and to the cultivation of the literary style that will interest him and rivet his attention to the subject.

Probably the ideal method of bringing to your notice the *advantages* to be derived from such a course of tuition will be the reading of excerpts from the printed lectures or lessons constituting such a course. The writer, however, does not guarantee that other courses of this character are to be placed on the same level of *excellence*. The extracts are to be taken as representative of the course from which they are taken, and of that course only.

Where material is so abundant as in the present case, an abstractor suffers from an embarassment of riches, and selection becomes difficult. Probably most of those present will agree that a plain explanation of the phenomena of the propagation of electric energy along a conductor accompanied by mathematical illustrations will not be a bad beginning.

"To the uninstructed the nature and character of electricity is a profound mystery, and as no progress can be made in its study until this lack of knowledge is removed, the first and second lessons have been designed, to furnish the student with correct ideas of how the energy is generated, that is the result o molecular motion.

'All energy, both mechanical and molecular, is the consequent of matter being moved. Motion is inseparable from matter, because the term motion means that some particle or mass of matter is in course of constantly swinging over a fixed point, or advancing from one point to another, along what is called the line of motion.

"A body at rest cannot manifest energy, because energy is the result of matter in motion. A body in motion is a store of energy. For example: a small stone lying on the ground does not excite or alarm an observer, but a small stone in motion is dreaded both by men and animals, because it calls into action the consciousness of danger, as when a dog or bird is alarmed on seeing a stone approach, when thrown by a boy. The amount of energy stored in a body is greater with a high than a low velocity, but this must not be taken to mean that the energy stored in a moving body is doubled when the velocity is doubled, and trebled when the velocity is trebled, for the energy varies as the squares of the velocity. That is the letter $V^2$ with a small figure 2 near the top, and at the right-hand side of the letter, means that, whatever rate V stand for, it must be squared or multiplied by itself. If the velocity is 5ft. per second, then $5^2 = 5 \times 5 = 25$; or if the velocity is 20ft. per second, then $20^2 = 20 \times 20 = 400$. The molecule, the minutest particle of matter that can have a separate existence, stores up energy in the ratio of the squares of its possible velocities, just as the largest masses of matter do. The motion by which electricity is transmitted is not mechanical. For example: when a current is transmitted, the conductor, cable, or wire does not move as a mass mechanically, but notwithstanding that, something does move, or energy could not be transmitted through such a medium, and the something that does move is the molecules that make up the mass of the conductor, for it is in these that the energy, called the potential of the current, is stored. A fine example of the truth of these conclusions, is found in looking at a tramcar in motion with its load of passengers, for the conducting wire does not move and pull the car with a direct mechanical effort, and therefore as energy cannot be transmitted without motion, something must move, and this the molecules do. As no motion is observable in the conducting wire the mystery is, how is the energy of the current transmitted, for the contact wheel of the trolley of the car only touches the cable, and it might be concluded that the vast power to run a car could not be transmitted through the motion of a molecule whose weight is almost infinitely small. This doubt, however, is removed when it is stated that a molecule, almost infinitely small, can be made the medium for the transmission of a current whose velocity is infinitely great. For instance, a small particle of matter whose weight is $\frac{1}{3,889,000,000}$ of a grain, or the $\frac{1}{27,223,000,000,000}$ of a pound, or about the three thousand nine hundred millionth of a grain, or the 27 billionth of a pound, is sufficient to transmit 1 h.p. continuously along the copper conducting wire that supplies current for running a tramcar. When the velocity of electricity is known, namely, 186,000 miles per second, or $186,000 \times 5,280 = 982,079,900$ft. per second, there being 5,280ft. in one mile, the mystery is solved, as the energy varies as the square of the velocities, it is clear that with such a speed maintained, while the consequent energy is consumed, the solution ceases to be a wonder.

"The method employed for finding the weight of the particle should now be made known. To find the energy stored up in a moving mass or molecule, the following formula is used $\frac{V^2 W}{2g} = F$. As has been noticed, $V^2$ indicates the square of the velocity in feet per second, W stands for the weight in pounds of the particle or mass, $2g$ stands for twice the velocity a body acquires after it has fallen in space for a period of one second, and F stands for the foot-pounds of energy stored in the body that has acquired the velocity V. The following is the method for finding the fraction that stands for the weight of a particle that will at the given maintained velocity transmit a given power, $\frac{2g F \times 7,000}{V^2} = W$. 7,000 is the grains in a pound. In this formula the letter $g$ is equal to 32·2, the velocity in feet per second a body acquires after it has fallen in free space for a period of one second, and $\frac{V}{2}$ is equal to the distance a body falls through in acquiring the velocity of $g$ or $32·2 . \frac{V}{g}$ is equal to the number of times the body will increase its velocity at the rate of 32·2ft. per second, when falling a given distance, $\frac{V}{2}$ is equal to the mean velocity, and as $\frac{V}{2} \times \frac{V}{32·2} = \frac{V^2}{2g}$ it follows that $\frac{V^2 W}{2g} = F$, for W is the weight of the body in pounds, and F is the foot-pounds of energy stored up in the body when it has acquired the given velocity. Therefore, as $2g$ is equal to 64·4ft., and V is equal to 982,079,900ft., and a horse-power is equal to 550 foot-pounds per second, it follows that $\frac{64·4 \times 550 \times 7,000}{982,079,900^2} = W \frac{1}{3,889,000,000}$ of a grain, or $\frac{64·4 \times 550}{982,079,900^2} = \frac{1}{27,223,000,000,000}$ or the twenty-seven billionth of a pound. A 1lb. weight having a velocity of electricity gives out no less than 27,230,000,000,000, or 27 billions of horse-power, for observe that $\frac{V^2 W}{2g \times 550} = \text{H.P.}$, then $\frac{982,079,900^2 \times 1}{64·4 \times 550} = 27,223,000,000,000$ h.p. From this it is evident that the mode of molecular motion called electricity is no longer a riddle, puzzle, or mystery, for it is subject to the laws of energy due to matter in motion like large masses of matter.

"To still further enlarge the conception of the learner of the magnitude of the potential or power of electrical or molecular motion, suppose that the average consumption of coals to generate 1 h.p. in a steam-engine to be 40lb. per average working day of 10 hours, then the quantity of coals per day to equal the power a 1lb. weight would transmit if the molecular velocity of an electric current was maintained would be no less than $\frac{27,223,000,000,000 \times 40}{2,240} = 486,125,000,000$ tons, and as the average output of all the collieries in the world is about 945,000,000 tons per annum, it would require the output of 514 years to supply the energy that would give to a 1lb. weight the power it would supply in one day if it had the velocity of electricity maintained while doing work, for $\frac{486,125,000,000}{945,000,000} = 514$ years.

"From all these facts but one lesson is learned—namely, that molecular motion accounts in a satisfactory manner for the origin of electric energy."

The doctrine of the conservation of energy is undoubtedly of the first importance to the earnest student, and an example of the luminous method of treatment of this subject cannot fail to be of considerable interest.

"*The Conservation of Energy.*"

"There are two kinds of energy, namely, kinetic and potential. Kinetic energy is that due to the motion of a body, and potential energy is what a body would acquire if allowed to fall, or to be thrown by the exercise of a propelling force. Again kinetic energy may be defined as the power a body can apply, or the work it can do when its motion is arrested, and potential energy is the work or power a body could apply if it was allowed to fall or move by the force of something pressing it. When a stone is thrown upward by the hand, the elevation to which it rises is proportional to the square of the velocity given to it, for example: if the velocity was equal to 50ft. per second, the height to which it would rise would be as follows $\frac{V^2}{2g} = F$, that is the square of the velocity divided by twice the velocity a body acquires after it has fallen for a period of one second. This velocity is 32·2ft. per second, and twice 32·2 = 64·4, therefore $\frac{50 \times 50}{64·4} = 38·82$ft.

"The velocity the body would acquire after falling 38·82ft. would be the same as that at which it was thrown upward by the hand. Calculations for potential energy are the converse of those for kinetic energy, for example with what velocity would a stone reach the ground after falling from an elevation in a spout of 38·82ft. Here $2g \times 38·82 = V^2$. This means that if

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twice the acceleration of gravity is multiplied by 38·82 the product will be equal to the square of the velocity as $\sqrt{64·4 \times 38\,82} = 50$ft. per second. Motion like matter cannot be annihilated, and motion like matter can be made to change its mode, for example, the molecular motion of electricity can be changed into that of heat or light, and all molecular motion can be changed into mechanical motion."

No one will deny the importance of Ohm's law to the electrical engineer, and the following extract shows with what degree of accuracy and care the subject is treated.

"*Ohm's Law.*"

"A volt of pressure is defined by the Board of Trade as the unit of constant E.M.F. which propels through a circuit having a resistance of one ohm, an unvarying current of one ampere. According to Ohm's Law this is true for $\frac{E}{R} = C$ accords with the Board of Trade definition, which claims that one volt divided by one ohm is equal to a current flow of one ampere. The terms E M.F., electric pressure, and voltage, all have the same relative value. The terms current strength and amperage both mean the same thing. The letter R stands for ohms, hence $\frac{E}{R} = C$ means $\frac{\text{Volts}}{\text{Ohms}} = \text{Amperes}$.

"Although it is usually said the E.M.F. divided by the resistance is equal to the current strength, and yet the term electromotive force has no meaning until it is stated in volts, resistance has no meaning until it is stated in ohms, and current strength has no meaning unless it is stated in amperes. The Board of Trade definition of the unit of resistance is as follows: the unit of electrical resistance when taken at the melting point of ice, is equal to the flow of a current of one ampere forced with a pressure of one volt through a column of mercury 106·3cm. long, and weighing 14·4521 grm., and of unvarying section. According to this definition, which is in harmony with the teaching of ohms, law $\frac{E}{C} = R$ or $\frac{\text{Volts}}{\text{Amperes}} = \text{Ohms}$.

"Ohms Law provides three equations by which volts, amperes, or ohms may be found, when two of the three are given to find amperes $\frac{E}{R} = C$, to find ohms $\frac{E}{C} = R$, and to find volts $C R = E$. Many beginners mistake current strength for watts, and to prevent this the following examples are given: suppose then the numerical values of E is 12, R is 2, and C is 6, then $\frac{E}{R} = C = \frac{12}{2} = 6$, and $\frac{E}{C} = R = \frac{12}{6} = 2$, and $C R = E = 6 \times 2 = 12$. By these three equations nothing has been found but the missing factor in each case. To find then the watts of work or power be careful to notice that if the volts are 12 and the ohms 2, then 10 of the volts remains to do work for $12 - 2 = 10$, and as the amperes formed were six in number then a current having a pressure of 12 volts, and a volume of six amperes, and a resistance of two ohms, has a current power of 60 watts, for $(12 - 2)\,6 = 60$, or substract the ohms from the volts then $12 - 2 = 10$ and $10 \times 6 = 60$."

It will be of interest to let you know what pains are taken to explain the relationship between work and power; and the C.G.S. system, it will be found, is treated in the same lucid manner as those other subjects which have been already extracted.

"Electricity, like all other manifestations of force, has to be measured, for without gauges of the work done and the power expended machines could not be constructed for the special uses to which they must be applied to do work with economy and efficiency.

"The basis of civilisation consists of standard units by which all the members of a community transact their business. Work done and power applied in Great Britain is measured by foot-pounds per second, consequently the amount of work done is directly proportional to the height a given number of pounds are lifted, or the distance through which a given number of pounds of resistance are overcome, and inversely proportional to the time in seconds, for example, suppose 250lb. are lifted 360ft. high by multiplying these factors together the product represents $250 \times 360 = 90{,}000$ units of work. We cannot estimate the value of the work done without the time, for 90,000 units of work may have been done in a second and then its value would be 60 times greater than if it had been done in a minute, and 3,600 times greater than it would have been had it been done in one hour, or 86,400 times greater than it would have been had it been done in 24 hours; suppose then it had been done in 20 seconds then the value is $\frac{250 \times 360}{20} = 450$ foot-pounds per second. The Empire of Great Britain is the largest on earth and the population is about 500 millions, and yet we cannot as a nation do as we like, for we must for the purposes of an immense trade keep in touch with the discoveries of other nations and adopt the terms that are generally accepted for the mutual good of all, and as the standards of measure for electricity for example are French they must be learned by the Student of Electrical Engineering.

"What is called the C.G.S. unit is only employed in making calculations for comparatively feeble currents of electricity, it should nevertheless be explained. C then is the initial letter for centimetre, G for gramme, and S for second of time, this combine of letters is called the Centimetre Gramme Second unit, just as the foot-pound per second might be called the Foot Pound Second unit. The C.G.S. unit is also known as the Erg or the Dyne. The unit, however, that should be learned first is the joule. This unit is really the mechanical equivalent of the British unit of heat, or the amount of heat that will raise the temperature of 1lb. of water 1deg., and is the mechanical equivalent of 772 foot-pounds of work. The French unit of heat is so much less than the British that its mechanical equivalent is only equal to a little less than ·7373 of a foot-pound, really it is equal to $\frac{550}{746}$. ·73726 + volts multiplied by amperes give watts, and the volt, the ampere, the ohm, and the watt, are each equal to one joule. In a horse-power there are 550 British foot-pounds per second, and in an electrical horse-power there are 746 watts, consequently $746 \times ·73726 = 550$ foot-pounds per second."

In a lecture headed "The Factors of Energy and the Static Charges of Armature Cores," we find familiar matters treated in such a way as to

". . . What is true of large visible masses of matter, is equally true of molecules and atoms, consequently large and small masses of matter are alike subject to the law of $\frac{V^2 W}{2g} = F$.

"The application of this equation or balance to find electrical powers is of great practical value, as by it the electrical units are made understandable. For example: Suppose a stream to be 16ft. wide and 3ft. deep, and the velocity of the water to be five miles an hour, then, if the transverse section of the stream, which is $16 \times 3 = 48$, be taken at 1ft. in length, we can reason that a mass of water equal to $48 \times 1 = 48$ cubic feet is in course of being moved with a velocity of 7·334ft. per second. For if the velocity of the stream is five miles an hour, that is equal to $\frac{5 \times 5{,}280}{60} = 440$ft. per minute, or $\frac{440}{60} = 7·334$ft. per second. Then the energy stored up in 48 cubic feet of water, moving with a velocity of 7·334ft. per second, is, when the weight of a cubic foot of water is taken at 62·5lb., equal to $\frac{V^2 W}{2g} = \frac{7·334 \times 7·334 \times 48 \times 62·5}{64·4} = 2{,}505·6$ foot-pounds. This result does not, however, correctly represent the energy of the stream. It would be true for a single mass whose weight was equal to $48 \times 62·5 = 3{,}000$lb., but this is not a single mass, but a continuously running stream; and as what is true of one stream is true of all streams, the rate of the flow per second must be introduced as a factor, for this is not a question of a single mass, but of 7·334 masses flowing per second. This being so, the energy delivered by that stream per second is equal to $2{,}505·6 \times 7·334 = 18{,}376·3$, or the weight of water delivered per second being equal to $48 \times 62·5 \times 7·334 = 22{,}002$lb., then $\frac{V^2 W}{2g} = \frac{7·334 \times 7·334 \times 22{,}002}{64·4} = 18{,}376·3$ foot-pounds of power per second. Let the square of the velocity, $7·334^2 = 53·786$, represent 53·786 volts of electrical pressure, and let the weight in pounds of 1ft. of the stream represent $48 \times 62·5 = 3{,}000$ amperes, then we could not find the power of the stream without the coulombs or number of ampere waves per second. By this illustration we learn that the volt is the unit of electrical pressure, the ampere is the amplitude or volume of one electric wave, and the coulomb is the unit of the number of waves per second. It is, therefore, evident that the energy of the electrical waves, like that of fluid streams, can only be measured by introducing the factor of time, which, in the case of electrical energy, is called the coulomb. In ordinary practice the current volume of electricity is expressed in amperes, and the coulomb is not, therefore, introduced. Molecules, like large masses of matter in motion, are subject to resistence, and the electrical unit of resistence is called the ohm. The chief cause of electrical resistence arises from the conversion of electric into heat energy. The amplitude of heat waves is greater than the electric ones, and when a conductor is too small to permit the free passage of an electric current, the ampere waves enlarge and at once become heat waves, and in so doing reduce the electric flow. Another resistance is generated by static charge or the storing up of inside work in a moving mass. All masses of matter when moved store up inside work, or more correctly, a static charge. For example: when a shot

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leaves a gun, it moves to its destination by the static charge it received from the blast of the explosion in the gun. A stone thrown moves by the static charge it received from the hand of the thrower. A flywheel equalises the movements of an engine by alternately taking up and giving up its static charge. A locomotive engine and its train furnish a fine illustration of taking up and giving up a static charge. Instinct teaches men and the lower animals that it requires considerable force to set an inert mass in motion. When a locomotive engine attempts to suddenly set a heavy train in motion, the wheels often slide or slip on the rails, and it requires a considerable amount of time for it to increase the speed to the required velocity, as during the time so occupied the mass is storing up the static charge, that is the equivalent of the speed and weight. The following example shows how the static charge is calculated: How many foot-pounds of inside work or static charge will be taken up by the mass of an engine and train that weigh 200 tons, and attain a velocity of 60 miles an hour on a level road. Sixty miles an hour are equal to 88ft. per second, and 200 tons are equal to $2,240 \times 200 = 448,000$lb. Therefore, as

$$\frac{V^2 \times W}{2g} = F, \quad \frac{88^2 \times 448,000}{64{\cdot}4} = 53,871,312\text{lb.}$$

This means that the static charge reaches its maximum when the maximum speed is attained. The distance the train will run after the steam is cut off, is if the coefficient of traction is 15lb. per ton as follows: $\frac{53,871,312}{15 \times 200 \times 5,280} = 3{\cdot}4$ miles.

"Molecules like large masses take up static charges or accumulate inside work that is measured in what is called Farads which unit is equal to a volt, namely, ·7373 of a foot-pound.

"Molecular inertia is the cause of the static charges that set up the current resistance in electric conductors, and is known as contra electromotive force. The static charges of water waves can be well seen in their behaviour when running up and breaking on a sea beach. . . . when the stones, pebbles, and shingle on a beach stop and retard the up flow of a wave . . . the upper stratum of the wave advances with its static charge . . . and ultimately so overlaps the foot of the wave, as to break over it, and leap before it in wild fury. When a wave is retarded in its advance, a portion of its pressure is converted into volume, and further on it will be found that electric waves are modified in the same way under like conditions.

*(To be continued.)*

## TRADE NOTICES AND NOVELTIES.

### Dynamo Stampings.

Messrs. Franz Meguin and Co., Limited, Dillingen-on-Saar, Germany, have recently issued a new illustrated catalogue of their perforated metals and dynamo stampings. We have received a copy of the English version of this catalogue from Mr. Andrew Brown, 110, Cannon-street, London, E.C., the firm's sole agent for the United Kingdom. Particular attention is called to a table on p. 12 showing the equivalents of the English and German zinc gauges in decimals of an inch, and also in millimetres with weights per square foot. This and other tables given should prove especially useful. We understand that Mr. Brown has been appointed London and district agent also for Messrs. G. B. Smith and Co., Glasgow, makers of iron and steel roofs and buildings and contractors for constructional work of all kinds.

### Ventilating the House of Commons.

"Facts Relative to the Ventilation of the House of Commons," is the title of a booklet published by Messrs. Matthews and Yates, Limited, Standard-buildings, City-square, Leeds. No attempt is made in this booklet to deal with the subject exhaustively, a defence of mechanical methods of ventilation being rather the aim. Incidentally we are told that the whole of the committee rooms and lobbies in the House of Commons are now fitted up with the above firm's "Cyclone" electric fans, and that the pressure fan they have installed for ventilating the debating chamber is also driven electrically.

### "Miniature" Arc Lamps.

The Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., have recently issued a pamphlet dealing with their "Miniature" arc lamps, which, it is claimed, have now been perfected, not only for direct and alternating currents, but also for very long burning. The lamps are made both for indoor and outdoor use, and of $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ amperes capacity, requiring respectively 150, 200, and 250 volts per lamp on the supply main.

### Water-Level Alarm Apparatus.

A leaflet which we have recently received from Messrs. Gent and Co., Limited, Faraday Works, Leicester, describes the firm's patent watertight contacts for use with water-level alarms. These latter are made for indicating high, low, or both high and low water, being arranged so that the bell which gives the alarm can be stopped ringing, but the signal showing that the water has reached the mark cannot be replaced until it has again fallen below the high-water mark or risen above the low-water mark, as the case may be. Thus, while preventing the batteries running down by the bell continuously ringing, the arrangement avoids the danger of the attendant resetting the signal without stopping or starting the pumps. Messrs. Gent and Co. also make indicators and recorders for showing the rise or fall of the water inch by inch as it may occur.

### Condensing Plant.

From the Mirrlees-Watson Company, Limited, Glasgow, we have received a binder for filing articles on condensing plant, etc., published by the firm. The first of these articles which is included describes and illustrates the surface-condensing plant installed at the British Thomson-Houston Company's Works, Rugby, to work in conjunction with a 500-kw. Curtis turbine. The tests taken after six months' working, without any preliminary preparation or cleaning, show excellent results.

### Multi-Burner Nernst Lamps.

We note that the Allgemeine Elektricitäts-Gesellschaft, Berlin, have now introduced a multi-burner Nernst lamp, or combination of three model A Nernst lamps within one fitting of elegant design, as shown herewith. Either vertical or horizontal burners can be used with this lamp, which is intended to replace arc lamps when extra uniform diffusion of light is required, or where it is desired to dispense with the frequent renewals of carbons. It can be provided with a switch to enable the burners to be switched on separately at will, according to the amount of light required.

Multi-Burner Nernst Lamp.

### Dead-Beat Moving-Coil Instruments.

Messrs. Nalder Bros. and Thompson, Limited, 34, Queen-street, London, E.C., have just issued a new edition of their catalogue Section II., which, we note, has been revised and extended. This section is devoted to the dead-beat moving-coil instruments which the firm has specialised with such conspicuous success. Some improvements have been introduced, more especially in regard to the mounting of these instruments. For instance, on p. 12 an illustration is given of a sector instrument fitted to an angle bracket (30deg. from vertical); also of a double-dial illuminated pattern instrument supported from below, while another is shown attached to a hinged bracket, all of which arrangements allow of subsequent adjustment for convenience of reading. On another page an edgwise instrument is shown attached to a swivel bracket. Considerable space is devoted to portable standard instruments, combined testing sets, motorcar instruments, and shunts for ammeters. Some interesting views of the machine shops at the firm's Dalston works are also included.

### Photo-Printing Apparatus.

The process of photo printing by electric arc is very fully described and illustrated in a list published by Messrs. B. J. Hall and Co., 39, Victoria-street, London, S.W., sole makers of the patent cylindrical electric light copying apparatus associated with their name.

### Electric Cranes, etc.

Messrs. Jessop and Appleby Bros., Limited, 22, Walbrook, Cannon-street, London, E.C., have recently issued a new edition of their pamphlet relating to electric cranes of standard and special types, electrically-driven winches, lifts, concrete mixers, and piledrivers. There seems no limit to the useful

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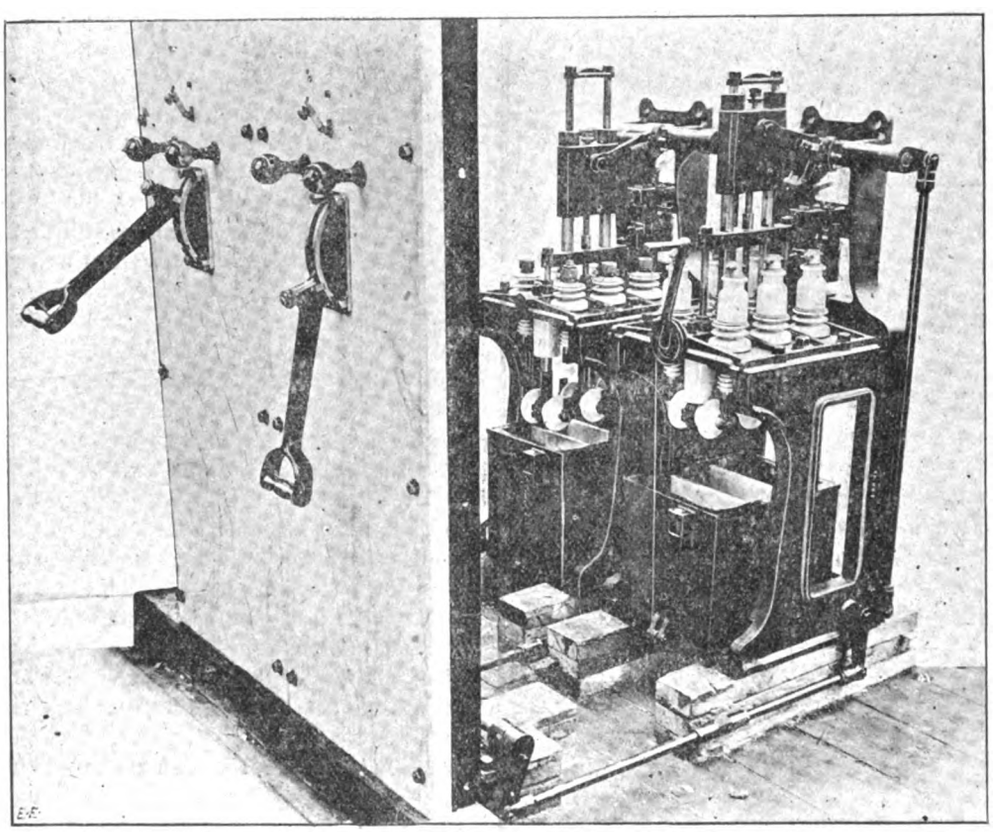
applications of the electric motor; new fields are constantly being opened to it. Concrete mixers and similar machines constitute one of these fields, and the pamphlet under notice includes illustrations of several novel installations of the kind. One is an electric travelling concrete mixer, the convenience of which is at once apparent, while another illustration shows a fixed mixer with continuous feed and delivery. Reference may also be made to a magnetic lifting overhead travelling crane, specially designed for service in street works. Full particulars are given in each case, besides some useful notes and general information, whereby the value of the pamphlet for reference purposes is enhanced.

## THE DICK-KERR HIGH-TENSION OIL SWITCH.

The rapidly increasing and extensive application to present-day commercial requirements of high-tension currents for the transmission of power, has brought prominently forward the necessity of providing suitable and reliable apparatus for handling these currents with safety. Soundness in design and care in construction are absolutely essential, for the slightest weakness or defect may disable the system of supply and lead to most serious results.



The Dick-Kerr High-Tension Oil Switch.

The high-tension oil switches which Dick, Kerr, and Co., Limited, have placed on the market possess some novel features, and as they are being largely used on systems at home and abroad, a short account of their construction and method of working, for which we are indebted to the above firm, should be of interest. The switches are supplied singly or in multiples to suit any number of phases, and may be operated automatically. Referring to the accompanying illustration, the main terminals for connecting the cables are secured to vertical rods, which are highly insulated with mica sleeves and porcelain insulators with large creeping surface. They are held in position by substantial insulators securely fixed to a cast-iron webbed plate which is bolted to the cast-iron frame. This plate acts as a cover to the oil-box which surrounds the switches. From the lower ends of the vertical rods depend the copper jaws which engage the switch blade. The switch blade is carried horizontally in a heavy porcelain insulator and attached to a turned steel rod, which is secured at the upper end to a cross-head, guide rods, and weight. The switches are enclosed in a large oil-box, which may be lowered by means of a winch attached to the frame. The oil-box is lined with impregnated material and fitted with fireproof partitions, consisting of marble or other suitable material, for separating the various switches, and when the box is fixed in position it entirely encloses the live contacts of the switch. It is also dust-proof and oil-tight. An oil-gauge is fitted to the side of the box by which the height of oil in the box may readily be observed. The top of the cast-iron frame is provided with columns for supporting the trip gear, weight, and horizontal cross-head, from which depend the vertical rods which are attached to the switch blades. The trip gear is attached to a series of links which connect up through cranks to the operating handle mounted on the switchboard. To close the switch, the handle must be forced down until the spring bolt locks. This motion raises the weight and cross-head and closes the trip gear and switch. The switch may be opened by withdrawing the spring bolt and raising the switch handle. On releasing the handle the trip gear is immediately brought into action; the weight falls smartly on the cross-head and throws the switch blades out with a quick break action. In addition to the ordinary operating handle, each switch is provided with an emergency throw-out. This takes the form of a solenoid attached to the frame of the switch, the armature of which actuates the trip gear. The local circuit for operating the solenoid is closed by a small press-button switch placed immediately above the main switch handle on the board. These switches may be fitted with automatic overload and no voltage release.

For larger work a special type of oil-break switch similar in design to the foregoing is manufactured, which is operated by a motor. This does away with the link and crank gear which connects the switch to the switchboard. In place of the switch handle on the board are two small press-button switches marked "on" and "off." These are joined up by clockwork and relay through a local circuit which starts and stops the motor. The motor is provided with a fly wheel and gearing; the gearing actuates a vertical rod which engages the trip gear for releasing the weight placed above the switch frame. The motor and gearing are made in the most compact form, and fitted neatly under the switch frame, while the clockwork and relay are fitted at the back of the switchboard behind the press-button switches.

## PERSONAL.

The Gloucester City Corporation have increased the salary of Mr. W. H. Bache, city electrician, by £50 a year as from April 1 last, and will also allow him to take two pupils.

Mr. D. H. Simpson, an assistant at the York Corporation electricity works, has received a special appointment as superintending engineer under Messrs. Davidson and Co., engineers, of Manchester and Belfast.

Mr. C. F. Butler, A.M.I.E.E., of the County of London Electric Supply Company, Limited, has been appointed managing engineer to the Hertford power station of the North Metropolitan Electrical Power Distribution Company, Limited.

The Rotherham Corporation have increased the salary of the electrical engineer, Mr. E. Cross, by £50 per annum.

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## MUNICIPAL MANAGEMENT OR MISMANAGEMENT.

Elsewhere in this issue will be found a report of a sub-committee appointed by the Electric Lighting Committee of the metropolitan borough of Southwark, which was appointed to enquire into the general working of the electric lighting undertaking which supplies the old district of Newington, one of the four districts forming the Southwark borough. As this report is likely to seriously injure the professional career of the resident engineer, we have reproduced it in full as an example of municipal management. With the reply from the engineer, which we also reprint, one is able to form an opinion of the competency of all concerned. In the first place, it is well to remember that the local conditions in Southwark are exceptional. The electric lighting order only applies to one quarter of the borough, and it is yet to be decided how far the profit or loss on the undertaking is to be confined to the district served, or spread over the whole of the ratepayers of the borough. Up to the present there have not been any profits to distribute, and the returns have not been sufficient to meet the repayment charges on the municipal loan. These, therefore, fall on the rates, and the matter then has to be considered by a Council, three-fourths of whose members represent ratepayers who have to contribute to the support of an undertaking from which they derive no immediate benefit. In the course of a year or so this position may be exactly reversed, but the conditions are such that party feeling is aroused, which should have no voice in the control of a commercial undertaking. After the last elections, therefore, a sub-committee was appointed by the Electric Light Committee to look into the management of the undertaking. It consisted of six members, four of whom were entirely without experience in electric lighting matters, as they had not previously served on the committee. Their report is unique in this respect, as in its ignorance both of humour and of the English language. We are concerned chiefly with the technical ignorance displayed, and also with the want of business knowledge. For instance, on the question of charging, the sub-committee had to deal with the price of electric light, which is supplied in the borough on the maximum demand system. This the committee seemed to think should be replaced by a uniform price for current. The engineer was able to show that the long-hour consumers were practically satisfied with the price, and that the complaints came chiefly from the short-hour consumers, whom in many cases it is unprofitable to supply. Surely it would have been better for the committee to have looked into this question of system of charges rather than condemn it, presumably because they individually will not take the trouble to understand the matter. The same remark applies to the regulation of voltage. The complaints made were generally on the grounds that the lighting was not so good as incandescent gas lighting, and a large number of complaints were considered when the voltage regulation was well within the Board of Trade limits. The real test of all these complaints is that of the number of consumers who have discontinued the supply. These, the engineer showed, amount to seventeen cases of total or partial reversion to gas out of some two hundred and fifty consumers. He adds that in all these cases the price was high, by which we presume he means that they were short-hour consumers, who did not get the benefit of the maximum demand system. Another point which speaks well for the undertaking is that it is more than holding its own in competition with an electric lighting company supplying over the same area. The municipal supply could not be very defective when more than thirty consumers of the company changed over on to the Corporation's service as against one change only

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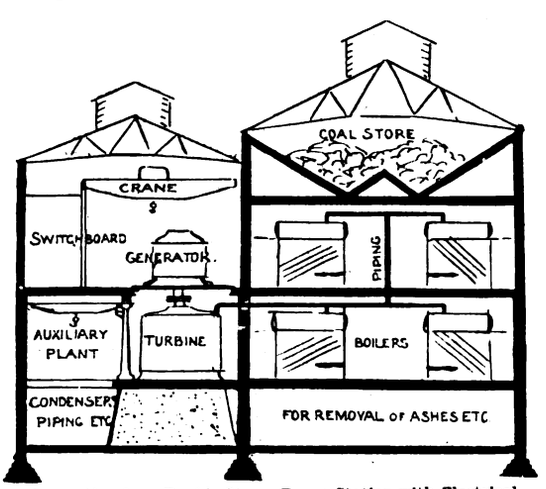
in the opposite direction. Leaving now the technical considerations and coming to the commercial management, we have no information on which to form an opinion as to whether the engineer is or is not deficient in commercial tact and administrative abilities. We do know, however, that the committee show by their report that they have no administrative ability whatever. For instance, what commercial undertaking could possibly be successful if the manager was not allowed a free hand to dismiss members of his staff when he found it necessary to do so. This power has been retained by the committee of Southwark, and has tended, we doubt not, to inefficiency in control of which they now complain. In view of the party politics involved, we have little hope that the Corporation of Southwark will be any wiser in their decision on this matter than their Electric Lighting Committees have been. In any case the position of electrical engineer under such a committee is one which few engineers would care to take, and we only wish that the new man may be of the milk-and-water type, compliant to the wishes of party politicians. The undertaking will suffer, but there is hope that the committee may some time be saddled with the results of their own mismanagement.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### DOUBLE-STOREY POWER STATION.

SIR,—As you reported my remarks in the discussion on the "Power Station Design" paper only very briefly, possibly the enclosed sketch may be of interest as showing the idea which I was trying to put forward. As you know, it is becoming the practice in power stations to generate at very high pressures—11,000 volts is quite common, and 16,500 volts is employed in at least one station. Now, with such high pressures in a water-power station, there is no risk of the insulation of the generators being suddenly brought down by a steam-pipe leakage, but in a steam station it is a serious eventuality. Even an exhaust pipe has been sufficient to shut down a whole station, although the machines were only low-pressure.




Suggestion for a Double-Storey Power Station with Electrical Apparatus Isolated from Steam Plant.

As will be seen from the sketch, the arrangement I propose isolates the electrical machinery and apparatus entirely from the steam machinery. The vertical spindle turbine lends itself admirably to the arrangement, the electrical floor being on the same level as the upper boiler-house floor. For repairs on the turbine, the main crane hook could, when necessary, be passed through to the bottom floor by temporary removal of floor plating. In this respect the arrangement would be no worse than the Curtis turbine is at present.—Yours, etc.,

E. KILBURN SCOTT.

### OXIDISING AND BRONZING.

SIR,—*Re* your letter in this journal last week, I shall be obliged if Mr. H. F. Purser will send me his address.—Yours, etc., DAN MOODY,

Oxidising and Bronzing Works, Trowbridge, Wilts.

### FIFTEQUIDA.

BY "SIMPLEX."

*With apologies to Longfellow and the reader.*

You shall hear how Fiftèquida,—
He, the haughty premium pupil,—
Paralleled an alternator.
(Very big was Fiftèquida;
Walked about in four-inch collars,
Had a College Education,
Had a Father on the Council.
All the greasers bowed before him
For the money that he lavished.
All the engineers blasphemed him
For the silly things he asked them.)
First he tapped the 'bus-bar meter
In the learnèd College fashion
Just to see it wasn't sticking.
Then he signalled up the engine.
Then he put the wrong field switch in,—
Said he did it for amusement,—
Got it altered, put the lamps up,
Watched them flicker very sternly;
Very wise looked Fiftèquida;—
Watched the phases grow more steady;
Gripped the main-switch very firmly,
(Didn't regulate the voltage
On the rising generator);
Crouched with fiercely-gleaming eyeballs;
As the tiger, ere its death-stroke,
Smites the unsuspecting victim,—
Draws its quivering strength together;
Then, with mighty force expended,
Crashed the main-switch into contact
With the phase in opposition;—
Heard the station roar and rattle,—
Saw the needles dance and waver,—
Realised he'd made a bloomer,—
Pulled the switch out,—wished he hadn't,—
Pushed it in again,—and staggered,
Stunned and shattered by the tumult,
By the loud reverberations
Of the detonating fuses;
By the sudden, utter darkness
That descended o'er the station;
By the tintinnabulation
Of the telephonic call-bell
Energised by mad consumers;—
Staggered to the nearest handrail,—
Wailed aloud for one to help him.
Thus did pupil Fiftèquida
Parallel his alternator.
Thus his primal operation
On the station switchboard ended.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the

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author. The matter must be written on one side only of the paper. Questions may be sent at any time.

## QUESTIONS.

693. What will be the best size of steam generating plant and battery for the electric lighting of a large building whose maximum demand will be about 80 kw.? The maximum demand will last about two hours a day, averaged all the year round. The remainder of the time the demand will not exceed 10 kw., and will average 4 kw. or 5 kw. How would the size of the units proposed be affected if the supply company were used as a stand-by in case of accident?—A.

694. It is found necessary on a certain tramway route to instal a track booster to reduce the O R drop along the rails caused by the current taken by the cars: (1) How would you determine the "boosting point" so that a minimum length of boosting cable may be required? (2) What conditions must be fulfilled by the booster (assuming it to be series-wound generator driven at constant speed) so that it may automatically maintain the rail-drop within certain limits, and also avoid circulating a current when no cars are running? (3) Explain the action of the booster-generator, showing how the potential at the boosting point is reduced and kept at the reduced figure.—C. E. W.

## ANSWERS.

*Question No.* 686.—A coil of a Brush 10-ampere arc lighter being burnt out, it was found that the seven or eight layers of wire nearest the core were completely charred, but there was nothing to show where the burning started. After running on full load for a few days an adjacent coil was burnt out in exactly the same way. Is there any reason for this? Also, are the coils hand or machine wound?

*Best Answer to No.* 686 (*awarded* 10*s.*).—For the benefit of those who have nothing to do with arc lighters in general, and the Brush arc lighter in particular, perhaps a few remarks about their design may not be out of place. The Brush arc lighter has an open-coil armature, ring wound, which differs, of course, from the ordinary closed-coil armature, inasmuch that the E.M.F.'s generated by every coil in any and every position (excepting, of course, the short-circuited coils under the brushes) form a part of the total E.M.F. Whereas in open-coil armatures the current is collected from a coil while it is in the position of its greatest activity, and while passing through the position of least activity, they are thrown out of circuit. Diametrical coils are joined in series, and are considered as one coil. The core of the armature is built of thin soft-iron ribbon wound in one length in a ring, and between each convolution is placed a number of H-iron stampings of the same thickness as the ribbon, the number of stampings inserted depending on the number of coils required. The coils are wound on by hand, and are insulated from the core by sheets of canvas and paper well shellaced. The coils are not well ventilated, and as the field magnets are placed with their similar poles opposite, the armature is run in an exceedingly strong field, the lines of force in the armature reaching as high as 27,000 per square centimetre, consequently the coil, though well laminated, gets very hot due to eddy currents; and there being very poor ventilation for the coils, the coils may have got overheated near the core and the insulation charred.

The more reasonable cause, however, for the lower layers charring is either some fault in the winding of the coils or in their commutation. As was stated above, the current is collected when in the position of maximum activity, the E.M.F. also a maximum. In an eight-coil machine, which is the number of coils usual in a 10-ampere Brush arc lighter, there is only one pair of coils at a maximum at a time, while there are two pairs with an E.M.F. rather less. Owing to their being in a slightly less active position, these two pairs of coils are capable of doing good work, but to do so they should not be joined up in parallel with the pair moving in the most active position as their E.M.F.'s are less. Were they to be joined in parallel, there would be a large current urged backwards through them, causing loss of efficiency and also overheating the coils, causing the insulation to be charred where the coils are hottest—viz., next to the core. The two pairs of coils moving in the less active position should, of course, be joined in series, then the external circuit will get the full benefit from the sum of their two E.M.F.'s. Perhaps the brushes are in such a position that they parallel the two pairs of coils having the lower E.M.F. with the pair of coils having the higher E.M.F. As stated above, the coils are hand wound.—C. A. B.

*Answer to No.* 686 (*awarded* 5*s.*).—It is probable that the breakdown is due to the gradual charring of the insulation on the wire through long-continued working under quite normal conditions. This charring would gradually get more and more pronounced, especially on the inner layers (which get no ventilation and are also heated by the iron core losses), and, finally, under the continued vibration of the machine, the insulation would fall off at one or more points and cause a short-circuit. All the coils would reach the breaking-down stage at approximately the same time, so that there is nothing strange in the fact that two coils broke down within a few days of one another. The charring is generally due to the working of the wire at too great a current density, and is often noticeable in armatures which have been at work for several years.—Q.

*Answer to No.* 686 (*awarded* 5*s.*).—In these machines the inner layers always get considerably hotter than those nearer the surface. On machines of a similar type the writer repeatedly found the coils to burn out in this manner. As well as being in a much warmer position, the first layer has to bear the effects of being bent sharply round the core. This wire, or rather the double cotton covering, is then more unfitted than that comprising the outer layers for its work, and yet has to perform it under worse conditions. The insulation, often mechanically damaged, becomes charred, and then a comparative conductor. This deterioration takes place over such a number of turns that, without showing scarcely any sign of short, the first two or three layers become stripped of their cotton covering, and the result is a burn-out. When rewinding, it will pay to tape the bends of the first layer with silk tape; this may appear at first a tiresome job, but the results will be satisfactory. The coils are wound by hand.—M. M.

*Answer to No.* 686 (*awarded* 5*s.*).—By the wording of the question it is implied that it is the field coils which have been giving trouble by burning out, as it would not be possible, owing to the shape of the armature core, to machine-wind the armature coils in a Brush arc lighter. The field coils, however, are machine wound. From the question it would appear that the machine has been working for some time on an overload. This would have the effect of heating up the coils, and especially the inner layers, which, owing to their position, would get no ventilation or chance of dissipating the heat. In time the insulation on these inner turns would become quite baked and charred, and the result would be a failure of the insulation between adjacent turns at several points, simultaneously creating a heavy short, which would burn out the coil and would account for the origin of the mischief being untraceable. The coil which failed a few days later would go owing to the same cause, but would have simply been able to hold out a little longer than the first coil, owing to its insulation not being damaged quite so much. The writer had a similar experience with a shunt motor. The motor was wound for 460 volts, but owing to emergencies was put across the traction bars, which were kept nearly constant at 550 volts. For three months the motor valiantly dealt with a more than 50 per cent. overload, and then one day collapsed. On examination it was found that the shunt had been ruptured. The outside turns on the field coils were turned a light brown, and the inner turns were found in exactly the same state as the coils mentioned in the arc lighter. Unfortunately, the firm who made the above motor have given up their manufacture.—W. T. W.

*Question No.* 687.—Compare the advantages of using for traction work (*a*) compound dynamos in parallel, and (*b*) separately-excited machines partly excited by the outgoing current.

*Best Answer to No.* 687 (*awarded* 10*s.*).—Compound machines in parallel, having the shunt windings energised from the 'bus bars, is the most satisfactory arrangement. The positive brushes must all be connected together by means of a balancing lead. If, then, one dynamo has a greater potential difference at its brushes than the others, this greater potential, by means of the balancing connections, causes an increase in the current flowing in the series winding of any generator whose voltage is lower. This increase of current strengthens the field, which again causes a rise in voltage, thus the tendency is to keep the generators at equal potentials, and consequently at equal outputs.

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In considering this question, it must be remembered that a tramway system is peculiarly susceptible to large and sudden variations of load. With such a sudden demand there may be a considerable drop in voltage; therefore, in order to supply the energy required, the current may run up to a very high figure, the result being opened cut-outs or blown fuses. In some stations such a case is met by increasing the voltage of supply, and thus, for an equal amount of energy, reducing the current. The main idea of separate excitation is to do this automatically. Such a case might be met by overcompounding the dynamos, but many engineers hold the opinion that over-compounded dynamos do not run well in parallel. Suppose, now, that the shunt windings are energised by a special dynamo, this dynamo being partly excited by the outgoing current. With a sudden load coming on, this exciting machine will have its field proportionally strengthened, so that its voltage will rise with the increase of the outgoing current. This will then cause all the generators to give an increased voltage, and thus negotiate the peak successfully. Against the employment of this auxiliary machine is the fact of greater complication; also anything happening to this one dynamo, all the main generators are thrown out of action. On the other hand, with compound machines connected as (*a*), should one fail, unless the others are considerably overloaded, things may be kept going until the trouble is remedied.—M. M.

*Answer to No.* 687 (*awarded* 5*s.*).—There is little to choose between the two arrangements. Both are alike as regards the series winding, for even with arrangement (*a*) the series windings are excited by the outgoing current, rather than by the individual currents of the machines, provided that the usual equalising bar is employed for putting the series windings of the different machines in parallel. As regards the shunt winding, if this is separately excited either from the 'bus bars or from some quite independent source, the polarity of the machine can never become reversed by accident, as is sometimes the case when the shunts are connected across the brushes. The bad effects of such a reversal can also be avoided with arrangement (*a*) by switching in the series winding of the incoming machine before connecting the armature to the 'bus bars. In this way the field of the incoming machine is built up in the right direction, but at the expense of a momentary drop in voltage during the time that the additional series winding is connected between the 'bus bar and the equalising bar whilst the armature is out of circuit. This drop can be avoided with arrangement (*b*) by switching in the shunt first and then the armature and series winding together. The behaviour of both arrangements, when a short-circuit occurs on the line, is much the same, for an ordinary compound dynamo, especially if arranged to compound up, can maintain a very high momentary overload current without fear of losing its field, though, perhaps, the separately excited machine is slightly better in this respect also.—Q.

*Answer to No.* 687 (*awarded* 5*s.*).—I conclude from the question that "E. V. C." wishes to know whether it is better to use compound machines, with the shunt self-exciting, or excited from an external source. The second part of the question may mean that the series coils only take a part of the current supplied by each machine. Taking the first case, we find that the principal disadvantage is the time required for a machine to start generating. When a machine is being put in parallel with the others the operations are as follows: The dynamo is run up to speed with all shunt resistance out until it starts generating. Some resistance is then quickly put in to prevent the pressure rising too high, and adjusted so as to bring the incoming dynamo's voltage equal to that of the 'bus bar. Probably the machine will take a minute to generate after running at full speed. The operation will take longer with carbon brushes than with copper gauze, especially if paraffin wax is used as a lubricant on the commutator working with carbon brushes. I have known a dynamo take half an hour running at full speed before it started generating. It was a two-pole, shunt-wound dynamo with wrought iron pole-pieces and carbon brushes of a poor type. There was very little residual magnetism in the poles and the carbon brushes offered too large a resistance. The delay occasioned by the slow building up of the voltage may prove annoying if one of the sets on load has broken down and another set is required immediately. One way of saving time is to close the equalising switch and the switch attached to the other end of the series coil. This sends a part of the current round the field coils of the incoming machine and helps to build up the voltage quickly. The disadvantage of doing this is that you are at the same time robbing the machines already on load of part of the current in their series coils, and thus seriously reducing the 'bus-bar volts if the load is a very heavy one. The sketch (Fig. 1) shows the diagram

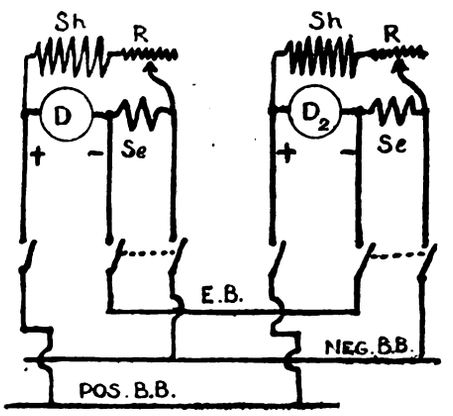


Fig. 1.

of connection for the first arrangement. The series coils, Se, are shown connected to the negative pole of the dynamo. This is the best arrangement, as then the minimum number of conductors are at a high pressure. The equalising switches and negative switches are coupled together, and can be closed so as to make a machine generate quicker; E B is the equalising bar.

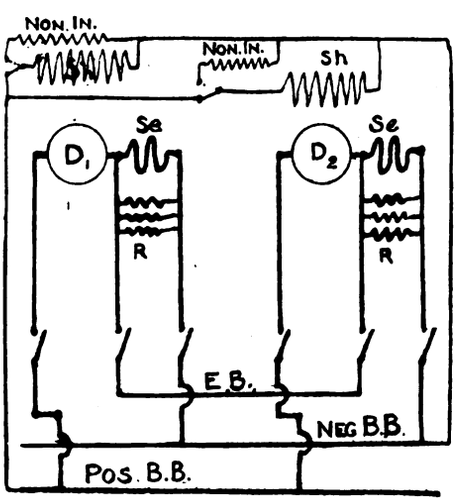


Fig. 2.

The second arrangement is shown in Fig. 2. It will be seen that the series coils are in parallel with resistance, R, so that the current divides itself in certain proportions, part returning through the series coils and part through the resistance, R. The proportion of current flowing through the series coils may be varied by either increasing or decreasing the resistance. Compound-wound generators of 300 kw. capacity and upwards generally have this arrangement, as the series turns need not have such a large sectional area as when the full current from the machine passes through them. The shunt, Sh, of each machine is shown in the sketch taken direct from the 'bus bars. A shunt-breaking switch allows the induced E.M.F. in the shunt coils to expend itself through the non-inductive resistance, Non. In. Of course, with this arrangement the shunt regulating resistance can be left in its normal working position when starting up a fresh machine and the shunt switched on, giving a full field at once. A very small amount of regulation will be needed before the machine can be paralleled on the 'bus. This arrangement will, therefore, enable machines to be started up and paralleled

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in less time than the first one. The great disadvantage of this second system is that it is possible for an attendant to switch the shunt current off a machine whilst it is supplying power to the 'bus bars. The consequences would be serious if the other machines were fully loaded at the time. Very often in a traction station where the shunts of the machines are supplied from the 'bus bars, an interlocking gear is fitted to each shunt-breaking switch, so as to prevent the shunt being broken whilst the main switches were closed. These automatic contrivances are not to be relied on as a rule, as not sufficient attention is paid them in most stations in keeping them in working order. The second arrangement of shunts ensures better working of the machines in parallel. The writer had a trying experience once in trying to make two compound generators driven from the same shaft run together in parallel on no load. It was not until the shunts were excited from the 'bus bars that the machines would work together satisfactorily.

To sum up, the first arrangement is the simpler and safest to work with. Under ordinary conditions there is always a little time to spare in getting a fresh machine in parallel, and the machines work well enough in parallel. The second arrangement enables a machine to be put on load quicker, but trouble is likely to happen from a mistake made by the attendant.—W. A. T.

*Answer to No.* 687 (*awarded* 5*s.*).—The advantages of using compound-wound dynamos in parallel for traction work are: (1) Simplicity and reliability, less complications than in the case of separately excited machines, partly excited by the outgoing current, which system introduces complications for which, in most cases, there are no commensurate advantages, as with compound machines the voltage regulation, though not so good as in the other case, is sufficiently good for most practical purposes. (2) As most towns now have both traction and lighting—and it is more economical to supply both from one large combined station—the machines are suitable for running on the lighting supply if three-wire system with 440 to 460 volts across the outers, by having change-over switches and running as shunt for lighting and compound for traction. Further, this system reduces the stand-by plant, and thereby capital and standing charges.

The advantages of using separately excited shunt circuits on the machines together with a series winding would be the securing of a steadier voltage than with ordinary compound machines, as in the case of the latter, if the voltage falls through the speed of the machine dropping from overload or otherwise, the shunt current falls, and thus tends to further reduce the volts; while, conversely, if the speed rises, the increased volts produced thereby send more current through the shunt, and tends to further raise the volts; while with a separately excited shunt—that is, one excited from an entirely independent source, either a storage battery or separate exciter—the shunt field would be constant under any conditions of load, while the series coils would compensate for the fluctuations, and thus secure a steadier voltage. This system is very seldom used, and has not met with much favour, owing to the complications it introduces, and thereby less reliability, also the extra capital required is not compensated for by any advantages gained, so that on the whole the advantages weigh much in favour of the compound machines in parallel.

If, however, it is found desirable to run much lighting off the traction network for street-lighting or other purposes, as is done by large tramway companies running in country districts, or light railways having powers over considerable areas, then the steadier voltage given by the separately excited machines may be of greater consideration, and weigh much more in their favour and justify their adoption. But it is questionable if in those cases it is not preferable to instal a storage battery working in connection with an automatic reversible booster, which will have the same effect in steadying the volts, while at the same time having the additional advantage of steadying the load on the machines, and causing them to work under more favourable and economical conditions, and also by taking the peaks of the load may enable the system to be run with less machines on 'bus, and corresponding saving.—W. R. A.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting of the Institution of Electrical Engineers, to be held on Thurday next at the offices of the Institution at 5 p.m., the accounts will be considered, together with the annual report of the Council. The statement of income and expenditure for the year ended Dec. 31, 1903, is given herewith. As there have been no further nominations, the office bearers for the next session will be those nominated by the Council, as published in our issue for May 6, 1904.

*Expenditure.*

| | £ s. d. | £ s. d. |
|---|---|---|
| **Management—** | | |
| Salaries | 1,385 7 1 | |
| Retiring allowance | 300 0 0 | |
| Accountants' fees | 15 15 0 | |
| Addressing of circulars and notices | 67 9 10 | |
| Printing and stationery | 419 4 6 | |
| Postage | 623 10 3 | |
| Telephone | 26 10 0 | |
| | | 2,837 16 8 |
| **Publications—** | | |
| *Journal* (printing and illustrating) | 842 16 1 | |
| *Science Abstracts*: net disbursements, £925. 7s. 5d.; less subscriptions, £369. 18s. | 555 9 5 | |
| | | 1,398 5 6 |
| **Meetings—** | | |
| Advance proofs, refreshments, etc. | 173 1 9 | |
| Reporting | 55 14 0 | |
| | | 229 15 9 |
| Rent, lighting, and firing | | 559 10 5 |
| Insurance | | 9 15 0 |
| **Depreciation—** | | |
| Library (5 per cent.) | 67 4 11 | |
| Furniture (5 per cent.) | 19 11 0 | |
| | | 86 15 11 |
| Premiums | | 90 14 8 |
| Conversazione (irrespective of printing and postage) | | 286 9 2 |
| Annual dinner | | 42 6 6 |
| Italian visit | | 6 17 3 |
| Local sections | | 352 10 11 |
| Grant to Engineering Standards Committee | | 250 0 0 |
| **Expenses in conection with removal to new premises—** | | |
| Removing furniture | 29 0 0 | |
| Renovation of furniture | 60 17 9 | |
| Electric light wiring and fittings | 56 2 6 | |
| Refixing telephone | 4 4 4 | |
| Name plates | 5 9 6 | |
| | | 155 14 1 |
| **General expenses—** | | |
| Address to H.M. the King of Italy | 18 10 0 | |
| Building plans | 13 4 0 | |
| Sundries | 110 16 11 | |
| | | 142 10 11 |
| Balance carried to general fund, being excess of income over expenditure | | 2,911 7 9 |
| | | £9,360 10 6 |

*Income.*

| | £ s. d. | £ s. d. |
|---|---|---|
| Subscriptions for 1903— | | |
| Received | 8,056 13 0 | |
| Outstanding (estimated value) | 500 0 0 | |
| | | 8,556 13 0 |
| Dividends on investments— | | |
| Life compositions | 167 14 1 | |
| General fund | 191 16 5 | |
| | | 359 10 6 |
| Interest on cash on deposit | | 77 6 3 |
| *Journal*— | | |
| Sales (net proceeds) | 125 6 1 | |
| Advertisements | 191 0 0 | |
| | | 316 6 1 |
| Wiring rules | | 50 14 8 |
| | | £9,360 10 6 |

At the ordinary general meeting on May 26 the following candidates were elected:

*Associate Members.*—H. M. Brown, care of Messrs. C. A. Parsons and Co., 66, Victoria-street, S.W.; F. V. T. Lee, 69-75, New Montgomery-street, San Francisco, Cal.

## SOUTHWARK ELECTRICITY SUPPLY.

The following are the reports referred to in our leading article with respect to the organisation of the borough of Southwark electricity department. In January last a sub-committee of the Electric Light Committee was appointed to look into this matter, and also to take into consideration the advisability of recommending the committee to adopt an uniform price for current, and, further, to bring before

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the Electric Light Committee any suggestions they might think practicable and beneficial to the undertaking. This sub-committee of six included two new members of Council and four members who had had no previous experience on the Electric Light Committee. Their report reads as follows:

Your sub-committee beg to report that they have, in accordance with the instructions of the Electric Light Committee, enquired into the general working and supervision of the electric light undertaking. The enquiries of the sub-committee have been directed more particularly to complaints of consumers, the manner in which the complaints have been attended to, and the general grounds for such complaints. Your sub-committee have held four lengthy meetings, and as a result of their investigations find that a number of complaints have from time to time been made by consumers—firstly, as to the defective illuminating power of the light; secondly, the great fluctuation in the voltage; and, thirdly, the price of electric light as compared with gas. The resident engineer, on being interrogated by your sub-committee as to the manner in dealing with complaints, appears to have considered it his duty not to have personally interviewed the complainants, and stated that it was not expedient to do so, as they were chiefly as to the price of current, in respect of which he could do nothing to remedy. That he did not admit the light was bad, and that no complaints were received from consumers, who, by the maximum demand system, got the current at a low price. With regard to the complaints made of the great fluctuation in voltage, which your sub-committee consider to be most serious, the engineer informed them that the causes were purely local, and arose through the mains being over-balanced—which could not be avoided—and would only come right by ordinary development, and subsequently submitted a full report on this technical question for the information of the sub-committee, and a copy thereof is appended thereto for the information of the full committee. Your sub-committee have also had before them a return, giving the new consumers or additions to old customers since March, 1902, to date, which shows that although a steady increase in the light has been going on during that period, a number of consumers have discontinued the light from various causes, such as left the neighbourhood, high price of current and bad light, and failure in business. Also a return of all the consumers' accounts for the past two years to Christmas last, with the view of ascertaining whether any falling off in the consumption of the light had occurred, and the return shows a reduction in the number of the consumers' accounts during the past year; also in several cases consumers have either partially or wholly discontinued the use of the light, which your sub-committee can only attribute to one or other of the causes previously referred to. As a general result of the sub-committee's investigations, they have arrived at the conclusion that the resident engineer, on whose skill, energy, and judgment the success of the undertaking so largely depends, has shown a lack of the qualities necessary in carrying out the responsible duties of his position, and therefore they have passed the following resolution: "That this committee express their dissatisfaction of the management of the electric light department, and recommend their committee to take steps that will ensure the better management for the future."

The resident engineer (Mr. J. R. Blaikie) was then invited to make any observations he might wish on the sub-committee's report, and in reply submitted the following statement:

On being invited to criticise the report of the sub-committee, I have no desire to throw myself into direct antagonism with the sub-committee, but if I am able to show you that the conclusions of the sub-committee are incorrect, I attribute the error to their lack of experience in electric light matters. The report of the sub-committee into the general working and supervision of the electric light station has been of a very limited character. It is stated that the enquiries have been more particularly directed to the complaints of consumers and the methods of dealing with them. In my opinion, this subject covered the whole scope of the enquiry. It resolved itself into a collection of evidence as to complaints, a discussion as to the cause of complaints, and, finally, an expression of opinion that the chief official does not realise the responsibilities of his position, and is lacking in skill, energy, and judgment. If this opinion can be substantiated, I would respectfully point out that the subjects that came before your sub-committee form a minor portion of the whole duties and responsibilities of the appointment. In dealing with the complaints of consumers, your sub-committee appear to have failed to notice two distinct classes of complaints. The first class is positive, and though in the majority of cases it is caused by the error or negligence of the consumer, such complaints are duly entered in a book kept for the purpose, and promptly attended to. A minor official investigates and generally succeeds in putting the matter right, if not, a superior follows, and, if necessary, the chief official. The second class is more or less indefinite, and consists chiefly of verbal criticisms communicated to persons reading meters or collecting accounts. It is the second class of complaint that your sub-committee was chiefly interested in and considered of serious importance. This style of complaint is more often in extravagant language, and, it should be borne in mind, is generally forthcoming when money has to be collected. It is usually a complaint as to the amount of the bill, the method of charging, or the quality of the light. Your sub-committee expressed their surprise and dissatisfaction that the chief official did not consider it his duty to personally interview all such complainants. It is not contended that any definite instructions have ever been given on this point, and it is simply a matter of opinion as to whether such a course is desirable or not. I might mention here that it has been my practice to interview consumers when I have considered it advantageous to do so. As an example of this form of complaint, I may mention a case which was brought forward at a sub-committee meeting, and which I afterwards investigated and duly reported at the next sub-committee meeting. The consumer interviewed stated that he has complained regularly for two years, and also that he had extended his lighting last Christmas. He also stated that he had seen me once at the works when he called to introduce a new consumer. Complaints as to bad light were considered at great length. Irregularities of voltage were explained as due to motors at work in the daytime and the difficulties of balancing a three-wire system at night. Your sub-committee did not seem to be aware that 4 per cent. variation is allowed by the Board of Trade, which is, of course, defined in the consumers' interest. An experiment was fitted up to demonstrate the effect of a variation in the voltage, but your sub-committee did not arrive at any definite conclusion as a result of their observations. It was also pointed out that a complaint of bad light almost invariably means as compared with incandescent gas lighting. There is, however, a perfectly independent test as to whether this bad light or irregular voltage is of importance or not. You are aware that a private company is competing in the same district. The residents, therefore, have a choice of two electric light supplies. In some instances we know that the company's price is more favourable, and yet the Council's supply has secured more than 30 of the company's consumers, and have only lost one, on a question of price, back to the company. Within the last month a large consumer, who has had both supplies for three years or more and a private plant of his own, has largely extended his demand from the Council's mains and is giving up his own plant. These figures should prove beyond doubt that the supply is satisfactory as compared with other electric light supplies. The comparison with gas is, without doubt, a serious matter, but it is purely a question of price. I ascertained a few days ago that in a neighbouring borough they have lost about 60 consumers, or 11 per cent. of their total connections up to date. A large proportion of these consumers, who have reverted to gas, were getting current at prices from 2¾d. to 3d. per unit. The whole electric light industry has been checked by the improvements made in gas lighting. On the other hand, developments in the Nernst type of lamp, and others, encourage the belief that electric light will still hold its own Turning to the statistics prepared for your sub-committee, it is somewhat gratifying to find only about 17 cases of total or partial reversion to gas out of some 250, and in all these cases the price was high. With further reference to the loss of some consumers, it should be borne in mind that it is anticipated in the report of the sub-committee appointed to consider the desirability of reducing the charge and introducing a flat rate. Certain consumers do not really pay, and only serve a temporary purpose in the early years when the capital is abnormally large. The system of charging automatically favours the desirable consumers; the others will sooner or later revert to gas. Your sub-committee minutely examined a return extracted from the ledger, showing accounts from consumers for two years. Of 165 cases which are complete for two years, 86 show an increase and 79 a decrease. Among the decreases four cases were shown to be due to using Nernst lamps. There is no reason to suppose that the lighting should either increase or decrease, and if the decreases had been in excess it might only indicate the general state of trade in the district. I think that I have now dealt completely with the report, but beg to offer the following general remarks: On more than one occasion a strong feeling was shown on account of the "taunts and sneers" that the department is subject to. I have felt this myself very keenly for some years past. In my opinion, it is due to the financial position and to the unpopularity of the side street lighting. On the financial position, last year there was a return of 4½ per cent. on the capital, which, though reasonable from a business point of view, does not meet the conditions laid down for a municipal loan. There was, in consequence, a call on the rates. For the year just closed at March 31, it is confidently expected that the return will fully meet the obligations of the loan, and possibly a small surplus. As to the unpopularity of the side street lighting, the Works Committee were entirely responsible in selecting the standard and the candle-power of the lamps from several samples erected for their inspection. In my opinion, expressed frequently at the Electric Light Committee, the only possible use of incandescent street-lighting was simply an indication of the existence of supply mains in the side streets. I have nothing further to add.

The whole committee then passed a resolution: "That the resident engineer be given three months to terminate his appointment." The matter is now before the whole Council.

## APPOINTMENTS VACANT.

**Clerical Assistant,** Poplar Borough Council Electricity Department. Salary £130 per annum. Applications to Mr. Leonard Potts, town clerk, Council Offices, High-street, Poplar, by noon to-day.

**Electrical Engineer,** Weymouth and Melcombe Regis. Salary will be £250 per annum. Applications to Mr. R. N. Howard, town clerk, by June 8. See advertisement in former issue.

**Assistant Lecturer in Engineering,** Swindon Education Committee. Salary, £150 a year. Applications by June 11. See advertisement in last issue.

**Electrical Draughtsman,** Metropolitan Asylum Board. Salary £125 per annum. Applications by 10 a.m. on the 7th inst.

**Charge Engineer,** York. Salary, £100 per annum. Applications to Mr. C. A. Midgley, city electrical engineer, by 13th inst. See advertisement.

**Instructors, etc.,** Northampton Institute, session 1904-5. Instructor in mathematics, engineering departments, salary £100 per session; junior demonstrator, junior technical assistant, junior lecture assistant, electrical engineering department. Applications by June 11. See advertisement.

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## HULL ELECTRIC LIGHTING ACCOUNTS.

The accounts of the Kingston-upon-Hull electric lighting department for the year ending March 31, 1904, show a total capital expenditure to that date of £282,910. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

| Dr. Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Coal or other fuel | 8,022 | 19 | 2 |
| Oil, waste, water, and engine-room stores | 563 | 14 | 10 |
| Wages at generating station | 2,316 | 15 | 9 |
| Repairs and maintenance of buildings | 317 | 19 | 3 |
| Engines and boilers | 885 | 12 | 1 |
| Dynamos, exciters, etc. | 467 | 4 | 8 |
| Other machinery, instruments, and tools | 336 | 13 | 4 |
| Accumulators and accessories | 130 | 10 | 6 |
| Distribution of electricity—Wages | 909 | 18 | 1 |
| Repairs, maintenance, and renewal of mains | 581 | 9 | 6 |
| Repairs, etc., of transformers, etc. | 82 | 6 | 0 |
| Public lamps | 138 | 4 | 9 |
| Rents, rates, and taxes | 3,102 | 5 | 11 |
| Salaries | 1,182 | 13 | 2 |
| Printing and stationery | 120 | 8 | 7 |
| General establishment charges | 264 | 7 | 10 |
| Law expenses | 6 | 9 | 6 |
| Insurance | 148 | 0 | 11 |
| Bad debts | 82 | 14 | 3 |
| | 19,660 | 8 | 1 |
| Balance carried to net revenue account | 18,226 | 17 | 3 |
| | £37,887 | 5 | 4 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current | 36,511 | 3 | 3 |
| Rental of meters | 1,016 | 4 | 11 |
| Public lamps | 291 | 10 | 0 |
| Testing installations, etc. | 2 | 0 | 0 |
| Rent of warehouse | 60 | 0 | 0 |
| Guarantees | 6 | 7 | 2 |
| | £37,887 | 5 | 4 |

Balance-Sheet.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Loans raised by stock | 179,132 | 7 | 10 |
| Bank of England | 103,403 | 16 | 2 |
| Deposits on supply of current | 285 | 16 | 4 |
| Sundry creditors | 2,956 | 19 | 0 |
| Sinking fund | 35,599 | 7 | 11 |
| Reserve fund | 11,752 | 10 | 0 |
| | £333,130 | 17 | 3 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended on works, less instalments written off meters | 276,848 | 1 | 0 |
| Discount and expenses on issue of stock | 8,717 | 7 | 12 |
| Hull Corporation 3 per cent. redeemable stock, 1934 | 35,599 | 7 | 11 |
| Stores on hand, March 31, 1904 | 472 | 8 | 11 |
| Sundry debtors for current and meter rentals | 11,410 | 10 | 5 |
| Materials and work done | 83 | 1 | 0 |
| | £333,130 | 17 | 3 |

Statement of Electricity Generated, Sold, etc.

| | | |
|---|---|---|
| Quantity generated in B.T. units | | 4,537,420 |
| Quantity sold { Public lamps 45,760 / Private consumers by meter... 2,971,428 } | | 3,017,188 |
| Quantity used on works | | 1,111,855 |
| Total quantity accounted for | | 4,129,053 |
| Number of public lamps | | 32 |
| Total maximum supply demanded—kilowatts | | 3,090 |

## BURTON-ON-TRENT ELECTRICITY ACCOUNTS.

The following is an abstract of the revenue account of the Burton-on-Trent electric lighting department for the year ended March 31, 1904.

Revenue Account.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 3,086 | 11 | 6 |
| Distribution of electricity | 147 | 6 | 3 |
| Street-lighting | 7 | 0 | 10 |
| Rents, rates, and taxes | 618 | 8 | 5 |
| Insurance | 30 | 13 | 0 |
| Management expenses and miscellaneous | 422 | 17 | 1 |
| Bank interest | 615 | 15 | 0 |
| Balance carried to net revenue account | 4,033 | 16 | 9 |
| | £8,962 | 18 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current for lighting | 6,127 | 2 | 5 |
| Sale of current for street-lighting | 4 | 19 | 9 |
| Sale of current for motors | 259 | 9 | 5 |
| Sale of current for tramways | 2,202 | 4 | 5 |
| Rents of meters | 233 | 2 | 0 |
| Fitting | 76 | 8 | 6 |
| Rents, less rates, taxes, etc. | 59 | 2 | 4 |
| | £8,962 | 8 | 10 |

Abstract of Return of Electricity Sold, etc.

| | |
|---|---|
| Quantity sold in units for light, power, etc. | 315,193 |
| Quantity sold in units for traction | 362 827 |
| Total quantity sold | 678,020 |
| Total cost of fuel | £962. 4s. |
| Total cost of fuel per unit sold | ·359d. |
| Total number of consumers to date | 343 |
| Consumers connected during year | 59 |
| 8-c.p. lamps connected during year | 2,573 |
| Total number of 8-c.p. lamps connected | 23,703 |
| Horse-power in motors connected during year | 51 |
| Total horse-power in motors to date | 115·5 |
| Maximum load for light and power (kilowatts) | 370 |
| Power factor per cent. | 12·5 |

## BARROW-IN-FURNESS ELECTRICITY ACCOUNTS.

The accounts of the electricity department of the Barrow-in-Furness Borough Council for year ending March 31, 1904, disclose a capital expenditure to that date of £78,575. An abstract of the revenue account is appended.

| Dr. Revenue Account. | £ | s. | d. |
|---|---|---|---|
| Coal | 1,492 | 1 | 6 |
| Oil, waste, and engine-room stores | 238 | 9 | 10 |
| Wages at generating station | 809 | 6 | 7 |
| Repairs and maintenance—Buildings | 31 | 16 | 7 |
| Ditto, machinery | 443 | 4 | 7 |
| Distribution—Wages | 48 | 1 | 10 |
| Repairs and maintenance—Mains and services | 173 | 2 | 9 |
| Meters, switches, etc. | 36 | 9 | 2 |
| Sub-stations | 265 | 11 | 0 |
| Private mains and services—Wages | 85 | 0 | 4 |
| Cable and other apparatus | 215 | 18 | 6 |
| Public lamps | 297 | 6 | 2 |
| Rents, rates, and taxes | 168 | 12 | 0 |
| Salaries | 646 | 11 | 10 |
| Printing and stationery | 100 | 14 | 10 |
| Office expenses, advertising, and sundry charges | 82 | 13 | 9 |
| Insurance | 37 | 15 | 5 |
| Amount transferred to net revenue account | 4,673 | 12 | 2 |
| | £9,846 | 8 | 10 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current and meter rents | 8,436 | 0 | 11 |
| Public lamps | 1,054 | 6 | 10 |
| Cable and other apparatus | 356 | 1 | 1 |
| | £9,846 | 8 | 10 |

## FORTHCOMING EVENTS.

Friday, June 3.

**Royal Institution.**—At 9 p.m., "The Development of the Theory of Electrolytic Dissociation," by Prof. Svante Arrhenius.

Monday, June 6.

**Society of Engineers.**—"Notes on Railway Surveys and Designs in New Countries," by Percy G. Scott." A synopsis appears in another column.

Thursday, June 9.

**Faraday Society.**—At 8 p.m., "The Hard and Soft States in Metals" (illustrated), by G. T. Beilby; "The Electric Furnace: its Origin, Transformations, and Applications," by Adolphe Minet.

**Institution of Electrical Engineers.**—At 5 p.m., annual general meeting,

**British Association of Waterworks Engineers.**—Annual meeting (June 9 and 10).

Saturday, June 11.

**British Association of Waterworks Engineers.**—Visit to Belgium.

**Association of Municipal Engineers.**—At Newport (Mon.), Western Counties District Meeting.

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

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# COMPANIES' MEETINGS AND REPORTS

## REUTER'S TELEGRAM.

The annual meeting was held at the offices of the Company on Wednesday, Alderman Sir John Hay presiding. Particulars of the report appeared in our last issue.

The **Chairman** alluded to the expenditure incurred over the Somaliland expedition, the bulk of which had proved fruitless. Arrangements had been made for an adequate supply of news from Tibet. The war which was raging between Russia and Japan naturally taxed the Company's energies to the utmost. Very great expense was involved in reporting the naval and military operations on both sides, as quite a number of correspondents had had to be engaged. Interpreters were also indispensable, because messages sent over the Japanese field wires must be written in Japanese, which meant that the telegrams must be first translated into the language at the front, and then retranslated into English at the base. This requirement necessary trammelled the activity of the Company's representatives, and the most rigorous censorship in force, on the Russian as well as on the Japanese side, explained the meagreness of many reports received. On many occasions the Company had not only been ahead of competitors on this side with important news from the seat of war, but in several instances people in China and Japan had learnt through a Reuter's telegram sent from London of serious occurrences happening in their immediate vicinity. Naturally, it was a source of pardonable pride to the executive that the Company's prestige as a distributor of news stood as high in Japan and China as on this side. The other departments of the Company's business did not call for detailed comment; but he might mention that a colossal code, consisting of half a million phrases, which had cost some thousands of pounds, had been completed, and was now at the disposal of the public at all the Company's agencies. Within the past fortnight they had purchased the freehold premises of 25, Old Jewry, so that the Company now owned 24 and 25, Old Jewry.

The report was unanimously adopted.

## VICKERS, SONS, AND MAXIM.

A special meeting was held at Sheffield on Wednesday to confirm the resolution passed at a previous meeting approving of the Bill being promoted in Parliament by the Corporation of Barrow-in-Furness involving an agreement between the Company and the Corporation. The Bill empowers the Corporation to construct a bridge across the Walney Channel, to make certain street works, to lay down additional tramways, and to execute works in connection with its water undertaking. The bridge is near to the Company's works, thus giving constant communication between the works and the large number of houses recently erected on Walney Island for the use of the Company's employés.

The resolution was passed without dissent.

## EDISON AND SWAN UNITED ELECTRIC.

An extraordinary meeting of this Company was held at Winchester House on Monday for the purpose of confirming as a special resolution the resolution passed on the 12th ult. to the effect that the capital of the Company be reduced from £1,000,000 to £941,090 by cancelling paid-up capital which has been lost, or is unrepresented by available assets to the extent of £2. 10s. per share on each of the 23,564 "B" shares. Mr. H. Wolfenden presided. The resolution was carried.

## LISBON ELECTRIC TRAMWAYS.

The report for 1903, to be presented at the meeting on the 9th inst., states that after charging interest and amortisation due on the debentures of the Companhia Carris de Ferro de Lisboa, there is a net profit of Rs.516,904, which, in sterling, gives £91,803 to be carried forward to credit of the London profit and loss account; and after payment of interest on debentures and other charges, besides London office expenses and directors' remuneration, there remains £59,814, which, with £6,080 brought forward from last year, gives an available balance of £65,895. Out of this arrears of preference dividend accumulated during construction to Dec. 31, 1902, amounting to £12,000, have been paid, and also the dividend of 6 per cent. for 1903, amounting to £25,533. The directors have also transferred £20,000 to depreciation reserve account, leaving £8,362 to be carried forward.

## MEXICO ELECTRIC TRAMWAYS.

The report for 1903, to be presented at the meeting on the 9th inst., states that the Company's operations for the year, after charging interest on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico, and after payment of the 3½ per cent. guaranteed on the share capital of that company (under the terms of the lease), shows a net profit of 314,566dol., which, at the rate of exchange of 20·72d., yields £27,157 to be carried to credit of the London profit and loss account. Interest received on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico (held by this Company), and the dividend declared by the Compañia de Ferrocarriles del Distrito Federal de Mexico on its share capital (all of which is held by this Company) is then added, and after charging expenses and obligations, etc., against the same, a net balance is shown at credit of profit and loss account of £35,545, which, added to the balance brought forward from last year of £183, gives £35,728. Out of this the usual dividend of 6 per cent. has been paid on the preference shares, leaving £5,728 to be carried forward.

## ROSS ELECTRIC LIGHT.

At a general meeting of the shareholders last week the first report was presented, which stated that after the payment of all charges there remained a balance in favour of the Company of £43. 12s. 4½d. The directors recommended that the balance be carried forward. The demand for current for the quarter ended March 31 last showed a large increase, and the directors believe that the working of the present year would show very satisfactory results. The report was adopted.

## BARCELONA TRAMWAYS.

The thirty-first ordinary general meeting was held at Winchester House on Tuesday, Mr. J. B. Concanon presiding.

In moving the adoption of the report, the **Chairman** stated that the total receipts for the year ended Dec. 31 last were £120,848 and working expenses £63,147. The passengers had diminished by 21 per cent., representing a decrease in the receipts of £3,796. A reduction of £1,728 in the cost of current had been effected, otherwise the traffic expenses had increased, as also had the cost of maintenance. After deducting loss on exchange there remained a profit of £26,619. To this they had to add the net amount received from Ensanche Corporation (£2,572) and the amount carried forward from 1903 (£2,558), which left a balance of £31,750. Of this sum the service of the debentures and of the debenture stock had absorbed £16,600, and after placing a further sum of £2,000 to the renewal fund, which would amount to £7,000, the directors recommended the payment of a dividend at the rate of 3 per cent. per annum (6s. per share) free of income tax, and that £1,501 be carried forward. Negotiations are proceeding with the Municipality for unifying the dates of the various concessions held by the Company. Some trouble had been experienced with the employés, which had been partially overcome, and if there were no strike he thought that the current year would show a material increase in the profits.

**Mr. W. F. Hamilton, K.C.**, seconded the adoption of the report, which was agreed to.

The retiring director (Mr. Neil Kennedy) was re-elected on the motion of the **Chairman**, seconded by **Mr. W. F. Hamilton, K.C.**

The auditors were also reappointed, and the proceedings terminated with a vote of thanks to the chairman and directors.

## RAND CENTRAL ELECTRIC WORKS.

The annual meeting was held at Winchester House on Tuesday, Sir C. Rivers Wilson presiding. Particulars of the report were given in our issue of the 20th ult.

In moving its adoption the **Chairman** said, that although the Board were not in a position to announce the payment of a dividend, yet they were able to congratulate the shareholders on the great improvement which had taken place in the Company's affairs. On Jan. 1, 1902, the accounts showed a debit balance of £25,231, owing to the war having caused a suspension of operations. Business was resumed after the termination of hostilities, and by the end of 1902 the adverse balance had been reduced by about £2,200, so that they commenced the period under review with a deficit of £22,990. In respect of the past year the total income amounted to £71,820, being an increase on that of 1902 of £18,856. The result was that the adverse balance at the end of 1902 had been reduced to £11,948. The estimated profit for the first quarter of 1904 came to about £11,000, and therefore, they might regard the Company as having started absolutely clear of the deficit from the beginning of April. When they next met he trusted that it would be possible to resume the payment of dividends on a substantial basis. At the present time they had contracts for the whole of the Company's available power, and had been obliged to bring into operation their reserve engine. In order to provide additional power an order had been placed for the necessary turbine plant, the first instalment of which would, it was expected, be erected by the early autumn. The cost of the new turbo-generator and appliances would be, approximately, £12,000. They would probably be able to add another dynamo of the same description for £4 000, so that for a total outlay of £15,000 or £16,000 they would obtain a large and profitable extension of their plant. They were in a position to provide the funds for these extensions out of their cash balances, which now amounted to nearly £45,000. In conclusion, he expressed every confidence as to the future prosperity of the Company.

**Mr. G. Zwilgmeyer** seconded the motion.

A **Shareholder** asked if the new electric turbine would be acquired in England or Germany.

The **Chairman** replied that it would come from Switzerland.

The motion was adopted unanimously.

# LIENS REGISTERED.

**Woking Electric Supply Company, Limited.**—Issue on April 23 of £600 debentures, part of a series created Nov. 2, 1899, to secure £25,000; charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £23,550.

**English De Laval Steam-Turbine Company, Limited, Leeds.**—Particulars registered May 17, under Sub-Section 4, Section 14, of the Companies' Act, 1900, of debentures for £20,000, created July 24, 1903; no trustees: charged on the undertaking and all the leasehold premises and other property, but not including the uncalled capital.

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**Longstreth's, Limited.**—Issue to M. Greenberg, of 8, Water-lane, E.C, by way of collateral security only, of £1,200 debentures, part of a series created May 6, 1904, to secure £2,000; charged on the company's undertaking and property, present and future, including uncalled capital. Date of issue, May 7, 1904. No trustees. No previous issue of same series.

**Church Stretton Electric Supply Company, Limited, London, W.C.**—Trust deed registered May 20 for £5,000 debentures. Trustees: Sir R. G. Head, Bart., 2, Sussex-place, S.W., and Major A. P. Bethune, of Seaton, Devonshire. Charged on land at Church Stretton, the benefit of a provisional order granted under the Electric Lighting Acts, 1882 and 1888, and all other assets, including the uncalled capital.

**Metropolitan Electric Tramways, Limited.**—A trust deed, dated April 28, 1904, to secure £350,000 debenture stock, created by resolution of March 23, 1904 (with power to issue further stock ranking *pari passu* up to one-half the issued capital for the time being), has been registered. Property charged: (1) tramways and buildings comprising the tramway undertaking of the company in Middlesex; (2) tramways, buildings, and land, comprising the undertaking of the Harrow-road and Paddington Tramways Company, agreed to be purchased by the company; (3) light railways in Middlesex and Herts, agreed to be leased by the company; (4) shares in and money due from the North Metropolitan Electric Power Supply Company; and (5) the company's general assets and undertaking, present and future, including uncalled capital. Trustees: Electric and General Investment Company, Limited, 1 2, Great Winchester-street, E.C.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Amelia (Perugia, Spain).**—The Municipality require tenders for an electric light installation. Tenders by Aug. 18.

**Villanueva de la Serena.**—The Municipal Authorities require tenders for the electric lighting of the town by June 25.

**Lincoln.**—The Corporation invite tenders for eight electric tramcars. Specifications, etc., may be obtained from the Electrical Engineer. Tenders by 10 a.m. on June 13.

**Handsworth.**—The Urban District Council invite tenders for the erection of generating station. Particulars may be obtained from the Town Clerk. Tenders by June 8.

**Leigh.**—The Corporation invite tenders for (1) one 350-kw. steam-driven set, (2) switchboards. Specifications may be obtained from the Town Clerk. Tenders by June 21.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao, including supply of material and rolling stock, by July 6.

**Portsmouth.**—The Town Council invite tenders for pump, pipes, etc. Specifications, etc., can be obtained at the Town Hall, Portsmouth. Tenders by June 11. See advertsement in last issue.

**Almeria.**—The Harbour Commissioners require a motor launch. The estimate is 29,000 pesetas, and the deposit required 1,450. Particulars from the Secretary of the above. Tenders by July 6.

**Edinburgh.**—The Council invite tenders for copper strip. Specifications, etc., can be obtained from the Resident Electrical Engineer, Dewar-place. Tenders by June 4. See advertisement in last issue.

**Batley.**—The Corporation invite tenders for a steam superheater, steam piping, valves, and accessories for the electricity works. Specifications may be obtained from the Borough Electrical Engineer. Tenders by June 2.

**Erith.**—The Urban District Council invite tenders for additions and alterations to the electric light station. Specifications, etc., may be obtained from the Quantity Surveyor, 12, Queen's-road, Erith. Tenders by June 15.

**Pontypridd.**—The Urban District Council invite tenders for supply of motors. Specifications, etc., may be obtained at the offices of Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders by 12 noon on June 4.

**Southampton.**—The Corporation invite tenders for cast crossings and points and mates. Particulars may be obtained from Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders before 2 p.m. on June 6.

**Dewsbury.**—The Corporation invite tenders for supply and delivery of one Lancashire boiler at their electricity works. Specification may be obtained from Mr. R. H. Campion, borough electrical engineer, Bradford-road. Tenders by June 8.

**Rochester.**—The Corporation invite tenders for the construction of permanent way and overhead line. Specifications, etc., can be obtained at the office of Mr. E. Rotter, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders by June 3.

**Dudley.**—The Electric Lighting Committee invite tenders for extension of offices and erection of workshops. Specifications, etc., may be obtained from Mr. R. P. Wilson, 66, Victoria-street, Westminster, S.W. Tenders by 12 noon on June 15.

**Madrid.**—The Public Works Department require tenders for the concession to construct (including supply of material and rolling stock) and work an electric tramway from Sarria to the foot of Mount Vallvidrera, in the province of Barcelona. Tenders by July 15.

**Suakim.**—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

**Bury.**—The Tramways Committee invite schemes and tenders for the heating required at the car depôt, Rochdale-road, Bury. Particulars may be obtained from Mr. Arthur W. Bradley, A.M.I.C.E., borough engineer and surveyor, Bury. Tenders by June 7.

**Wimbledon.**—The Urban District Council invite tenders for two water-tube boilers, economisers, feed pump, and pipework for the electricity works. Specifications, etc., may be obtained from Mr. H. Tomlinson-Lee, chief electrical engineer. Tenders by June 17. See advertisement.

**Wiring.**—The May-Oatway Fire Appliances, Limited, invite tenders for wiring following installations: St. Mungo Manufacturing Company, Govan; E. Chalmers and Co., Leith. Particulars from Managing Director, 49, Queen-street, Glasgow. Tenders by June 8. See advertisement.

**Norwich.**—The Corporation invite tenders for lighting the streets, roads, and public places of Norwich for one, two, or three years, at the option of the Corporation, from July 1. Particulars can be obtained from Mr. Arnold H. Miller, town clerk, Guildhall, Norwich. Tenders by June 4.

**Uphall.**—The Bathgate District Committee of the County Council of Linlithgow invite tenders for fitting up an electric light installation for Uphall lighting district. Specifications, etc., may be obtained from Mr. A. Lindsay, 11, Jamaica-street, Glasgow. Tenders by 12 noon on the 10th inst.

**Warrington.**—The Corporation invite tenders for the supply, delivery, and laying of steel rail, paving, etc., forming permanent way. Specifications, etc., may be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on June 14.

**Deptford.**—The Borough Council invite tenders for the supply, delivery, and erection of (1) two 25-kw. steam dynamos and a booster, (3) switchboard. Specifications, etc., may be obtained from Messrs. F. H. Medhurst and Lloyd, 13, Victoria-street, S.W. Tenders before 4 p.m. on June 21.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for the supply of various stores for year commencing July 1, including electrical stores. Specifications, etc., may be had on application to the Superintendent of Stores, 16, Robertson-street, Glasgow. Tenders by 10 a.m. on June 4.

**Cheshire.**—The Committee of Visitors of the Parkside Asylum, Macclesfield, invite tenders for (1) electric light wiring and fittings, (2) electric light plant. Specifications, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 78, King's-street, Manchester. Tenders by June 20.

**Amsterdam.**—A dispatch has been received at the Board of Trade from H.M. Consul at Amsterdam, reporting that on June 15 the Netherlands Minister for the Colonies will be prepared to receive tenders for the supply of (359) zinced iron wire, (360) zinced iron supporters for insulators, and other materials.

**York.**—The North-Eastern Railway Company invite tenders for the supply of various stores, including arc lamp carbons, electric lamps, electric wires and cables, etc., for six months ending Dec. 31. Specifications, etc., may be obtained from Mr. F. H. Clark, Stores, Gateshead. Tenders by 9 a.m. on June 4.

**York.**—The North-Eastern Railway Company invite tenders for the supply of telegraph apparatus and telegraph wire and line stores for six months ending Dec. 31. Particulars may be obtained on application to Mr. C. H. Ellison, the company's telegraph superintendent, York. Tenders by 9 a.m. on June 4.

**Walthamstow.**—The Urban District Council invite tenders for the following stores for the electricity works: incandescent lamps, switches, cut-outs, cables, enamelled steel conduits, arc lamp carbons, carbon brushes, white cotton waste, asbestos packing, etc. Particulars may be obtained from the Electrical Engineer. Tenders by June 3.

**Southampton.**—The Corporation invite tenders for the supply of 150 tons of rolled-steel rails and the necessary fishplates, anchor joints, soleplates, bolts, nuts, and tiebars, according to particulars to be obtained upon application to Mr. J. A. Crowther, borough engineer, Municipal Offices, Southampton. Tenders before 2 p.m. on June 6.

**Stepney.**—The Borough Council invite tenders for laying on a complete electric light installation at their public baths in Goulston-street, Whitechapel, E. Specifications, etc., may be obtained from the Borough Engineer, 15, Great Alie-street, Whitechapel, E., on and after June 6, between the hours of 10 a.m. and 12 noon. Tenders by June 20.

**West Ham.**—The Education Committee invite tenders for the electric wiring and fittings for an installation of electric light at the West Ham Park Elementary Schools, Stratford, E. Specifications, etc, may be obtained from Mr. W. Jacques, A.R.I.B.A., 2, Fencourt, E.C., before the 9th inst. Tenders by 5.30 p.m. on the 20th inst.

**Greenwich.**—The London County Council invite tenders for the supply and erection of two continuous coal and ash conveyors of the gravity bucket type, at the electricity generating station, Greenwich, and for the maintenance of the same for 12 calendar months. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on June 14.

**Erith.**—The Urban District Council invite tenders for a steel trough-floored road bridge, with brick and concrete abutments, etc., over the South-Eastern and Chatham Railway at the Lower-road level crossing, Erith, together with making up the approaches, fencing, kerbing, etc. Specifications, etc., may be obtained from Mr. Charles H. Fry, clerk of the Council, District Council Offices, Erith, Kent. Tenders by June 13.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that 979 has been deposited.

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The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Exeter.**—The Corporation invite tenders for (1) construction of permanent way and paving (including copper bonding) of about four miles of route length line, single line, with passing places; (2) overhead electrical equipment of the above lines and of car-shed; (3) supplying and laying of insulated cables and stoneware ducts for the same length of tramway in connection with the above; (4) supply and delivery of 12 double-decked single-truck motorcars. Specifications, etc., can be obtained for Contracts Nos. 1 and 4 at the office of Mr. Thomas Moulding, Municipal Offices, Southernhay West, Exeter, and for Contracts 2, 3, and 4 at the office of Mr. H. J. Munro, city electrical engineer, New North-road, Exeter. Tenders by June 9.

**Madrid.**—Tenders are required for construction of a telephone system between Madrid and Cordoba, Malaga, Sevilla, and Cadiz, with stations in Madrid, Ciudad Real, Cordoba, Sevilla, Cadiz, and Malaga. The estimate per kilometre is 1,800 pesetas for an underground line and 14,700 per aerial line, and the adjudication will turn upon whatever reduced prices are offered. Similar tenders are also required for a system connecting Madrid, Santander, Asturias, and Galicia, with stations in Madrid, Valladolid, Palencia, Santander, Leon, Oviedo, Gijon, Monforte, Corufia, and Vigo. The deposit for each of these two contracts is 10,000 pesetas, and particulars may be obtained from the Post and Telegraph Department, Madrid. Tenders by June 8.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Reichenberg (Austria-Hungary).**—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

## RESULTS OF TENDERS.

**Bristol.**—The Corporation has placed an order with Bruce Peebles and Co., Edinburgh, for the supply of a 400-kw. generator.

**Aberdeen.**—The tender of Bruce, Peebles, and Co., Edinburgh, for the supply of a station governor at Gallowhall has been accepted.

**Islington.**—The tender of Crompton and Co. for the supply and erection of 78 electric arc lamps in the Highbury district has been accepted.

**Bridgwater.**—The order for the supply of storage battery, consisting of 260 standard lighting type cells, has been placed with the Hart Accumulator Company.

**Birkenhead.**—The Corporation have accepted the tender of Johnson and Phillips, Electric Cable Works, Old Charlton, Kent, for supply, delivery, and laying extensions to feeder and distributing mains.

**Londonderry.**—The order for the supply of battery, consisting of 122 standard lighting type cells, to be installed at Gransha Lunatic Asylum, has been placed with the Hart Accumulator Company, Stratford, E.

**Kilmarnock.**—The Corporation have accepted the tender of Dick, Kerr, and Co., London, at £22,784. 6s. 6d. for permanent-way excavations, concrete foundations, steel rails, fishplates, and special work, paving, etc.

**Stepney.**—The Council have accepted the tender of Ward Bros., Basinghall-street, for installation of the electric light in St. George's, East, Library, at £92. 4s. 6d., and Emerson and Sons, for electrically lighting Limehouse Town Hall, at £200.

**Chatham Dockyard.**—Messrs. Isaac Storey and Sons, Limited, Empress Foundry, Cornbrook, Manchester, have received from Messrs. Bruce Peebles and Co., Edinburgh, an order for six sets of surface-condensing plant in connection with the Chatham Dockyard contract.

**Dundee.**—The following tenders have been accepted for general engineering stores, for the Electricity Department: G. Stephen and Sons, Dundee; R. Stiven and Co., Dundee; R. C. Stiven and Sons, Dundee; C. D. Braid, Dundee; Kirk and Coutts, Dundee; R. Fergusson and Sons, Dundee. Electrical goods—Edison and Swan United Electric Light Company; Ward and Goldstone, London; Sir Hiram Maxim United Electrical Company; Union Cable Company. Piping—Stewart and Menzies, Glasgow.

**Kirkcaldy (Scotland).**—The Lighting Committee have received the following tenders for one extension switchboard panel and cable connections for one 430-kw. generator now on order:

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|---|---|
| Cox-Walkers, Darlington (accepted) | £200 |
| J. E. Spagnoletti and Co., London | 230 |
| W. McGeoch and Co., Limited, Glasgow | 275 |
| Edison and Swan, Dundee | 400 |

**Wiring.**—The May-Oatway Fire Appliances, Limited, have accepted the following tenders for wiring various buildings: For Messrs. J. and B. Coates, Limited, mills, Paisley—Contracts 1, 5, and 6: National Telephone Company; 4 and 7, Wylie and Lochhead, Limited; 2 and 3, J. T. Elpatrick and Sons. For the Moss Empire Theatre, Edinburgh—W. Douglas, Limited; J. Taylor and Son, Edinburgh; Stapley and Smith, London; Troup, Curtis, and Co.; McIntyre, Hogg, Marsh, and Co., London; W. L. Lucas and Co.; Private Wire Installation Company.

**Aberdeen.**—The Electric Lighting Committee have received the following tenders for supply and erection of mild-steel coal bunkers, together with coal and ash conveyor of the endless-chain bucket type, with accessories: Babcock and Wilcox, Limited, 21, St. Vincent-place, Glasgow (accepted); Askham Bros. and Wilson, Limited, Yorkshire Steelworks, Sheffield; H. Barry and Co., West North-street, Aberdeen; R. Dempster and Sons, Limited, Elland, Yorks; Spencer and Co., 32, Queen Victoria-street, London; New Conveyor Company, Limited, Smethwick, Birmingham; Graham, Morton, and Co., Hunslet, Pepper-road, Leeds.

**London.**—The Metropolitan Asylums Board have received the following tenders for electric lighting at Western Hospital and Ambulance Station:

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|---|---|
| Donnison, Sillem, and Co., 116, Great Portland-street, W. (accepted) | 3,270 0 0 |
| Alliance Electrical Company, Limited, 137, Regent-street, W. | 4,286 12 0 |
| Bergtheil and Young, 12, Camomile-street, E.C. | 4,367 5 0 |
| Buchanan and Curwen, 64, Victoria-street, S.W. | 4,530 0 0 |
| Eastlakes, Limited, 1, Carteret-street, Westminster, S.W. | 5,820 0 0 |
| Drake and Gorham, Limited, 66, Victoria-street, Westminster, S.W. | 6,260 16 6 |

**Aberdeen.**—The Electric Lighting Committee have received the following tenders for supply and erection of surface-condensing plant, air-pump and piping: Blake and Knowles Steam Pump Company, 179, Queen Victoria-street, London (accepted); W. H. Allen and Co., Limited, Bedford; I. Storey and Sons, Limited, Manchester; Alley and MacLellan, Limited, Glasgow; Mirrlees-Watson Company, Limited, Glasgow; Wheeler Condenser and Engineering Company, Limited, London; Thomson, Son, and Co., Dundee; Worthington Pump Company, Glasgow; Klein Engineering Company, Limited, Manchester; W. H. Bailey and Co., Limited, Manchester; Mather and Platt, Limited, Manchester; Thornton and Crebbin, Bradford; Wallsend Slipway and Engineering Company, Limited, Wallsend; Pulsometer Engineering Company, Reading; J. Abbot and Co., Limited, Gateshead; Summers and Scott, Limited, Gloucester; Bertrams, Limited, Edinburgh; Cole, Marchent, and Morley, Bradford.

# BUSINESS NOTES.

## TRACTION.

**Darlington.**—The tramways have been formally opened.

**Aberdeen.**—The service of cars is being largely increased for the summer season.

**Burton.**—The receipts for Bank Holiday amounted to £112. 1s. 9d., a record for the town.

**Blackburn.**—The receipts for the holidays (Saturday to Tuesday, inclusive) show a decrease of some £75 over last year.

**Walsall.**—The receipts at Whitsun constituted a record, 84,741 passengers being conveyed and £502 taken in four days.

**Reddish.**—The Stockport Corporation are applying for an extension of time of one year for the completion of the Reddish tramways.

**Gloucester.**—Terms have been provisionally agreed upon between the Council and the Great Western Railway Company in regard to level crossings.

**Leicester.**—Through journeys have now commenced. From Saturday to Monday 300,000 passengers were carried, the fares amounting to £1,250.

**Lincoln.**—It is stated that on taking possession of the company's undertaking on July 1, the Corporation will proceed to electrify the tram system between Lincoln and Bracebridge.

**Bury, Rochdale, and Oldham.**—The arbitration proceedings in connection with the taking over of the Bury, Rochdale, and Oldham Steam Tramways Company by the local authorities have been held.

**North-Eastern Railway.**—The company advertise an extension of their electric train service from New Bridge-street Station to Monkseaton, commencing on Monday. The trains will run every half-hour.

**Kilmarnock.**—The tender of Messrs. Dick, Kerr, and Co., amounting to £22,784, for the permanent-way construction in connection with the Corporation electric tramway system, has been unanimously accepted.

**Burma.**—It is announced in *Indian Engineering* that sanction has been accorded to the introduction of Sykes's electric block and inter-

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locking between Rangoon and Insein on the Burma Railway, and work will be started forthwith. The estimated cost is some £2,000.

**Keighley.**—Notice has been given that at the next meeting of the Town Council a resolution will be moved that in the construction of the electric tramway to the railway station, the Tramways and Electricity Committees be empowered to lay double lines forward from the railway station to Stockbridge.

**Kirkcaldy.**—The engineers are at present engaged staking out the route of the proposed tramway through the Wemyss Estate. It is stated that a provisional order will be applied for to enable a junction being effected with the Kirkcaldy system at Gallatown, and also the extension of the route from East Wemyss, *via* Buckhaven and Methil, to Leven.

**Halifax.**—The Tramways Committee recommend that the proposals submitted by a private syndicate concerning tramways outside the borough be not entertained. At Wednesday's meeting the Corporation decided to give instructions for the extensions from Brighouse to Bailiffe Bridge and from Salterhebble to Elland to be commenced forthwith.

**Folkestone.**—Lord Radnor has refused his consent to the adoption of the overhead system. A long discussion took place at the last meeting of the Council as to what should be done next, and it was eventually decided to enter into an agreement for the construction of the tramway on the "G. B." system if the company would give an indemnity.

**West Ham.**—The tramways from Whit Sunday to Tuesday carried 175,355 passengers and took £680 in fares. On Whitsun Monday the receipts were £310, and for the six days ending last Tuesday night they were £1,100. Two new sections of the system were opened on Monday giving access to the dock districts, and they promise to be most remunerative routes.

**London United Tramways Co.**—The extension to Uxbridge was examined and passed by the Board of Trade on Tuesday, and the service commenced the following day. The company conveyed over 675,000 passengers on Whit Sunday, Monday, and Tuesday. The company's Bill for an extension to Staines has been ordered for third reading in the House of Commons.

**South Shields.**—At a meeting of the Tramways Committee last week the town clerk reported the receipt of letters from the British Electric Traction Company and a Manchester syndicate, who had previously sent in tenders for the leasing of the tramways, in which they stated that they would be prepared to amend their offers. The new tenders are to be in within 28 days.

**Proposed Light Railways.**—A light railway is talked of between Dulverton and Washford, Somerset, a large district which is only served by the carrier. Notices of application are published in the *Gazette* for orders authorising light railways from Gisburn to Barnoldswick, Yorks; from Tarporley to Northwich, Cheshire; and for two lines from Corwen, Merioneth, to Pontyswych Carnarvon.

**Malvern Wells-Maisemore.**—A joint committee of the Gloucester and Worcester County Councils adopted the somewhat novel procedure of travelling by coach through the districts affected, ascertaining the opinion of the ratepayers with regard to the proposed light railway between Malvern Wells and Maisemore. All along the proposed route opinion is practically unanimous in favour of the scheme. The committee will report to their respective councils in due course.

**Bournemouth.**—At the meeting of the Town Council on the 25th ult., it was stated that the total number of miles run by the trams since April 28 was 19,978. The passengers carried numbered 235,552, the receipts were £919. 13s. 3d., the average per car mile being 11·09d. The arbitration upon the terms of the acquisition by the Borough Council of the Poole and Christchurch undertakings from the Poole and District Electric Traction Company has been held.

**Pontypridd.**—At last week's meeting of the District Council a report was submitted upon the negotiations with the British Electric Traction Company with respect to the company's terms for the sale to the Council of the portion of their tramway undertaking in the urban area. It appeared that differences existed as to the "life" of the tramway track, the quality of the pitching, etc. The negotiations had been adjourned in order that the track might be further examined.

**Sheffield.**—It is stated that the Sheffield Tramways Committee have decided to make an early trial at one of the High-street junctions of a new automatic point shifter, which is being made by S. Dixon and Sons, of Leeds. This apparatus dispenses with the services of a pointsman at tramway junctions, the points both of the rails and the overhead wires being actuated by electrical power, and controlled by the motorman of the approaching car. If the experiment is successful, the apparatus will probably be installed at all the important junctions.

**Mexborough and Swinton.**—Recent developments indicate that the construction of the proposed tramway depends upon the attitude of the local authorities, as the promoters are not disposed to comply with the stipulation that they should provide a dust destructor and use specially-constructed cars for the removal of the nightsoil. There was no such arrangement with the Mexborough Council, but the Swinton authorities are inclined to adhere to the original terms unless some equivalent is granted. The company have been in communication with the Rawmarsh Council on the subject.

**Falkirk.**—The *plébiscite* on the question of Sunday running is to be taken next week by house-to-house visitation. The Town Council are divided in opinion. Meantime the company have indicated their willingness to agree to certain restrictions to meet the views of the objectors. They are willing, when the time arrives for the Town Council to consider the advisability of buying the undertaking, to sell on a six-day profit-earning basis. Further, they are prepared not to run the cars during the hours of divine worship. There is, however, a feeling among a large section of ratepayers that the Council should themselves undertake the tramways.

**Glasgow.**—The financial year of the Corporation tramways has just closed, and the statistics up to last Saturday show that the system has carried 187½ million passengers, and yielded £711,607 in fares. When the three additional days necessary to complete the year are added it is estimated that the Glasgow tramway cars will have carried fully 189 million passengers and drawn about £718,000 in fares, being an increase of about 12 million in the former and £60,000 in the latter as compared with last year. There are now 70 miles of double track open for traffic as compared with 65 at this time last year.

**Ashton.**—The negotiations with Stalybridge are at a standstill. The manager of the Corporation tramways (Mr. A. Covenay) has organised a circular system of cars on the Hurst and Dukinfield route. In connection with the dispute between the Ashton Corporation and the Manchester Carriage Company, the arbitrator (Mr. Harris) has fixed the price which Ashton will have to pay as £26,000 in the event of their having to take over the Cowhill-lane depot, 10 cars, and 141 horses. In the alternative, the Corporation will have to pay the carriage company £17,250. It now remains for either party to apply to the King's Bench to test the accuracy of the interpretation of the statute.

**Wellingborough.**—At the last meeting of the Town Council, a letter was read from the company stating that they were unable to give a definite date when the actual construction of the tramroads would commence, as the state of the money market had been such that the company did not feel justified in raising the capital. Notices to treat had been served for all the property necessary, and prices had already been agreed to the extent of £6,200. Tenders for the construction of the tramroads and working drawings had already been prepared. It was further pointed out that the period allowed to carry out the scheme was July 31, 1905. The Council generally were disposed to assist the company as far as possible.

**Saddleworth and Springhead Tramways.**—Notice is published in the *Gazette* that application will be made to Parliament by the Saddleworth and Springhead Tramways Company for leave to introduce into the Bill now pending provisions for the extension of time for the transfer by the Saddleworth and Springhead Urban District Councils to the company of the undertakings authorised by various orders; to authorise the abandonment only of tramways Nos. 3 and 4 instead of the whole undertaking; and to vary the powers of the company as to the issue of shares. Printed copies of the additional clauses can be obtained from Messrs. Baker, Lees, and Co., agents for the company, 54, Parliament-street, Westminster.

**Tees-side Tramway Profits.**—A conference is being arranged with the public authorities on the line of the Tees-side tramway route, between Middlesbrough and Norton, to consider the application of the tramways company, who are seeking to alter the terms of purchase and give the Corporations of Middlesbrough and Stockton and the Parish Councils of Norton and Linthorpe a wayleave in lieu of a share in the profits. By the order of 1897, the tramway company were to pay to the local authorities a certain share of the profits over 8 per cent., but up to the present nothing has been received from the company. Thornaby has already made an arrangement with the tramway company to receive £200 as wayleave in lieu of their share of the profits.

**Dewsbury.**—It appears that the brakes of the car which got out of control, as stated in our last issue, proved, on examination after the accident, to be in working order. The driver, having applied the electric brake without, as he imagined, producing the usual effect, reversed the controller. It is asserted by the driver, whom the manager states is one of the most reliable in the service, that an injury to his hand sustained in the collision with a cart prevented him from lifting the latch of the front door so as to reach the rear of the car, and that it did not occur to him to signal the conductor to apply the hand-brake. The conductor was occupied in preventing the passengers from attempting to jump off the car. A Board of Trade enquiry has been held.

**Steyning.**—At the meeting of the Steyning East Rural District Council the Town Clerk reported that he had called the attention of the Brighton Corporation to the fact that the tramway line in a portion of the Dyke-road had not been laid in the centre of the highway as shown upon the deposited plans, and as no satisfactory explanation had been received from the Corporation, it was resolved that formal notice be given the Corporation to relay such tramway in accordance with the deposited plans, and that the attention of the Board of Trade be called to the matter. The question of the laying of electric cables from Southwick and along the Shoreham road was considered, and after some discussion the Council decided to do certain work themselves.

**Sunderland.**—The tramways show a profit of £4,420, which will go to the relief of the local rates. The accounts show total receipts, £63,067 (£62,506 for fares); total expenditure, £58 647 (of which £36,318 is for working expenses, and £22,328 for interest, sinking fund, and depreciation). Despite the unfavourable weather 14,848,958 passengers were carried, an increase on the previous year of 861,837. The average taking per day were £170. 15s. 8d., the average per car per day £3. 6s. 11¾d., and the average receipts per car mile were 10·46d., giving a net profit per car mile of ·74d. Electricity for motive power and lighting cost £12,208, and wages of motormen and conductors £13 586. Of the various sections, four are worked at a profit and five at a loss. The Roker line is especially remunerative.

**Cheltenham and District Light Railway.**—The Board of Trade notify that the Light Railway Commissioners have submitted to them for confirmation an order authorising the construction of an additional light railway in the borough of Cheltenham, and the abandonment of the construction of part of another light railway already authorised in the same borough. Any objections to the confirmation of the order should be addressed to the Assistant Secretary (Railway Department), Board of Trade, and must be lodged with the Board on or before the

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25th inst. These should be accompanied by copies of any clauses or amendments that may be desired to remove the objections, and copies of such objections and clauses or amendments should at the same time be sent to the promoters' agents, Messrs. Winterbotham, Gurney, and Co., solicitors, Cheltenham, from whom copies of the order may be obtained at the price of 1s.

**Newcastle.**—The Town Council having amended the terms of settlement submitted by the company so as to materially limit the proposed through service, the company have signified their rejection of the offer. A meeting of the Parliamentary and By-laws and Tramways Committee of the Newcastle Corporation was held yesterday, Alderman J. Baxter Ellis occupying the chair. Members of the Tramways, etc., Committee have been appointed to represent the Corporation and give evidence before the Select Committee of the House of Commons against the application of the company. The committee have decided to obtain further evidence in support of their opposition. Sir Chas. Hammond has resigned the chairmanship of the Parliamentary Committee, stating that the decision to associate the Tramways Committee with the Parliamentary Committee in opposing the company's Bill amounted to a vote of censure on the Parliamentary Committee.

**Aston.**—The report of the committee states that the reconstruction of the permanent way between the city boundary and Aston Cross will be finished in a day or two. Crossovers have been laid at each end, and the contractors are now erecting the poles and overhead wires and other work in connection with the electrical equipment, which will be completed by the second week in June, so that there is no reason why this portion of the line should not be worked on the overhead electric system at once and intercommunication with Birmingham effected, providing the company are able to make satisfactory arrangements with the city of Birmingham for running powers. The contractor has finished the reconstruction of the permanent way in Witton-road, Bevington-road, and Trinity-road, and has made the junctions with the existing tramways so that the company may run over these lines with the steam cars, leaving the Witton-lane and Park-road free for reconstruction. The contractor is making good progress all round.

**Manchester.**—The inner electric tramway circle of the city lines is approaching completion. Up to last week cars starting from the tramway shed in Queen's-road, Cheetham Hill, ran along Queen's-road and through Lamb-lane to Oldham-road. The route was then extended along Hulme Hall-lane and Forge-lane to Ashton New-road, and along Grey Mare-lane to Ashton Old-road, and through cars will be run between Cheetham Hill-road and Ashton Old-road. On the other side of the city there is a service from Brooks's Bar through Moss Side and along Dickenson-road to Longsight and so to Hyde-road. The only part of the circular route which remains uncompleted is the line along Potter-lane, Gorton-lane, and Belle Vue-street to connect Ashton Old-road with Hyde-road. This will shortly be undertaken, and it will then be possible to go round the city on its east and south sides to Brooks's Bar. Lines to other parts are, of course, crossed, and cars to various districts can be taken at these junctions. The receipts from the Corporation cars last Saturday amounted to £2,867, which is the largest amount taken in a single day since the inauguration of the system.

**Brighton.**—The Town Council have decided to appeal against the judgment of Mr. Justice Grantham in the action brought by Messrs. McCartney, McElroy, and Co. The Council met privately before the public meeting, and it is stated that they then had before them a letter from the contractors offering to accept £12,000 and costs to settle the whole matter in lieu of the £14 600 and costs awarded by Mr. Justice Grantham. Eventually, however, it was decided to appeal. The Works Committee have considered a suggestion from Mr. Magnus Volk with regard to Volk's Electric Railway and the proposed Rottingdean tramroad that cars should be permitted to be worked on the two systems without passengers having to change cars. Mr. Volk also requested the Corporation to waive their right to take over the electric railway before the end of the lease; and in a subsequent letter Mr. Volk agreed, if the concession was granted, to give a sum of £250 and a similar sum in 12 months for the purpose of advertising the borough. The committee decided not to accede to the suggestion that the Corporation should waive their right, but were willing to agree to Mr. Volk's cars running over the proposed Rottingdean tramway. At a second meeting the committee decided eventually that they could not recommend the Council to waive their right to take over the railway under the terms of the lease.

**Southport.**—The company who lease part of the tramways within the borough from the Corporation have submitted a draft agreement embodying the terms upon which they would be prepared to lease the whole of the Corporation's undertaking, intimating at the same time that if the Corporation prefer to buy the company out, the latter are open to consider any proposition. The draft agreement provides that the rent to be paid by the company shall be an amount representing the net interest and sinking fund on the basis of the minimum rates for the longest terms over which the Corporation is entitled to spread the repayment of loans in respect of the several items—viz, permanent way, electrical equipment, cars. The company to purchase all energy needed from the Corporation on the same terms as hitherto. The agreement as to certain payments for maintenance, repair, and renewal shall apply to all the lines. The Corporation shall provide all capital required for such improvement, alteration, or extension as may be carried out with their approval and consent, and the company shall pay an increased rental in respect thereof on the same terms as for the existing service. After payment of the rent and of the sums for maintenance, repair, and renewal, the company shall be entitled to the payment of 5 per cent. on so much of their capital as has been expended in the borough of Southport, which, for the purposes of the agreement, shall be deemed to be £25,000. The company shall be entitled to establish a depreciation fund of not exceeding 4 per cent. per annum on the sum of £12,500. The remainder of the revenue shall be deemed to be profit, of which one-third shall go the company for working the undertaking, and the remaining two-thirds shall be divided equally between the company and the Corporation. Any obligation entered into by the Corporation with the Southport District Tramroad Company or with the Lytham Tramroad Company shall be accepted and fulfilled by the company. The company shall not increase the existing fares except with the consent of the Corporation. They may, however, modify the existing stages to facilitate the working of the lines when combined in one undertaking.

**The Underground.**—The *Financier* publishes an interview with a gentleman closely connected with the District Railway Company, in the course of which he stated: "As things are going, the engineers consider that the entire cost of electrification of the District Railway—not the lines over which it has running powers—will not exceed one million sterling. That is for 13 miles of double track and the cost of the new rolling-stock and so forth. It would be a great deal more but for the fact that the company will not have to sink any capital in putting up a power-house. It will have the advantage of a supply of current from the great generating station which the Underground Electric Railways Company is building at the pure cost of production, plus 10 per cent. Looking at the weak financial position of the District, this arrangement will suit us better than having to take up a lot more capital. Besides, it is better that the power for the whole system, including the tube railways connected with the Underground Company, should be supplied from one centre. The Metropolitan Railway will, of course, have its own independent power from the station it is building at Neasden. From the experimental electric service of the District we are learning some useful lessons from it. In a new installation there are certain to be little defects to put right. We had two trains running at first, but one of them developed certain faults, and we have taken it off the regular service, using it now and again, and then making a careful examination to see the reasons for the faults developed. But, really, there is very little that is new in the system of electrical working we have adopted. It is, in all essentials, a duplication of what is being done in the States. So we are on sure ground. When the time comes for putting the new rolling-stock on the rest of the system we shall know the trains will run. We hope to start the new system on the main line next January. But the date at which the change will actually take place will depend on many circumstances. I believe work on the Metropolitan is going on quite satisfactorily, and there is no reason to suppose they will be behind us, but it is too soon yet to make any hard-and-fast statement. Both companies will try to be ready by January, and I think we shall be. When we are ready to make the change the electric trains will run right round continuously. I dare say for the first month we may still have a good many of the old trains and locomotives in use; perhaps the electric trains will alternate with the others, but in about a month from the start the locomotives will disappear. We shall train our own drivers. In fact, that is one of the uses of this five miles of experimental line. We are putting the present engine-drivers on to the electric motors and teaching them how it is done. So far as possible we shall retain the present staff of drivers. But it is not so easy to get these men to accommodate themselves to the new conditions. They do not altogether like it, particularly the older men. You see, they have been driving a steam locomotive for the best part of their lives. When they are put on to an electric motor they not only have something strange to learn, but they have something to forget—which is even more difficult. The line will be worked entirely on the multiple-unit system of traction. We shall have no locomotives. It will be far more economical to dispense with the additional weight, and the unit arrangement makes the whole equipment more elastic and easier to manage—easier when everything goes right and the line is in perfect order, and very much easier if any breakdown happens or in the event of an accident." Interviewed by a New York pressman, Mr. Yerkes stated that he expected the new system to be in operation by Jan. 1, 1905, and that the confidence of British investors in the undertaking was shown by the great advance in the price of the stock.

**Liverpool.**—A complete electric track welding outfit, for working the Lorain Steel Company's method, in charge of a Lorain staff is now at work on an experimental complement of joints on the Liverpool tramways. Two thousand joints are to be welded by the process. The machines have been at work this week in Upper Parliament-street. The outfit comprises four trolley cars, one being a dynamo car, one a sand-blast car, one a welding car, and one a grinding car, and blast-lamp apparatus for burning all traces of pitch off the rails when they are first bared by the removal of the setts. Following the lamps comes the sand-blast car. This car is provided with an electric motor of 10 h.p., which works an air-compressor. There is a tank for storing the air, a sand-bin, and a vertical cylindrical sand-mixer of Tilghman pattern. The air is compressed to about 20lb. per square inch. This blasting car operates but little in advance of the welding car, the necessity of having perfectly clean metal faces for welding making it desirable that the joints are not prepared far in advance of the welder. When cleaning the rails for welding, an attendant directs a nozzle on the part to be cleaned, and the air, carrying with it the sand, impinges on the rail. Every particle of dirt is removed from the rail, the metal being left in its fresh and natural silver-grey. The welding car is fitted with a 5-h.p. motor, which drives a horizontal shaft provided with friction clutches for working a crane carrying the welder. The crane has a massive arm or jib, and performs a raising or lowering motion, and a motion from side to side to admit of the welder being moved to either rail. The welder is of the Thomson Electric Welding Company's type, of Lynn, Mass., and is supported from the arm of the crane, slightly in advance of the car. It has two powerful jaws, by means of which the actual welding pressure is imposed. The welder comprises a transformer, the primary winding of which has two coils in parallel, with 44 turns each. The secondary coil consists of a single loop of copper of large sectional area, the terminals of which form the contacts or jaws of the welder which

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grip the rail. The primary coils are enclosed within the secondary winding, and are insulated in oil. Pressure is applied by means of two insulated levers, which are connected by a hydraulic jack. A pressure of 4,100lb per square inch is obtained on the rams of the jack, which are 3⅞in. in diameter, by means of a hand pump. A welding pressure varying from 10 tons to 37 tons is obtained, the pressure being gradually increased to the maximum. Current for welding is taken from the trolley wire overhead by the ordinary trolley arm arrangement at about 500 volts, and is transformed first to alternating current of 300 volts by a General Electric Company's rotary converter in the dynamo car. At the welder it is transformed to seven volts, and is then of 20,000 to 30,000 amperes. About 125 kw. is required to weld, and to effect this the current is on for about 2½ minutes. To weld a joint a bar of flat rolled steel, from 18in. to 48in. long, 3½in. wide, and 1in. thick, cast with a special welding piece at each end, and provided with a welding strip in the centre, is used like a fishplate on each side of the joint. The jaws of the welder grip the ends and the middle of the two plates as they lie against the rails in turn, and the three welds which from the joint are effected. The end welds are horizontal; the middle weld is vertical. The final operation is that of planing down any inequalities which may remain on the surface of the rail. This is accomplished by means of an emery-wheel or grinder, which forms part of the outfit of the fourth and last car. This car is also provided with a motor, to work the emery-wheel backwards and forwards over parts which require to be "planed" down. The wheel is supported in a swing frame, which admits of it being used on either rail. The making of a joint occupies from 13 to 14 minutes. Continuous working is reckoned upon, and with this about 80 joints can be made per 24 hours on an average. The operations at Liverpool are being carried on under the direction of Mr. J. G. Raymond, who represents the Lorain Company on the particular piece of work.

**Birmingham.**—The first three months' working of the Aston line of the Birmingham municipal trams has proved very successful, yielding £4,428 profit. This represents an average receipt per car mile of 1s. 6d. of which 6d. is profit. The inspector pointed out that it would be necessary to obtain the sanction of the Board to expenditure relating to tramways as distinct from lighting, and the city engineer has been instructed to dissect the items in order that the necessary application may be made. The Council have approved a provisional agreement with the City of Birmingham Tramways Company for the immediate electrification of the Small Heath route, and for the future working of the line. The terms of electrification are practically the same as those for the Dudley route. Alderman Beale explained that at the present time the route consisted of three sections: the line from Station-street to Small Heath Park, which was a steam route belonging to the Corporation, but leased to the company till Dec. 31, 1906; the line from Small Heath Park to the city boundary, a newly-constructed and electrically-equipped line, also belonging to the Corporation, and leased to the company until December, 1906; and the new electric line from the city boundary to Yardley, which had been newly constructed and was in the hands of the tramway company for a period of 30 years from 1903. The old steam part of the route was much in need of repair, and the company found themselves in the position of being called upon to pay for relaying the lines under the terms of their lease, and with very small prospect of getting very much out it during the small term that remained to them. The company accordingly approached the Tramway Committee, and asked them to deal with this portion of the route in the same way that they had dealt with the Dudley-road route in connection with the Birmingham and Midland Company. It was obviously an advantage that the steam cars should be got rid of and that the line should be electrically equipped as early as possible, and in this instance the change would render it possible for the company to run their cars through from Station-street to Yardley. There was, however, the question of the position which would be created at the commencement of 1907. Unless some arrangements were made, the Corporation would find themselves at another deadlock, necessitating that the passengers should change cars at the city boundary. The Tramways Committee had, therefore, come to the following arrangement for through working, which had been embodied in the provisional agreement. The parties were to provide cars in proportion to their length of interest in the route. Each would find its cars in its own district. Each party would find its own power, and the receipts would be divided in proportion to the respective interests. The agreement contemplated the possibility of the company desiring at some future date to go beyond Yardley, possibly to Sheldon, in which event the committee thought they should have the option of saying whether they would apply the arrangement to the extended route, or whether they thought that was too far for the Birmingham cars to run out into the country. In the latter event the company might run their cars from the furthest point into Birmingham, the Corporation taking the whole of their earnings in Birmingham and paying them an agreed figure, which he thought there would be no difficulty in arranging when the time came. Another clause had reference to the depôt opposite Small Heath Park, and provided for the company having access to the establishment upon certain terms in the event of the Corporation not electing to purchase it. It was provided that the arrangements should go on till June, 1911, and that until that date the Corporation would not extend the 1d. stage beyond Small Heath Park. The committee were, however, pretty confident that if the arrangement was found to work well it would be continued for a further period. June, 1911, was the date when the interest of the City of Birmingham Tramways Company in all the lines inside Birmingham would cease, and it would doubtless be the occasion for a general tramway rearrangement. The company had agreed to pay 15 per cent. interest on the cost of relaying roads for the remainder of the lease, and tenders would shortly be invited. In regard to the different treatment of the Corporation and company employés on the Small Heath route, he did not anticipate any difficulty. The committee would shortly submit proposals for various extensions and alterations, so that parliamentary powers might be available when all the steam routes came into the possession of the Corporation in 1906. In conclusion, Alderman Beale expressed the hope that having now met in friendly negotiation the Corporation and the company might be able to come to terms for through working on other lines.

## LIGHTING AND GENERAL.

**Bolton.**—There appears to be considerable friction with the employés at the electricity station.

**Sale of Plant.**—Particulars of the sale of two steel Lancashire boilers will be found in another column.

**St. Pancras.**—The Borough Council are raising a loan of £19,000 in respect of the extension of the electric lighting.

**Hartlepool.**—The Town Council have decided to provide a number of additional arc lamps in various parts of the town.

**Derbyshire and Nottinghamshire Electric Power Bill.**—This Bill has been read a second time in the House of Commons.

**Stoke-on-Trent.**—The Town Council have decided to apply for sanction to borrow £1,250 for the provision of electric light fittings.

**Rochdale.**—The Town Council propose to apply for sanction to the borrowing of the sum of £42,405 for purposes of extensions at the electricity works.

**Gravesend.**—Steps are being taken to ensure an extension of the Gravesend Electric Lighting Order of 1890 so as to include in the area the parish of Rosherville.

**Retford.**—The Town Council are actively considering the installation of the electric light. If the price is suitable, the Board of Guardians will become a customer.

**Newcastle.**—Permission has been granted to carry overhead wires along Welbeck-road for the electric lighting of the thoroughfare by means of a number of 120-c p. lamps.

**Horsham.**—There are now 5,860 lamps connected with the District Council's electric lighting mains, and 150 lamps are applied for. The number of private consumers is increasing.

**Colwyn Bay.**—The price of the current is to be reduced this year from 4½d. per unit to 4d., as the electric lighting department showed a clear profit of £385 on last year's working.

**Barnstaple.**—Mr. Hadfield is preparing a report as to the cost of lighting the corn exchange with electricity. An electric motor is to be substituted for the gas-engine at the music hall.

**Woolwich.**—The Infirmary Committee of the Guardians are reconsidering a recommendation that the electric light be laid on at the infirmary at a cost estimated by the borough engineer at £420.

**Goole.**—We understand that the Council intend to retain their electric lighting order, and will probably instal a small plant of their own. They have already acquired a site for this purpose at a cost of about £900.

**Edinburgh.**—It is proposed that the surplus of the year's working of the electric lighting department, amounting to £17,000, after payment of interest and sinking fund, should be placed to the reserve fund.

**Sunderland.**—The electricity supply undertaking of the Corporation realised a gross profit of over £16,000 during last year. The Electricity Committee have accepted a Berlin tender for three-phase cables.

**Ilford.**—The enquiry into the Council's application to borrow £32,000 for the purposes of the electricity department was held last Thursday. Part of the loan refers to excess expenditure and part to new mains and plant.

**Exeter.**—The work of laying the telephone wires underground instead of overhead is proceeding in the principal business parts of the city. When completed the extension of the underground system all over Exeter is anticipated.

**Folkestone.**—The Town Council have decided to appoint a sub-committee to consider the question of telephone charges as they apply to the Corporation. The annual charge is £167, out of which £74 is for fire brigade purposes.

**Wellingborough.**—The Urban District Council have agreed to give to the County of Northampton Electric Power and Traction Company 12 months' notice of intention to determine the agreement between them and the Council dated Feb. 18, 1902.

**Hull Telephones.**—The municipal exchange is to be opened shortly. It is reported that the number of subscribers already secured has far exceeded the anticipations of Councillor Brown (the chairman of the Telephone Committee) and Mr. T. Holme (the manage ).

**Bo'ness.**—With regard to the deadlock, it is announced that the Secretary for Scotland will, in case he decides to still disallow the electric lighting loan as proposed, sanction a loan by the Town Council on the understanding that they do the work themselves.

**Bombay.**—The municipal electricity works are nearing completion, and their opening should also open a demand for motors, lamps, and electrical apparatus and appliances of all kinds. It is reported that the local merchants are quite out of stock in any of these lines.

**Underground Electric Railways Company of London, Limited.**—The London and Westminster Bank, Limited, are prepared to deliver the definitive engraved notes in exchange for the provisional certificates of the 5 per cent. profit-sharing secured notes.

**Wisbech.**—Provisional contracts have been sealed for the purchase by the Corporation of Virginia Waters at a cost of £800, and so much of the adjoining land as the Council may require at £400 per acre, for the purpose of providing a site for the electric generating station.

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**Southport.**—At the Chamber of Commerce on Monday Mr. Jagger undertook to call attention at the next meeting, as a subject suitable for discussion, to the excessive payment in aid of the rates by the Gas and Electricity Committees in lieu of reducing the prices for the supply of the same.

**Aston.**—The town clerk is preparing an agreement with the City of Birmingham Tramways Company for the supply of electrical energy in connection with the running of the trams in the borough. New cables, etc., are to be laid, at a total cost of £900, to supply consumers in various streets.

**Little Lever.**—The Lancashire Electric Power Company recently asked whether the Council would take electricity in bulk from them, or whether they would authorise the company to supply it. The Council declined to surrender their powers under the Electric Acts, but they are apparently willing to take into consideration any special demand for the supply of electricity which might arise in their district.

**Caerphilly.**—The Board of Trade have issued an electricity supply provisional order to the Urban District Council. The order expressly provides that nothing in the Electric Lighting (Clauses) Act, 1899, shall be construed as preventing the undertakers from entering into any arrangement which under the South Wales Electrical Power Distribution Company Act, 1900, may be entered into with that company.

**Telegraphs to the Continent.**—Lord Stanley has informed the Liverpool Chamber of Commerce that he is paying special attention to the working of the direct wires between Liverpool and Hamburg and Liverpool and Bremen, and will not fail to take any steps in his power to improve the service. The Hull Chamber have received a similar reply with regard to telephones from the East Coast to the Continent.

**Criccieth.**—At the Urban District Council meeting on Monday a special committee reported that gas had been proved to be undesirable, and the question thus resolved into the adoption of either electric or incandescent oil lighting. Electricity was felt to be most suitable, and it was thought advisable to defer further action until the Portmadoc and South Snowdon Company had completed their scheme, which embraces Criccieth. The report was adopted.

**Swansea.**—At the last meeting of the Chamber of Commerce, the secretary reported that the Harbour Trust had agreed to establish municipal telephonic communication with the various dock entrances and with the Mumbles lighthouse for the benefit of traders. It was objected by several present that the Corporation telephones would be useless to many, and it was decided that the trust be also asked to put in the National Telephone Company's service.

**Stourbridge.**—At the last meeting of the Council the Electric Powers and Destructor Committee reported that Mr. McLean, on behalf of the Midland Electric Corporation for Power Distribution, had confirmed in general terms the offer to supply electricity in bulk to the Council, referred to at the public enquiry. Further representation is to be made to the Board of Trade with the view of assuring the continuance of the Council's electric provisional order.

**Bristol.**—The year's report of the Electrical Committee shows a net profit of £8,207. The capital expenditure to date has been £542,243. The gross receipts for the year were £61,371, and the gross profit was £31,530. Of this sum £13,967 was used for payment of dividends on stock, interest on loans, and bankers' overdraft, and £9,356 to repayment of borrowed money. A sum of £5,026 is placed to the depreciation and contingency account, £2,000 to reserve, and £1,194 is carried forward.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: Electric Lighting and Traction Company of Australia's further issue of £75,000 5 per cent. debenture stock; Electrolytic Alkali Company's further issue of 50,000 ordinary shares of £1 each, fully paid, Nos. 152,219 to 202,218, and a further issue of 50,000 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 50,001 to 100,000.

**Removal.**—We are informed by Messrs. J. H. Tucker and Co., late of 3, Bury-street, W.C., that, owing to increasing business, they have removed to larger premises at 217, Shaftesbury-avenue, W.C., to which address all communications from the South and East Coast districts should be sent. Mr. G. T. Baker, who has been the London and district representative of the firm for many years, will continue in charge. The head office will still be at Sampson-road North, Birmingham.

**Brighton.**—The report of the electricity works for 1903-4 shows a total income of £88,306, the expenditure as £49,990, and the gross profit £38,336. In the previous year the sums were £82,392, £47,208, and £35,184. With a balance of £7,984 from last year, the total is £48,320. This the committee propose to apportion as follows: interest on debt, £15,636; sinking fund, £15,739; and reserve fund, £4,734, leaving £3,250 to be handed over in relief of the rates, and a balance of £6,959 to carry forward.

**Keighley.**—The Electricity Committee in their last report state that 13 993 units of electricity were sold during April, as compared with 10,347 units in the corresponding period of last year, the increase being 3,646 units. From July 1, 1903, to April 30, 1904, 162 346 units were sold as compared with 121,808 in the corresponding period of last year, the increase being 40,538 units, which is equal to 33·2 per cent. Two extensions of cable, estimated at £228, are to be laid, and application will be made for sanction to borrow £11,500 on the electricity account.

**Pembroke.**—An enquiry has been held into the application of the Urban District Council for sanction to borrow £25,000 to extend the electric lighting system. The previous loan of £33,000 having been expended, Mr. Robert Hammond stated that the estimated expenditure in respect of the loan for electric lighting was £7,169 a year, and the present revenue £6,922, leaving a deficit of £197, which would be wiped out by the increased demand for electric light. The price having been fixed at 4½d., extension was necessary with a view to improved financial results.

**Buxton.**—Mr. W. J. Leeming, the electrical engineer, has prepared a comparative statement of the working of the electricity works during the past year and previous years, showing that the total revenue for the last year is £3,883, as compared with £3,187 of the previous year, being an increase of £696. The total expenses for the last year were £2,543, as compared with £2,247, being an increase of £296. Thus in taking the increased costs from the increased revenue, a net gain of £399 remains on the year's working. Since the beginning of this year 162 8-c.p. lamps were connected, and applications for another 422 8-c.p. lamps are in hand.

**Leeds.**—The single arc lamps on the tramway poles in the centre of certain roads are shortly to be taken down and replaced in each case by two small enclosed arc lamps fixed on double-arm brackets, projecting 3ft. from the tramway poles on either side and parallel with the car track. The brackets are to be so fixed that the lamps shall not be more than 17ft. from the ground. The lamps and swan-neck brackets now fixed to side poles are also to be removed, and small lamps attached to the side of the bracket arm of each pole substituted. The lamps are to be as near the centre of the road as possible, and at a height of not more than 18ft. The work will be done by the Corporation Lighting Committee.

**Tunbridge Wells.**—During a discussion on Wednesday at the Town Council on the question of applying for parliamentary powers to extend trading privileges in connection with electric lighting, the Mayor said the undertaking had undoubtedly made great strides. In the course of eight years the system, which had cost £80,000, had contributed £2,750 to the rates, and there was a reserve fund of £3,000. It was recommended that powers be sought to extend the area of supply, to undertake free wiring, and to provide motors on the hire system. The provision of motors and radiators on the hire purchase system would increase their revenue, and they could build up their business. The recommendation to apply for powers was lost by nine votes to thirteen.

**Edmonton.**—It will be remembered that the late Council accepted a scheme from a firm of electrical engineers for establishing an undertaking at an estimated cost of £44,000, and directed that plans and specifications should be prepared with a view to tenders being invited for carrying out the necessary works. At a special meeting on Tuesday night a motion was passed to the effect that the North Metropolitan Electric Power Supply Company and the Tottenham and Edmonton Gas Company, who, it was stated, intended to apply for the necessary parliamentary power, should be invited to state the terms upon which they would lease the Council's provisional order. The electrical engineers already engaged are also to submit a modified scheme, which is to be considered at the same time as the offers from the companies.

**Islington.**—The Lighting Committee have been authorised to expend £150 in giving a supply of electricity to premises in Cross-street, where motors are to be installed aggregating 15 h.p. With regard to the rearrangement of the staff in the electrical department already referred to by us, we learn that the commencing salary of shift engineers and mains engineers is to be £2 per week, rising by annual increments of 5s. per week until a maximum of £3 is reached. The commencing salary of junior shift and junior mains engineers is to be £1. 10s. per week, rising by annual increments of 5s. per week until a maximum of £2 is reached, and in future the shift men will be given 10 days' holiday per annum, in addition to Christmas Day, Good Friday, and the four bank holidays, instead of one day per month and one week per annum as at present.

**Hull.**—The accounts of the electric lighting department, which show a very successful year, appear in another column. At the last meeting of the Electric Lighting Committee, an application from Messrs. J. Reckitt and Sons for a supply of electricity, chiefly for motive power, to their starch works was granted. They estimated that they would require about 560,000 units per annum. The engineer (Mr. Bell) stated that the supply would necessitate an extension of plant costing about £4,600. The committee also considered the application of the North-Eastern Railway Company for lighting and motive power for their stations, docks, and sidings in the city, estimating the supply required at about 1¼ millions of units per annum. For this there would be needed extensions costing £2,300, and it was decided to enter into an agreement with the company.

**Bolton.**—The Town Council on Wednesday agreed that on the maximum demand system 4d. per unit be charged for the first three hours of maximum demand, and 1d. per unit for all units consumed in excess of the above; that for motive power the charge for the first 1,000 units in any one quarter be at a uniform rate of 2d. per unit, and for all units in excess 1d. per unit; that, subject to the consent of the Board of Trade, the charge for electric current for tramway purposes be at the rate of 1·10d. per unit. Dr. Panton, the chairman of the committee, said the output for the year was 5,056,898 units, an increase of more than 1¼ million units. The sale of current had brought in £37,285, an increase of £5,228 over the previous year. The gross revenue was £39 309, and the cost of generating £14,914, the gross profit being £24,395, an increase of £3 588. The net profit was £7,480, and it was proposed to credit £6,818 to the relief of the rates. The lowest cost of production was in Rotherham with ·66 per unit, but Bolton came next with ·707.

**London Gazette.**—Mr. C. J. Singleton, 8, Staple-inn, London, has been appointed trustee in the estate of Charles Manners Downie (trading as the Lighting Corporation), electrical engineer, 4, Bloomsbury-street, London, and 28, Heathville-road, Crouch Hill, Middlesex. Mr. T. Tranter, 51, North John-street, Liverpool, has been appointed trustee in the estate of John James De Lacy, residing at 53, Seaview-

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road, Liscard, and Howard Kyan De Lacy, residing at Wynnstay, Seaview-road, Liscard, Chester, carrying on business in co-partnership as De Lacy Bros., at 58, Oldhall-street, Liverpool. The Dover Electricity Supply Company, Limited, is to be wound up voluntarily. Sir William Henry Crundall, of Dover, Kent, and Mr. R. P. Sellon, 4, Queen Victoria-street, London, have been appointed liquidators. The final meeting of the Wigan and District Tramways Company, Limited, will be held at 2.30 p.m. on June 30 at 23, King's-street, Wigan. The final meeting of the Giffre Electro-Chemical and Power Company, Limited, will be held at 12 noon on July 7 at 11, Queen Victoria-street, London, E.C.

**Watford.**—An enquiry has been held into the application of the Urban District Council for sanction to borrow £26,000 for electric lighting. In the evidence it was stated that a demand equivalent to 30,000 8 c.p. was anticipated by December, for which the present plant was insufficient. The committee had accepted tenders for two boilers in advance, because it was absolutely necessary that matters should not be delayed. The present connection to the supply was 878 kw., and the maximum demand at any one time had been 375 kw. The present plant was only sufficient to supply 330 kw. Watford began by lighting the public streets, and had they commenced with providing for private consumers and lighted their streets afterwards they would no doubt have made a profit from the commencement. In 1899-1900 they only received £135 per month from the light, and now they were receiving £600 per month. The population had increased 6,000 in the last four years, whilst the area of supply had increased very considerably. This year there was an increase in the area of supply of 217 acres. There was no opposition.

**South Shields.**—An enquiry has been held into the application of the Corporation for sanction to borrow £12,046 for the purposes of electric lighting in the borough. The greater part of this amount—namely, £7,215—represents new work, while £4,831 refers to certain excessive expenditure on work previously sanctioned. The undertaking was commenced in 1896, and has made rapid progress. There was an increase of over 10 per cent. in the units generated during last year as compared with the previous year, the number of consumers having increased at the same ratio. It is proposed to provide for at least 500 new consumers, which, estimated at £8 a consumer for putting in meters, requires £40,000. In addition, it is estimated that the mains in respect of these consumers will cost £5 each, making a total of £2,500; £320 is required for fuseboards at sub-stations. The last quarterly statement shows that in the three months ended March 31 last the number of consumers was 1,010 as compared with 890 at the corresponding period of last year; the units consumed were 267,163, as against 243,060; and the total amount of sales, etc., amounted to £5,164, as compared with £4,727.

**Liverpool.**—The Council will next Wednesday continue a discussion on a proposal to apply for power to borrow £20,000 for feeder, distributing, and service cables, electric meters, and house service materials required during the ensuing three years. On Wednesday the chairman of the Electric Supply, etc., Committee (Alderman Beecham) said the net profit on the electricity undertaking for the year had been £2,599, as compared with £576 in the previous year. For the year ended March, 1903, the number of units sold for lighting purposes was 290,000, and last year it had risen to 342,000. For motor power 363,000 units had been sold, against 209,000. It would be noticed that the amount of current sold for motors was more than for lighting purposes. For traction, 1,387,000 units had been sold, against 1,014,000, and the total units sold had been 2,093,883 against 1,514,745, or an increase of 38 per cent. Against this increase the cost of production had also been smaller, for the cost of management at the works had been less. The expenses of management had been £250 lower, and he thought the Council would agree with him that it reflected the greatest credit upon the engineer, who had held his present position only 15 months.

**Wood Green.**—An enquiry has been commenced by Mr. H. Ross Hooper, M.A., into the application of the District Council to borrow £43,200 for purposes of electric lighting. The proposed scheme includes the erection of an electricity generating station on the Moat House site, Wood Green. Mr. Hawtayne said the supply would be on the continuous-current system, and the estimated cost of the scheme would be £43,175. The total revenue resulting from the scheme was estimated at £7,116, the total works cost £3,940, leaving a gross profit of £3,176. The interest on sinking fund absorbed £2,592. There would be 50 arc lamps, and they had the right to use the tramway company's poles for their lighting purposes. In cost the estimated price would be 2·25d. per unit, but as the scheme grew the cost would be materially reduced. In Ilford a considerable profit had been made on a similar scheme, and he considered Wood Green was beter suited for a scheme of that sort than Ilford. Each lamp would consume 16 units per lamp, which was a very low estimate for London. He allowed for house connection £6 per house, and for meters £2, which included the cable connection. After further evidence the enquiry was adjourned until Wednesday, June 8.

**Italian Exhibition.**—While it is some years since anything like the pleasant and artistic transformation of this year has taken place at Earl's Court, the exhibition is unique owing to the fact that arts, commerce, and industries of Italy are most successfully represented in this exhibition, which has been organised under the auspices of the Italian Chamber of Commerce (London). As a special feature of this year we must mention the excellence of the official publications, due no doubt to the press manager, Mr. H. J. Thompson. The old theatre has been entirely transformed, re-wired and relighted by many large standards imitating gas lamps, but bearing powerful incandescent lights. Electricity enters into most of the entertainments. Fine effects are obtained in the lighting of the blue Grotto of Capri. A serviceable little apparatus is used for controlling and dimming the aurora borealis in the reproduction of a scene of the Abruzzi Polar Expedition, entitled "Farthest North." The Roman Forum next to it is particularly interesting. Entirely due to electric stage effects are the graceful entertainments shown under the names of the electric butterflies and the electric fountains of Milan respectively. Radium has a tent to itself. The electrophone and the electric launches are still to the fore. Sir Hiram Maxim's flying machine, the theatre, and a number of other attractions make it impossible to take all in at one visit.

**Batley.**—We have received the following figures relating to the Corporation electricity department: "(1) Analysis of accounts for period from Aug. 1, 1903, to March 31, 1904—capital expenditure at end of year, £28,609. 1s. 4d.; revenue from electricity supply, £1,403. 17s. 11d; revenue from other sources (meter rents, etc.), £9. 4s. 2d.—total revenue, £1,413. 2s. 1d.; total costs, £1,206. 12s. 3d; gross profits before providing for interest, £206. 9s. 10d.; percentage of gross profits to capital, ·72 per cent.; deficit of £864. 8s. 4d. after providing for interest; interest on loans, less interest receivable, £1,070. 18s. 2d. (2) Analysis of costs—generation and distribution costs: coal, £473. 8s. (·59d. per unit); oil, waste, engine-room stores, £37. 16s. 6d. (·05d.); wages of workmen, £352. 12s. 11d. (·44d.); repairs and maintenance of buildings, etc., £12. 12s. 2d. (·02d.)—total works costs, £876. 3s. 7d. (1·11d.); general costs—rents, rates, and taxes, £88. 16s. 10d. (·11d.); management expenses, £241. 5s. 10d. (·30d.)—total costs, £1,206. 12s. 3d. (1·52d.). (3) Supply records—number of 8-c.p. lamps connected at end of year (arcs, incandescents, motors, equivalent in 8 c.p.), 5,484; number of units sold—private supply, 31,917; public lighting, 14,378; traction supply, 14,376—total, 190,011; units sold per 8-c.p. lamp (connections during year averaged), 13; maximum load on feeders, 305 kw.; load factor, 14·5; capacity of dynamos at end of year, 450 kw.; average price obtained—private supply (power 1·55d., light 4·34d.), 2·71d.; public lighting, 2·4d.; traction supply, 1·5d.—total supply, 1·78d."

**Stepney.**—We deal elsewhere with the reduction in prices for current just agreed to by the Borough Council. The Works Committee in their last report stated: "There were 150 15-ampere arc lamps in lighting to March 31, 210 to June 30, and 240 to December 31. The cost of the current for the 12 months was £3,952. 12s. 1d., being equal to £18. 19s. 1d. per lamp. The cost for maintenance during the same period amounted to £1,258. 14s. 10d., or £5. 11s. 5d. per lamp. The total cost, therefore, of electric lighting by a 15-ampere arc lamp is £24. 10s. 6d. per lamp per annum. There were 20 10-ampere lamps in lighting throughout the year. The cost for current was £262. 11s. 7d., or £13. 3s. per lamp. The cost for maintenance being £5. 11s. 5d. per lamp, the total cost of lighting by a 10-ampere lamp is £18. 14s. 5d. per lamp per annum. There were six half-ampere Nernst lamps from February to July 31, and 24 from July to Dec. 31. The cost for current amounted to £41. 16s. 9d., this being equal to £2. 7s. 6d. per lamp. The cost for maintenance was £40. 4s. 3d., which included 16 16-c.p. incandescent lamps that were in lighting up to the end of July. Since the incorporation of the Council 125 arc lamps had been erected in Commercial-road, Mile End-road, and Burdett-road. The annual cost of lighting and maintaining is about £3,065. It is generally admitted that the lighting of these roads was anything but perfect under the old system of gas lighting, which cost the local authorities something like £900 per year. The cost per candle-power for an electric arc lamp was about one-third the cost of gas of the same candle-power; moreover, there was no disputing the fact that electric light is a more cleanly illuminant, consequently a much more healthy light than that of gas."

**York.**—The accounts of the Electric Lighting Committee for the year ending March 31 last show that the total expenditure has been as follows: buildings, £21,019; machinery, £34,294; accumulators at generating station, £3,393; mains (including services), £32,504; transformers, motors, etc., £4,133; meters, £3,113; electrical instruments, £480; miscellaneous (including parliamentary expenses), £581—total, £99,519. Up to March 31 the amount received in loans and mortgages was £92,926, and the sinking fund contributions amounted to £3,570—total, £96,496. The balance due to the treasurer on March 31, 1903, was £2,401; to that is added for year ending March 31 last a sum of £1,169, being a total of £3,570. Deducting the latter amount from the £6,593 owing on capital, leaves a sum of £3,022 due to the treasurer. The balance-sheet is as under: liabilities—to loans, £92,926; sundry creditors (revenue), £965. Treasurer—owing on capital, £6,593; ditto revenue, £2,254—£8,848; sinking fund accumulations, £3,570—total, £106,310. Assets: By expenditure on capital, £99,519; sundry debtors (revenue), £3,013; stores on hand (revenue), £206; sinking fund accumulations, £3,570; deficit balance on reserve fund account, 14s. 5d.—total, £106,310. The quantity of electricity generated during the year was 924,263 Board of Trade units, of which 811,027 were accounted for. The public lamps lighted included 66 arcs, 8 incandescents, and enclosed arcs. The sale of current realised £8,685, being £7,528 from private consumers and £1,162 for public lighting. The total income for the year was £9,112, and the working expenditure was £4,962, leaving a balance to be transferred to net revenue account of £4,149. Of this balance £3,799 is required to meet interest and sinking fund contribution, leaving a surplus balance of £350, which has been transferred to reserve fund account and used for wiping out the deficit of £351 at March 31, 1903. By this means the deficit balance is reduced as at March 31 last to 14s. 5d. The amount of capital expenditure last year was £25,462, being £11,814 on buildings, and £13,374 on machinery, and £273 on accumulators at generating station.

**Sheffield.**—The following figures are available of the last year's working of the Corporation electric supply department: Income was £57,100. 10s. 9d.; total cost of generation, distribution, and management, £18,097. 10s., leaving a gross profit of £39,033. 0s. 9d., out of which interest on the capital borrowed absorbed £21,969. 3s. 10d., and the instalment of sinking fund for the extinction of loan indebtedness £11,603. 10s. 4d., leaving a surplus after covering all charges of £5,430. 6s. 7d. The surplus for the previous year ended March, 1903,

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amounted to £6,533. 15s. 6d., and in the year 1901-2 the surplus was £5,604. The gross profits, however, are much larger than in the previous or any preceding year, and their reduction to a smaller net surplus is due to the growth of interest charges and the very much heavier sinking fund instalment (£11,603, as compared with £6,060). Over £120,000 has been spent in the year under review, bringing the total capital expenditure to £740,943 up to date, and this expenditure must continue until the new power-house at Neepsend is completed and while the business is growing. The surplus earned during the year has been added to the previously accumulated surpluses, and the accounts show a total available surplus of £21,002. The total output during 1903-4 was 3,980,049 units, against £2,919,722 units in 1902 3, and with this larger output there was a reduction all round in the cost of production per unit, both as to cost of coal, of wages of workmen, of repairs and maintenance of plant, buildings and mains, and of general management expenses. The saving on coal alone amounts to no less than 18 per cent., or over £1,000 in the coal bill, and is said to be due to a large extent to the patent hot-air arrangements which were introduced on the boilers about a year ago. The number of units sold continues to grow, and has reached nearly four millions in the year under review, against under three millions in the previous year, and about 2¼ millions in 1901-2. The equivalent in 8-c.p. lamps installed has risen from 169,000 in April, 1902, to 275,000 in March, 1904. The minimum supply at the beginning of August last year was over 60,000 8-c.p., and the maximum at Christmas was nearly 115,000 8-c.p. lamps.

**Birmingham.**—An enquiry has been held into the Corporation's application for sanction to borrow £447,129. In 1902 the sanction was obtained to a loan of £251,974, which included £128,890, the cost of the erection and equipment of a new generating station, and only £84,196 of the sum sanctioned has been expended. The Corporation's application stated that the sanction with regard to the balance should be cancelled and the new and larger loan granted. In 1906 an extensive system of tramways will come under the control of the Corporation, and in 1911 the whole of the tramways will come into their hands. There is also an increasing demand for current for private lighting and other power purposes, and the present works are taxed to the utmost. The last report of the Electric Supply Committee is considered the most favourable and satisfactory report the committee have presented to the Council since the inauguration of the undertaking. It states that during the last year there has not been any hitch or breakdown in the conduct of the works. The works and plant had been maintained in a high state of efficiency, and the result of the year's working had been the largest they had hitherto obtained. They had sold 4,367,164 units compared with 3,737,419 in the preceding year, an increase of nearly 17 per cent. as compared with increases of 10 per cent. and 11 per cent. for the two preceding years. There was an increase of 234 new consumers, an addition of 12,000 lamps of 16 c.p. or their equivalent, and an extension in the mileage of the system of over 5¾ miles. The committee had felt for some time that the cost of production and distribution, which had hitherto stood at 2d. per unit, was a somewhat high figure. As the result of several improvements in the working and other directions which had been suggested by the engineer, the cost had been reduced this year to just under 1¾d. per unit, and as several other improvements were in progress they hoped that the figure would be still further reduced during the current year. Although there had been an increased output they had made a saving of nearly £1,000, or nearly 10 per cent. on the coal bill, owing to the decreased consumption, prices being equal. Other savings were £1,000 under the heading of repairs and maintenance and renewal of works and £200 under distribution. Had it not been for the reduction in price last July the gross profit would have been larger. As it is, it amounted to £36,939. The charges for interest on sinking fund were £26,527, leaving a net profit of £10,412. 4s. 7d. as compared with £6,788 8s. 1d. last year. The whole of the surplus is to be carried to the reserve fund, making the balance to its credit £37,613.

**Dundee.**—The accounts of the electricity department for the period recently closed show a successful year's working. For the 12 months 300 000 units more than last year have been generated at the station, and that at a slightly less cost. The revenue shows an increase of £4,000, of which sum £600 has been derived from the tramways and the balance having accrued from the development of the electric lighting and power system in the city. The total revenue for the year in the electricity departments was £27,226. Of this sum £14,377 was derived from private lighting, against £12,600 for the previous year; £1,335. 4s. 4d. from private motors, as against £554; £1 055 from public lamps, as against £1,026; and £10,448. 17s. 5d. from tramways, as against £9,859. The expenditure totalled £18,127; generation of electricity cost £10,136; distribution, £4,288; rents and taxes, £2,438; and management, £810. A balance of £9,098 was carried forward to the net revenue account, and after meeting interest and sinking fund there remains on hand a surplus on the year's working of £23. The estimated revenue for the current year is £27,588, made up as follows: private lighting, £16,000; private motors, £1,500; public lamps, £1,065; tramways, £9,000. The expenditure on generation is estimated at £10,600; on distribution, £3,000; on rents, taxes, etc., £2,520; on management, £950; and on interest and sinking fund, £9,900, making a total estimated expenditure of £27,420, and bringing out an estimated surplus of £168. 15s. 4d. The reduced revenue estimated from tramways is framed on the basis that 1½d. instead of 1¼d. per unit will be charged for current used for that purpose. In view of the state of the accounts, it has been resolved to recommend the Council to sanction an arrangement providing for the supply of the tramways for traction purposes at 1½d. per unit. The rate at present charged is 1¼d. per unit, concerning which the statement has frequently been made that it is excessive, and imposes an undue burden on tramway finance. The difference of rate now proposed to be charged represents a saving of £1,200 per annum on the tramway accounts. In regard to the finances of the electric department, it should be stated that the capital expenditure shows no increase compared with last year, the cost of the extensive alterations which have been made having been met out of revenue and reserve fund. On Saturday the Council paid a visit to the electric station to inspect the alterations and improvements which have been made and are being carried out in that establishment. Before leaving a minute was framed and signed by the members, in which they recorded their appreciation of the vast improvement in the engine-room and their satisfaction that in this and other respects the whole work had been so creditably done by the staff. The electricity department's breakdown squad recently had a surprise turn-out in order to test their alacrity and readiness to take duty in cases of urgent emergency. Two electricians, along with the "town ladder" vehicle, were summoned to a supposed breakdown in the centre of the city, and in 90 seconds the horses were yoked and the squad was dashing at top speed to the scene of the "accident."

**Bermondsey.**—At the last meeting of the Borough Council a recommendation from the Housing Committee was submitted that, subject to an estimate being submitted by the Finance Committee, the electric light be installed in the staircases and courtyards of the Council's houses upon the Fulford-street area, at an estimated cost of £260; also that tenders be invited by advertisement for the work being done, such tenders to be referred to the committee for consideration and report. The estimate of the electrical engineer, upon which this recommendation was based, showed that the wiring and fittings for the tenements would cost £1,069 and the staircases and courtyards £238. This would allow one point two 8-c.p. lamps in each living-room, one point one 8-c.p. lamp in each bedroom and in each scullery, making a total of 715 points for the whole of the tenements—viz., 25 one room, 165 two rooms, and 45 three rooms. The lamps in the living-rooms could be used singly or both at one at will. For the staircase and courtyard were included one point one 8-c.p. lamp on each landing, making a total of 60 points on the whole of the blocks, and six points 12 16-c.p. lamps for the courtyard. In addition to the sum already mentioned, £1,000 would be required for slot meters, making a total estimated expenditure of £2,307. The committee did not think the tenants would use the electric light if it was installed, hence they did not recommend the installation of electricity in the rooms. The recommendation was adopted. An amendment to the effect that the Council instal the electric light all over the buildings was defeated, it being argued that the £2,307 estimated for the 235 tenements worked out at 2d. per week, and that this extra amount would make the rents too heavy for the persons for whom the dwellings were specially erected. At the same meeting the Electric Lighting Committee presented an estimate of expenditure for the ensuing year, showing a total of loans authorised for the undertaking amounting to £45,660, of which £2,700 was at 3¼ per cent and the remainder at 3½ per cent.; the amount repaid was £124. The expenditure on capital account was £69,266. This sum included land £2,925, buildings £8 999, machinery £10,844, accumulators £2,058, mains (including cost of laying the mains and services) £37,185, meters £1,156, electrical instruments £1,832, general stores £957, artesian well £2,011, water-softening plant £94, printing, advertising, furniture, tools, and miscellaneous expenditure making up the balance. The receipts, including the loans mentioned, were £45 880, the balance being overdrawn in anticipation of further loans. £23,385. The expenditure was £5 820, with a further amount of £2,154 carried to net revenue account. The income included £3,964 from sale of current, £3,065 for public lighting, wiring consumers' premises £755, water supplied to destructor from artesian well, rentals, sales, etc., making up the total of £7,974. During the years 1902-3-4 985,253 Board of Trade units were generated, of which 318,272 were sold for public lamps and 524,529 to private consumers, 89,176 used on the works, and 53 286 units not accounted for. The number of arc lamps increased from 71 in 1902 to 132 in 1904, and the incandescent lamps from 142 to 381. The total maximum supply demanded increased from 84 kw. in 1902 to 320 kw. in 1904. The amount estimated as required for the year ending March 31, 1905, is £10,239, including £2,884 repayment of loan and interest, and the estimated income £12,091. The income for the past year was £7,974, being £954 more than was estimated. The estimates were approved without dissentient, and also the recommendations to continue the existing scale of charges and to create a reserve fund, to which £500 of the surplus be transferred and invested in London County Council stock.

## PROVISIONAL PATENTS, 1904.

MAY 17.

**11284. Improvements in counterweights for electric light fittings and the like.** Hugo Hirst and John Hillery Collings, 71, Queen Victoria-street, London.

**11288. Improvements in electric accumulator electrodes or plates.** Albert Ricks, 28A, Verlaengerte Wilhelmstr., Gross-Lichterfelde, near Berlin, Germany.

**11350. Improvements in and relating to means for indicating when the supply of a predetermined amount of electric current is being exceeded.** John Roberts, 18, Southampton-buildings, Chancery-lane, London.

**11359. A damping arrangement for the index vibrations of electrical measuring instruments.** Adalbert Fleischmann, 6, Lord-street, Liverpool.

**11363. Improvements in or relating to apparatus for use in the distribution of alternating currents.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

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**11364. Improvements in or relating to alternate-current distributing systems.** Charles Hesterman Merz and Bernard Price, 46, Lincoln's-inn-fields, London.

**11368. Improvements in electric switches suitable for use in connection with telephonic apparatus and for other purposes.** Edward Alfred Graham, 46, Lincoln's-inn-fields, London.

MAY 18.

**11390. Improvements in hangers for suspending overhead trolley wires or other conductors of electric current.** Henry Brecknell and Brecknell, Munro, and Rogers, Limited, Thrissell-street, Bristol.

**11405. An automatic electric switch for the intermittent lighting of electric lamps or groups of lamps.** Charles Thomas Pounsford and Frederick Thomas Love, 47, Sefton Park-road, St. Andrews, Bristol. (Complete specification.)

**11409. An improved system for regulating and varying the speed in direct-current motors.** Harold Vincent Bowen and Charles Henry Schill, 17, St. Ann's-square, Manchester.

**11439. Improvements in or appertaining to incandescent electric lamps.** Dennis Joseph O'Brien, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, May 25, 1903, being date of application in United States.) (Complete specification.)

**11443. Improvements in electrical ignition apparatus for internal-combustion engines.** John Leighton and Robert Hacking, 24, Southampton-buildings, Chancery-lane, London.

**11444. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11447. Improvements in dynamo-electric machines.** The British Thomson-Houston Company Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11448. Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11465. Improvements in and relating to electric arc lamps.** Ignace Hippolyte Hegner, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**11470. Improvements in or connected with the poles or electrodes of electrolytic apparatus and the like.** George Jones Atkins, 115, Cannon-street, London.

**11471. Improvements in dynamo-electric machines.** Siemens Bros. and Co., Limited, Patent Department, York Mansion, York-street, Westminster, London. (Siemens und Halske Actiengesellschaft, Germany.) (Complete specification.)

MAY 19.

**11491. Electric light fog signal.** Rowland Payne Skinner, 5, Alcester-road, Abbeydale, Sheffield.

**11522. Improvements in commutator brushes.** The Morgan Crucible Company, Limited, and Charles William Spiers, 4, South-street, Finsbury, London.

**11525. Improvements in magnetic compasses.** George Charles Lilley, Billiter House, Billiter-street, London. (Complete specification.)

**11531. Improvements in and relating to electric controllers or switches.** The British Thomson-Houston Company, Limited, and Archibald Hannard Cubitt, 83, Cannon-street, London.

**11532. Improvements in and relating to prepayment meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The Allgemeine Elektricitäts-Gesellschaft, Germany.)

**11542. Apparatus for transforming a single-phase alternating current into single-phase or polyphase alternating current of lower frequency.** Johann Sahulka, 55, Chancery-lane, London. (Complete specification.)

**11545. Improvements in induction coils.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

**11568. Improvements in or relating to electric current switches.** James Hall and Arthur Hackblock, 37, Essex-street, Strand, London. (Complete specification.)

**11571. Improvements in and relating to apparatus operable by thermostatic instruments and the like.** Paul Hensel, 27, Chancery-lane, London. (Otto Rennert, ——.)

**11572. Improvements in and relating to thermostatic indicators.** Paul Hensel, 27, Chancery-lane, London. (Otto Rennert, ——.)

**11573. Improvements relating to thermostatic indicators and in thermostatic systems.** Paul Hensel, 27, Chancery-lane, London. (Otto Rennert, ——.)

**11574. Improvements in electrical thermostatic apparatus and similar instruments.** Paul Hensel, 27, Chancery-lane, London. (Otto Rennert, ——.)

MAY 20.

**11595. Knocking off finger arrangement for electric slubbing intermediate and roving frames at any part of the lift.** Edward Goulding, 59, Church-street, Castleton, near Manchester.

**11604. Improvements in dynamo-electric machines.** Leonard Wilson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 1, 1903, being date of application in United States.) (Complete specification.)

**11607. An improved method of electromagnetic meter control which can be operated from a distance.** Harold Birdsall Bullingham, Rockbeare, Robinson-road, Tooting.

**11649. Improvements in or connected with incandescent gas, acetylene and electric arc lamps.** Hermann Winkler, 4, South-street, Finsbury, London.

**11650. Improvements in or relating to incandescent gas, acetylene, and electric arc lamps.** Hermann Winkler, 4, South-street, Finsbury, London.

**11651. A portable insulated support for double-wire electric lines.** Albert Collet, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, Aug 4, 1903, being date of application in France.) (Complete specification.)

**11665. An improved distributing switch, chiefly designed for use in high-tension electric ignition gear for multiple-cylinder explosion engines.** Louis Alexandre Gianoli, 11, Southampton-buildings, Chancery-lane, London.

**11688. Improvements relating to electric telegraphy.** Alexander Muirhead, 323, High Holborn, London.

MAY 21.

**11710. Improvements in or relating to switches.** Frederick Michael Green and George Hallam, 18, Hertford-street, Coventry.

MAY 24.

**11777. Improvements in or relating to electrical tumbler and like switches** Mark Lawton and Henry Whitmore Whetson, 24, Temple-row, Birmingham.

**11814. Emergency automatic safety cut-out for overhead electric traction line wires.** Fred Ainsworth, 479, Walmersley-road, Bury, Lancs.

**11831. Improvements in gas or vapour electric apparatus.** Max von Recklinghausen, Westinghouse-buildings, Norfolk-street, Strand, London.

**11832. Improvements in gas or vapour electric apparatus.** Max von Recklinghausen, Westinghouse-buildings, Norfolk-street, Strand, London.

**11842. Improvements in apparatus for lighting railway vehicles by electricity.** Henry Wright, 24, Southampton-buildings, Chancery-lane, London.

**11848. Improvements in electric igniters for explosion motors.** Wilhelm Sander, 56, Ludgate-hill, London. (Complete specification.)

**11857. Improvements in and relating to electric switches.** Frank Stevens, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11862. Improvements in and relating to electric arc lamps.** Herbert John Haddan, 18, Buckingham-street, Strand, London. (Firm trading as Allgemeine Beleuchtungs und Heizindustrie Actiengesellschaft, Germany.) (Complete specification.)

MAY 25.

**11873. Improvements in electrical motor starting switches.** Ughtred Horsfall, Joseph Crowther, and Arthur George Brown, 49, Deansgate, Manchester.

**11880. Improvements in magneto-electric generators.** Albion Motorcar Company, Limited, and Thomas Blackwood Murray, 121, West George-street, Glasgow.

**11884. A new or improved safety device for overhead electric conductors.** Frank Walter Hayward and Reginald Charles Fox, 23, King-street, Norwich.

**11887. Rotary switch for electrical conductors.** John Dugdill, 305, Oldham-road, Failsworth, Manchester.

**11890. Improvements in and relating to stereoscopes, electroscopes, and the like.** Alexander John Bowerman, Aldersgate-chambers, London.

**11917. A process for obtaining producer gas and electrical energy from peat.** Frederick Tynte Warburton, National Liberal Club, Whitehall, London.

**11920. Improvements in and relating to the manufacture of electrodes for electric accumulators.** Carlo Bruno, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11928. Draw-off water-tap for electric filters.** Marius Otto, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11930. Improvements in alternating-current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11931. Improvements in electric locomotives.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11932. Improvements in vapour generating apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11933. Improvements in electric rheostats.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11943. Improvements in electric miners' safety lamps.** John Price Rees, 322, High Holborn, London.

MAY 26.

**12017. Improvements relating to electric switches.** John Barye Rankin Swan, 7, Southampton-buildings, Chancery-lane, London.

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**12020. Improvements in magnetic ore separators.** Henry Charles Jenkins, 18, Southampton-buildings, Chancery-lane, London.

MAY 27.

**12056. Improvements in electromagnets.** James Watson, jun., 16, Victoria-place, Newhaven, near Edinburgh.

**12061. Apparatus for the sterilisation of water by means of an electric current.** Compagnie Française de L'Ozone, 22, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 20, 1903, being date of application in France.) (Complete specification.)

**12076. Improvements relating to lining and insulating of chambers, or cases carrying switches or fuses or both.** James Henry Ward and Meyer Hart Goldstone, 45, Dutton-street, Strangeways, Manchester.

**12082. Improvements in microphones.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London.

**12087. Improvements in prepayment electrical measuring instruments.** Frank Conrad, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901 June 24, 1903, being date of application in United States.) (Complete specification.)

**12097. Improved regulating apparatus for automatically maintaining accumulator charging currents constant.** Aktiengesellschaft Brown, Boveri, & Cie., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 16, 1903, being date of application in Germany.) Complete specification.)

**12101. A new or improved electric motor.** James Bonham, Hugh Rennie, Frank Taylor, and Kenneth John Henderson, 9, Regent-street, London.

MAY 28.

**12123. Improvements in alternating-current electric motors.** Frederick William Davies, 35, White-street, Derby.

**12136. Improvements in the manufacture of welded conduit for electric wiring.** Thomas Taylor, Parkfield, Somerville-road, Sutton Coldfield.

**12160. Improvements in means or apparatus for preventing accidents from explosions in mines, and other places wherein electrical energy is employed.** William Collins and John Morgan, 55, Chancery-lane, London.

**12187. Improvements in and connected with telephone and telegraph systems** Georg Ritter, 6, Lord-street, Liverpool. (Complete specification.)

**12188. A method of producing electric energy by the direct utilisation of the chemical energy of any suitable combustible.** Henri Tourneur, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, June 11, 1903, being date of application in France.) (Complete specification.)

**12191. Improvements in and relating to electric controllers, switches, and the like.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**12192. Improvements in brush-holders for dynamo-electric machines.** The British Thomson-Hous on Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 16, 1904.*

1903.

**9231. Electric telegraphy.** Brown.

**9531. Method of, and means for, electro-depositing metals on parabolic reflectors and analogous articles.** Alexander Round and William Round, executors of the late Benjamin James Round, deceased, and Round.

**11525. Extra-highly vibrating electric contact breaker.** Mamy.

**11529. Rheostats.** Lake. (General Incandescent Arc Light Company.)

**11545. Telegraphic punching and perforating machines.** Timm.

**11739. Coin-freed telephone apparatus.** Lake. (Sem.)

**11765. Fusible electric cut-outs.** Bill.

**12301. Electric arc lamps.** Ewart.

**12312. Manufacture of materials suitable for electric insulating purposes.** Carolan. (General Electric Company.)

**12314. Electric motor-control systems and switches therefor.** Carolan. (General Electric Company.)

**12379. Electric fire-alarms and thermo-indicators.** Hawthorn.

**12408. Dynamo-electric machines.** Parsons and Stoney.

**12838. Electric heaters.** Carolan. (General Electric Company.)

**12956. Electric switches or cut-outs particularly adapted for arc lamp circuits.** Carolan. (General Electric Company.)

**23862. Electric log recording and like apparatus.** Von Köhler.

**26776. Manufacture of incandescence bodies for electric glow lamps.** Abel. (Siemens und Halske Actiengesellschaft.)

1904.

**1676. Processes for manufacturing electrodes for arc lamps.** Blondel. (Date applied for under International Convention, Feb. 5, 1903.)

**6539. Spark arresters and extinguishers.** Zink. (Date applied for under International Convention, May 5, 1903.)

**6523. System of electric lighting especially intended for use on road vehicles.** Tolman. (Date applied for under International Convention, July 30, 1903.)

**6619. Secondary electric batteries.** Commelin and Viau. (Date applied for under International Convention, March 18, 1903.)

**7869. Power cut-out systems for electric railways.** Pieper.

**9123. Electric arc lamps.** Foster, Grote, and Ely.

**9310. Electric burglar and fire alarms.** Birkbeck. (Schwarzschild, Dodd, and Johnson.)

**9453. Electric shoes.** Gibbs. (Date applied for under International Convention, July 16, 1903.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¾-⅞ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ¼-⅜ |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | .. | 5¼-5⅜ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-106 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manur., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3¼-3⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 87-90 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | .. | ¾-1 |
| —— Non. Cum., 5 per cent. Pref. | 2 | .. | ¾-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 96-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | – | 104-108 |
| —— Ordinary | 5 | – | 10-11 |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 3 | – | 1⅜-2¼ |
| —— 5 per cent. Debentures | 100 | – | 96-99 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | .. | ¼-⅜ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¾-1⅛ |
| —— 5 per cent. Debentures | 100 | – | 74-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference | 5 | – | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | – | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 19-20 |
| —— 4 per cent. Debentures | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary | 10 | – | 14¼-15¼ |
| Telegraph Construction and Maintenance | 12 | – | 35-38 |
| —— 5 per cent. Bonds | 100 | – | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 .. | 1 | – | ⅜-½ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. .. | 100 | – | 120-125 |
| Bournemouth and Poole, Ordinary | 10 | – | 11¼-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 100-103 |
| Brompton and Kensington, Ordinary | 5 | – | 10⅜-11¼ |
| —— 7 per cent. Preference | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 .. | 5 | – | 7-7¼ |
| Nos. 30,001-30,000 | 5 | – | 7-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 xd |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 7¼-7⅜ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 103-105 |
| Chelsea Electricity Supply | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 107-110 |
| City of London, Ordinary | 10 | – | 10⅜-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | – | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref. | 5 | – | 5⅜-5⅞ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11¼-12¼ |
| —— per cent. Debenture Stock Red | 100 | – | 102-105 |
| Kensington and Knightsbridge and Notting Hill | 100 | – | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¼-10¼ |
| London Electric, Ordinary | 3 | – | 1¼-1⅜ |
| —— 6 per cent. Pref. | 5 | – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 85-88 |
| Metropolitan Ordinary | 10 | – | 19¼-20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-103 |
| Notting Hill Electric Lighting | 10 | – | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs, Nos. 1-500 (Reg.) .. | 100 | .. | 99-102 |
| Oxford Electric, Ordinary, 1-96 and 4,[illegible]-14,510 | 5 | .. | 5¼-5⅜ |
| —— 4 per cent. Debenture Stock | 100 | .. | 98-101 |
| Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-103 |
| Smithfield Markets Electric Supply, Ltd., 3rd., 1-12,000.. | 5 | – | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| South London, Ordinary | 5 | – | 3⅞-4¼ |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8-9 |
| —— 3½ per cent. Deb. | 100 | – | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4⅜-4⅞ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 4⅜-4⅞ |
| Westminster, Ordinary | 5 | – | 12¼-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,851 | 5 | – | 6¼-6⅜ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 91-94 |
| —— 4 per cent. Pref. | 100 – | 101-104 |
| —— ,, ,, deferred | 100 – | 85-88 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 – | 110-113 |
| City and South London, Consolidated Ordinary | 100 – | 50-52 |
| —— 4 per cent. Debenture Stock | 100 – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 123-126 |
| —— ,, ,, ,, '96 | 100 – | 120-123 |
| —— ,, ,, ,, '01 | 100 – | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 – | 4-4¼ |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 99-101 |
| Waterloo and City, Ordinary | 100 – | 89-92 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 5-5¼ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 – | 130-135 |
| Blackpool and Fleetwood Tramroad | 10 – | 13¾-13⅞ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1½-2¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3¾-4¼ xd |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 96-103 |
| British Columbia Electric Railway Co., Ord. Def. | 100 – | 100-103 |
| —— Ord Pref. | 100 – | 97-100 xd |
| —— Non-Cum. 5 per cent. Pref. | 10 – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 – | 102-104 p.e. |
| —— 4½ per cent. Vancouver Power Deb. | 100 – | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 9⅜-10¼ |
| —— 5 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10¼-11 |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 115-118 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2⅜-2⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 5-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 106-109 |
| —— Prov. Cert., all paid | 100 – | 100-103 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 99-102 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12¼-13¼ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 13-19 |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 – | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 – | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8-8½ xd |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11-11¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 – | ¼-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 – | ¼-1 |
| New General Traction, Ordinary | 5 – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12-12½ |
| —— 5 per cent. Cum. Pref. | 10 – | 9½-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8-9 |
| —— 6 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 101-104 xd |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,152 6 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 104-106 |
| —— Deferred Stock | 100 – | 86-89 |
| —— 6 per cent. Cum. First Pref. | 10 – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5¼ |
| —— 3½ per cent. Deb. Stock, Red. | 100 – | 98-100 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 103-105 |
| Oriental Telephone and Electric Company | 1 – | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | Receipts per | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 28 | 1,375 | 1,133 | + 241 | +12,790*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 28 | 704 | 281 | + 13 | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 28 | 35 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 29 | 1,171 | 1,131 | + 40 | + 57 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | April 23 | 268 | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | May 27 | 1,155 | 993 | + 162 | + 699 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 26 | 1,667 | 1,803 | – 136 | + 1,568 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 28 | 1,597 | 424 | +1,173 | + 921 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 22 | 1,752 | 2,089 | – 337 | – 223 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 25 | 1,384 | 963 | + 421 | + 841 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 21 | 4,357 | 3,643 | + 894 | + 5,625 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 29 | 1,192 | 990 | + 202 | + 228*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 27 | 6,202 | 5,893 | + 309 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 28 | 1,190 | 837 | + 353 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 29 | 462 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 28 | 2,526 | 2,095 | + 430 | + 1,148 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 30 | 178 | 186 | – 8 | + 264 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | May 28 | 6,693 | 6,818 | – 125 | – 2,032*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 29 | 2,675 | 2,733 | – 58 | – 2,406*h* | 6⅜ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 19 | 482 | 512 | – 30 | – 326 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 27 | 241 | 294 | – 53 | – 120 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 28 | 264 | 223 | + 41 | – 161 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 29 | 199 | 122 | + 77 | + 211*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 27 | 4,427 | 4,280 | + 147 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 27 | 1,197 | 1,037 | + 160 | | | | | | | | | | | |
| Dundee City Tramways | ,, 25 | 861 | 886 | – 25 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 28 | 942 | 741 | + 201 | + 913 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 28 | 14,993 | 14,751 | + 242 | +60,232*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Gloucester Corporation | ,, 25 | 346 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 18 | 2,624 | 2,221 | + 403 | + 842 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 24 | 1,719 | 1,262 | + 457 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | ,, 23 | 2,420 | 1,797 | + 623 | + 1,777 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 28 | 656 | 503 | + 153 | + 696 | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 25 | 207 | 253 | – 46 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 25 | 223 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 28 | 6,979 | 5,776 | +1,203 | + 4,817 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Leicester Corporation | ,, 28 | 1,603 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 21 | 10,354 | 10,416 | – 62 | + 4,472 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 29 | 1,908 | 1,663 | + 245 | + 283*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 7 | 10,728 | 8,483 | +2,245 | +22,034 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 28 | 236 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 28 | 14,712 | 12,570 | +2,142 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 28 | 139 | 69 | + 70 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 28 | 4,025 | 3,325 | + 700 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 28 | 650 | 380 | + 270 | + 1,309 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 28 | 2,387 | 1,777 | + 610 | + 1,932 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 30 | 195 | 165 | + 30 | + 82 | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 26 | 937 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 30 | 5,344 | 3,945 | +1,399 | + 5,458 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 28 | 269 | — | — | — | 7⅜ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 29 | 5,560 | 4,593 | + 965 | + 2,033 | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 19 | 953 | 938 | + 15 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 25 | 440 | 302 | + 138 | + 296 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 27 | 708 | 362 | + 346 | + 1,887 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 29 | 1,655 | 1,190 | + 465 | + 721 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 28 | 880 | 724 | + 156 | + 373 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 26 | 1,247 | — | — | — | 1⅜ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 26 | 972 | 482 | + 490 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Faraday House.**—Commencing yesterday, Prof. C. A. Carus-Wilson is delivering a special course of lectures to the senior students upon direct-current motor construction.

**The British Association.**—At a meeting of the York City Council it was unanimously resolved to invite the association to hold its annual meeting in 1906 at York.

**Australian Patent Law.**—It is announced that the Australian Commonwealth Patents Act has been proclaimed and is now in force, thus enabling protection to be obtained in the six States by a single patent.

**Turbines.**—At the general meeting of the German Engineers' Association it was unanimously resolved to confer the Grashof medal upon the Hon. Chas. Parsons and M. de Laval for their pioneer work with turbines.

**Radium.**—A suggestion has been advanced by Prof. Joly, of Trinity College, Dublin, that radium may be an atomic combination of radioactive products with some elements present in pitchblende, and so represent the synthesis, not the decompositions, of an element. In this connection, the experiment of an American who found the radioactive emanations of radium amalgamate with aluminium is interesting.

**Manchester Section.**—The report for its fourth session of this branch of the Institution of Electrical Engineers records an increase of 77 in the membership, the total being 549, including students, for whom a special section has now been organised. Eight meetings were held, and the attendances showed a material advance over the previous year, further evidence of the interest taken in the papers being provided by the large number of members who participated in the discussions. Several of the events were recorded in these columns at the time, including the general meeting, which concluded a successful session.

**Electrical Standardising Bureau for Canada.** The *Electrical World* of New York announces that a deputation of Canadian electrical interests has waited upon the Minister of Inland Revenue asking that the Government establish an electrical standardising bureau to be maintained independent of any other branch of the public service, and placed in charge of a qualified electrical expert, at whose disposal should be placed trained assistants and proper facilities. The delegation also asked that the law be amended so that if any device was found in the possession of anyone to prevent the proper registration of electric current, it should be *primâ facie* evidence for his prosecution and conviction.

**Birmingham Section.**—During the past session this branch of the Institution of Electrical Engineers held seven meetings and visited three large works. We chronicled some of the events at the time. The membership (all grades) increased during the year from 199 to 258, and altogether a successful session was experienced. The committee for 1904-5 is as follows: Mr. W. E. Sumpner, chairman; Mr. R. Threlfall, vice-chairman; Sir Oliver Lodge, Mr. Henry Lea, and Mr. J. C. Vaudrey, past-chairmen; and Messrs. R. A. Chattock, T. Hawkins, S. H. Holden, R. H. Housman, R. C. Jackson, J. H. McLean, R. K. Morcom, R. Orsettich, W. O. Rooper, C. E. C. Shawfield, A. M. Taylor; Mr. D. K. Morris, hon. secretary; Mr. J. K. Catterson-Smith, assistant hon. secretary.

**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on the afternoon of the 6th inst., his Grace the Duke of Northumberland, president, in the chair. Prince Albert of Monaco was elected an honorary member. Mr. Richard Bagot, Mr. W. Carrington, Mr. E. G. Fellows, Mr. W. R. Freeman, Mr. R. F. Nicholson, and the Hon. C. A. Parsons, F.R.S., were elected members. The sincere thanks of the members were returned to Dr. Andrew Carnegie, who is so intimately associated with the iron and steel industries, for his donation of £1,200 to enable Prof. Dewar and Mr. R. A. Hadfield to prosecute their joint investigation on the physical properties of steel and other alloys at low temperatures, and to Dr. Frank McClean for his donation of £100 to the research fund of the Royal Institution.

**Summer Sessions.**—The *Journal of Electric Power and Gas* (San Francisco) announces that the University of California will commence its six weeks' summer session on the 27th inst. For the scientific and engineering section the lecturers will include Sir Wm. Ramsay, Prof. Hugo de Vries, of the University of Amsterdam, Prof. Svante Arrhenius, and other distinguished scientists. This course is intended primarily for adults, and the appreciation of the students is testified to by the fact that last year no fewer than 868 enrolled themselves. In the same journal we notice that at the University of Wisconsin the Summer School of Artisans is to hold its fourth annual session, instruction being provided in electricity, mechanics, and other subjects. This idea is such a commendable one that it seems well worthy of adoption in this country, where technical institutions with well-equipped laboratories—such as the Central Technical College, King's College, etc.—lie idle during the summer recess.

**Vibration Conference.**—On Saturday last representatives appointed by electrical undertakers in Greater London attended the conference at the St. Pancras Town Hall to consider the advisability of petitioning the Board of Trade for modifications in the Electric Lighting Act so as to prevent actions being brought against the undertakers unless serious damage or nuisance be caused by vibration or otherwise, in which case it is proposed that the undertakers shall have power for the compulsory acquisition of the property affected. The Mayor of St. Pancras (Mr. T. H. W. Idris) was appointed chairman, and in opening the conference he commented upon the harshness of some provisions of the Act, instancing the suit recently brought against his Council. In that action the judge emphatically laid down that undertakers were responsible for any vibration, and that vibration of any kind must be considered a nuisance. The conference appointed a committee to formulate propositions as to the course of action to be taken, which will be submitted to a future meeting.

**Telegraphy in Persia.**—A consular report for the past year chronicles the great progress made with the construction of the Central Persia telegraph, which is to supplement the present Indo-European service on account of the increased traffic. The original main line is quitted at Kashan, where work was commenced early in December, 1902. Notwithstanding adverse atmospheric and other conditions, the line was laid to Yezd, a distance of 237 miles, at an average rate of 15 miles per week. After a short halt there, the line was proceeded with to Kerman, which was reached at the increased rate of 20 miles per week. A little more than a month sufficed to reach Bam, where the party waited for instructions as to the course to be pursued. It was finally decided to construct a single line joining the British frontier at Kuh-i-Malik-i-Sia, which was expected to be finished in two or three months. The new line will thus follow a direct route from Persia to India, instead of two sides of a triangle as with the present one. The report anticipates a valuable influence upon the territory affected in the way of stimulating commerce.

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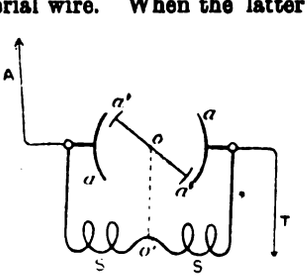
**System of Charging.**—From information to hand respecting the fight at Dundee over a new system of charging for electrical energy, it would seem that the councillors there require enlightenment. In course of time it may become the practice to admit as members of electric lighting committees only those councillors who can pass a qualifying examination in elementary mathematics. As the matter now stands, a scheme has been rejected by 14 votes to 6 which would have extended the business of the electrical supply undertaking on profitable lines. We are not very surprised that this has been so, as there has been trouble in the same direction elsewhere. We are surprised, however, to find that in Dundee Scotchmen noted for hard-headed shrewdness should fail to see the point in another matter brought up at the same Council meeting. It seems that one firm of consumers use power for motors, and treat the town mains as a stand-by only. This the Council are content should go on, in spite of the fact that they have had to incur capital expenditure to a considerable amount in order that the firm in question may take a little energy from the mains when their own plant is being overhauled. The new Electric Lighting Act will prevent such a state of affairs in the future.

**Municipal Wiring.**—We gather from the *Electrical Contractor*, which is the official organ of the National Electrical Contractors' Association, that strong opposition is to be brought next session against the London County Council's Bill for granting powers to local authorities to execute wiring. It seems that the County Council were asked to receive a deputation from the Contractors' Association on the subject, but have refused to do so. In view of this the association is going to agitate strongly against the Bill, which, it is considered, would harm their business. We are inclined to side with the contractors in this, as the wiring department of a municipal authority is likely to be open to serious objections. In the first instance, they can compete with contractors on favourable terms because of the support received from the public rates. As years go on, however, the state of affairs is not so satisfactory, as, having killed competition, work carried out by municipal employés may tend to cost more than if done by private firms. In any case, we have the curious position that the engineer to the municipal authority has to pass the work of his rivals in business, which opens the way for considerable trouble.

**American Meeting.**—We learn that the arrangements for the entertainment of the Electrical Engineers and their ladies during the visit to America are rapidly taking definite shape. In a letter communicated to us, addressed to the President by Mr. Calvin W. Rice, vice-chairman of the Electrical Congress Reception Committee, who has in hand the organisation of the details of the programme, the latter states that, in contrast to the provision made by the American Society of Mechanical Engineers for the reception and entertainment of their sister society during the first week of the current month, preparations on a lavish scale of a much more elaborate nature are in progress for the entertainment of the Institution of Electrical Engineers. The party will be taken charge of throughout their entire trip by the American Institute of Electrical Engineers, and entertainments will be organised in each city visited. Reception committees are also being formed at every stopping place, whose business it will be to take charge of the ladies of the party. Members are assured that no fears need be entertained regarding hotel accommodation at St. Louis, and rooms may be booked there weeks in advance without incurring any risk of having them on their hands in the event at the last minute of being unable to go to St. Louis, as owing to the great demand for rooms during the time of the congress cancellations can easily be effected.

**Electrolytic Preparation of White Lead.**—In a paper read before the American Electro-Chemical Society on this subject by Mr. C. F. Carrier, jun., some observations are recorded on the preparation of electrolytic white lead. The author investigated whether basic lead carbonate of the desired composition can be produced by some process differing essentially from that of Luckow, and the process of Richards and Roepper was chosen as the subject of the experiments. It consists in electrolysing a 5 per cent. solution of a mixture of one part $Na_2SO_3$ and 40 parts $CH_3COONa$ with lead anodes, a small quantity of some nitrate being added to aid the solution of the anode. With a current density of 100 to 200 amperes per $m^2$, the acetic acid anions are supposed to be decomposed at the anode, yielding $CO_2$ to precipitate the white lead, the necessary admixture of hydroxide being formed by action of the sulphite. The author found that the use of copper cathodes reduces the voltage between the cell terminals. With a current density of 100 amperes or more per $m^2$, the anode dissolves irregularly, "pitting" badly. With a solution containing enough hydroxide to precipitate white lead, spongy lead is deposited on the cathode. To prevent a large deposit of lead on the cathode, it would seem necessary to have a permanent store of $CO_3$ ions in the solution, thus making $Na_2CO_3$ or other soluble carbonate an essential constituent of the electrolyte. The solution effect of nitrates on lead, when added to the acetate solution, seems to have a higher efficiency than chlorates alone. The tendency of lead to deposit on the cathode is less with the more dilute solution.

**New Type of Receiver for Wireless Telegraphy.** A recent issue of *Industrie Electrique* contains an article by Lippmann describing a new type of receiver for wireless telegraphy, constructed by N. Vasilesco Karpen. Between two cylindrically-curved armatures, *a a* (see the accompanying diagram), is placed a moving system of aluminium consisting of the curved segments, *a' a'*, connected by a fine rod, and suspended at the point *o* by means of a quartz thread. The armatures, *a*, are connected through a coil, *s* of stout wire possessing suitable self-induction. One terminal of the apparatus is earthed, the other being connected to the aerial wire. When the latter is affected by




electrical waves, alternating differences of potential are set up at the terminals of the apparatus whose frequency is the same as that of the waves, and the needle turns in such a manner as to increase the capacity of the system. When the waves cease, the needle returns under the influence of the torsional stress due to the suspension to its position of rest. The deflections are read by means of a mirror and scale. It remains to add that the self-induction, *s*, and the capacity of the system must correspond with the condition of resonance, in order that the best results may be attained. Unlike the coherer and the magnetic receiver, this apparatus increases the wave effect, and provides a means for measuring the energy transmitted.

**The Hall Effect in the Electric Arc.**—In a paper contributed by Mr. C. D. Child to the American Physical Society the author remarks that if two carbon pencils are

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so placed in an arc that there is little or no potential difference between them, a potential difference is produced by creating a magnetic field about the arc. This may be as high as 1·5 volts. It appears to be similar to the Hall effect in metals, and if this be the case, it would show that the negative ions have a velocity enormously greater than that of the positive. The effect cannot be produced by blowing the arc to one side, nor by moving the carbon pencils to one side of the arc, rapidly reversing the field, and with each reversal reversing the connections to the voltmeter does not diminish the effect. The effect decreases with decreasing strength of the field. Changes in the current through the arc and in the length of the arc do not appreciably influence it. Putting salts in the arc diminishes the drop of potential at the anode, and it also diminishes the effect here studied. With $KNO_3$ the anode drop becomes as small as the cathode, and with it the potential difference between the two pencils becomes approximately zero. However, in a vacuum where the pressure is approximately 1cm. of mercury the effect also disappears, and here the ratio between the drop at the anode and that at the cathode is nearly the same as in air at normal pressure. With an enclosed arc the effect is the same as in air. Diminishing the pressure of air produced no great change in the observed potential difference until a pressure of 20cm. was reached. Between that and 10cm. the effect was greatly diminished, and between 10cm. and 1cm., as far as could be observed, it entirely disappeared. Though the ratio between the anode and the cathode drop is not greatly changed, they each separately decrease, the principal change being between pressures of 20cm. and 1cm. The effect, therefore, is not diminished by any change in the ratio between the anode and the cathode drop in potential, but, as far as has now been observed, it decreases when the voltage between the terminals of the arc decreases, becoming inappreciable when this becomes less than about 30 volts. No definite explanation can at present be given of the observed phenomena.

**Electrical Engineers at the Military Tournament.**—At the Royal Military Tournament last Friday evening a gala performance was given in the presence of the Duke and Duchess of Connaught, Prince Arthur, and the Princesses Margaret and Patricia of Connaught. During the evening a most excellent military tattoo was performed by the massed bands of the Guards, while the troopers of the Royal Horse Guards acted as torchbearers. The superb spectacular effect of the whole scene was, however, in a great measure due to the efforts of a small party of the corps of Electrical Engineers. After "lights out" had been sounded, lights were lowered and two powerful searchlight projectors threw various-coloured rays of light across the arena, making a gorgeous picture of the massed bands of the brigade of Guards and their escort. During this part of the performance no less than 450 soldiers, comprising bandsmen and torchbearers, were illuminated at one time by the wedge-shaped beams of the searchlights. The projectors used were those which accompanied the Electrical Engineers to South Africa during the late war, where they rendered invaluable service in various ways. The preparations for illuminating this novel performance were not extensive. Under the able direction of Captain Dumble, R.E., and Captain Phillips, the portable South African projectors were placed in position at each end of the hall, and coloured screens were hastily adapted to suit the new circumstances. It will probably be remembered that the corps, which was responsible for this part of the performance, came into existence about seven years ago. Its origin was due to the energies of the late Dr. Hopkinson, who considered that a body of electrical volunteers would be of the greatest possible use to the Royal Engineers in time of war by assisting them in all classes of work connected with electrical engineering. At the present time the corps, which is about 700 strong, is commanded by Colonel Crompton, C.B., and is mainly composed of highly-trained men, who are experts in the various branches of electrical and mechanical engineering. Thanks for this most brilliant performance are due to the management of the Gaiety Theatre, who kindly allowed Q.M.S. Applebee to assist Captain Phillips, and to Sergeant-Major Gunn, who also rendered valuable aid.

**St. Louis Exhibition.**—If British electrical exhibits at the St. Louis Exhibition are rather moderate, except those of testing, measuring, and recording instruments, and the Post Office telegraphic apparatus, this country makes an excellent show in chemistry, both on the theoretical and practical sides. This fact is illustrated by the wide range of products exhibited in this section—phosphorus, sulphur, arsenic, bichromates, copperas, alum, cyanides, and all the varied products of the acid and alkali manufactures, not to mention pure drugs and pharmaceutical preparations. The *Times* remarks that the exhibition serves as a reminder that in pure research Great Britain has taken no insignificant part, and that in one particular branch at least she still retains the predominance won more than a century ago. "La Chimie," Wurtz declared, "est une science française." When one thinks of the names of Boyle, Black, Cavendish, Priestley, Davy, and Faraday, it may be said with greater truth that the chemistry of gases has been a British science, and the British exhibits at St. Louis suggest that, in spite of notable contribution by workers in other countries, such it still remains. During the last decade five new gases have been added to the list of those contained in the atmosphere, and this addition has been made by the joint efforts of two British men of science, Lord Rayleigh and Sir William Ramsay, the latter of whom shows specimens of the new substances. During the same period Prof. Dewar has completed in the laboratories of the Royal Institution the work which was begun in the same laboratories by Davy and Faraday a century ago, and has reduced to the liquid and solid state all the "permanent" gases of the older chemists. One of the most striking exhibits at St. Louis is a reproduction, on an even larger scale than the original, of the apparatus used by Prof. Dewar for the liquefaction of hydrogen. This apparatus has been constructed to the order of the Royal Commission from designs by him, and it is to be shown in operation at frequent intervals during the course of the exhibition. Further, in connection with this exhibit a series of lectures is to be given by Mr. J. E. Petavel on the scientific work carried out on the subject from the time of Faraday down to the present, for which purpose a large quantity of apparatus has been sent over.

**Incorporated Municipal Electrical Association.** In order to remind our readers of the ninth annual convention of this association, which will be held from June 29 to July 2, we reprint the programme which appeared in our issue of April 22, with a few additions which have since been arranged. On the first day, Wednesday, June 29, the meeting will be at Derby, and will be commenced by the reception of the members by the Mayor. Mr. T. P. Wilmshurst will then give his presidential address, which will be followed by a paper by Mr. C. Shawfield, of Wolverhampton, on "The Commercial Practicability of Electric Traction by Surface Contacts"; and a paper on "The Organisation and Management of a Central-Station Meter Department," by Mr. A. J. Cridge, of Sheffield. The afternoon will be

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devoted to an excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation. The electricity works and the Osmaston-road car-shed of the Derby Corporation will be open for inspection during the convention. The meeting on Thursday, June 30, will be at Nottingham, where, after a reception by the Mayor, two papers will be read and discussed. The subjects of these are as follows: "Polyphase Sub-Stations, their Equipment and Working," by Mr. S. L. Pearce, of Manchester; "Some Notes on the Bristol Electricity Works Fire," by Mr. H. Faraday Proctor, of Bristol. In the afternoon visits are arranged to the electricity and other works, and the annual dinner will be held that evening in the Mechanics' Institute at Nottingham. On Friday, July 1, the meeting will be at Sheffield, where, after a reception by the Lord Mayor, the following two papers will be read and discussed: "Boiler-House Economies," by Mr. R. S. Downe, of Southport, and "The Financial Position of Municipal Electrical Undertakings," by Councillor Blakeway, of Southampton. The afternoon will be devoted to visits to Messrs. Hadfield's steelworks at Tinsley, and to the Corporation's tramway station, Kelham Island, and electricity works at Neepsend. The annual general business meeting, for members only, will be held at Derby on Saturday, July 2. All communications respecting the convention should be addressed to the secretary, Mr. C. McArthur Butler, Staple-inn-buildings, Holborn, London, W.C.

**The Tariff Commission.**—The commission has now held 26 sittings, the latter of these being devoted to the iron and steel, engineering, and machinery and textile trades. The witnesses included Mr. T. O. Callender (Callender's Cable and Construction Company, Limited) who gave evidence as to the manufacture of cables for electric lighting and power purposes; Mr. Alfred R. Tattersall, consulting and milling engineer; Mr. R. G. Evered, of Messrs. A. Evered and Co., Limited, who gave evidence as to the brass trade; Mr. Frederick Andrew, chairman of Messrs. Robey and Co., Limited, Lincoln, manufacturers of steam, gas, and oil engines, mining machinery, etc.; Mr. H. D. Marshall, managing director of Marshall, Sons, and Co., Limited, Gainsborough, who gave evidence upon engineering generally; Mr. W. Harrison, president of the Agricultural Engineers' Association; Mr. Graham Forester, sole agent for the Welsh Anthracite Collieries and other companies; Mr. A. K. M'Cosh, managing director of Wm. Baird and Co., who gave evidence as to the pig iron and coal trades of Scotland; and Mr. W. P. Rylands, managing director of Rylands Bros., Warrington, and president of the Iron and Steel Wire Manufacturers' Association, who has given evidence in regard to the wire industry. The questions covered by the evidence include causes of fluctuations in trade with foreign countries, the Colonies, and British possessions; increase or decrease of total net profits in relation to turnover; proportions of semi-manufactured and fully-manufactured good exported; probable effect on these proportions of an extended preferential arrangement with the Colonies; amount and continuity of employment in recent years; conditions as to the British supply of raw material; probable effect on these conditions of improvements in market organisation, improvements in means of transport, development of Imperial sources of supply; return freights and the Colonies; foreign railway rates and organisation of transport by land and water; any advantages which foreign countries have in respect of processes of manufacture; relative conditions of the different branches of each witness's trade; British and foreign methods of finance and accounting; incidence of local rates in its relation to prime cost in this and other countries; importance of technical and commercial training and higher education of all grades; causes and effects of amalgamations; proportion of different elements of cost; relative cost of production in Great Britain and foreign countries; effect of foreign and Colonial tariffs; conditions of fair competition; incidence of duties; and experiences of Colonial preferences.

**London Traffic Commission.**—The Commission last week concluded its sittings for the hearing of evidence. The first witness was Sir Homewood Crawford, the City solicitor, who remarked that the Corporation had always resisted the introduction of tramways within the City on account of the narrow and crowded streets. In regard to tube railways, the Corporation required clauses to be inserted providing for the work to be done under the supervision of its engineer, and, where possible, for the construction of subways between adjacent stations, the setting back of stations so as to provide accommodation for the extra traffic caused, and the commencement of operations within 12 months. He considered that the position in regard to the opening of streets for telegraphic and lighting purposes was still unsatisfactory, and stated that the Corporation were willing that power should vest in the Board of Trade or some similar department or tribunal to decide disputes arising out of such questions. Mr. A. C. Ellis, general manager of the Metropolitan Railway Company, stated that when the electric service is inaugurated, the company propose to run 24, and possibly 30, trains an hour on each line of the Inner Circle, and also to increase the service on the Baker-street to Uxbridge extension. Electrification would increase the carrying capacity by 33 per cent. with the service at first proposed, and would result in the purification of the atmosphere in the tunnels. Mr. E. Speyer, of Messrs. Speyer Bros., bankers, tendered evidence as to the financial side of tube railways, and stated that in the lines constructed by the Underground Electric Railways Company no cost had been spared in obtaining the latest inventions for the safety of passengers. The final witness was Mr. J. Clifton Robinson. He commented strongly upon the purchase clause of the Tramways Act of 1870 as a serious obstacle in the way of tramway development, and recommended that in any future rearrangement the term of years allowed should bear some relation to the capital outlay. Further, he specially deprecated Standing Order 22, requiring the assent of two-thirds of the local authorities before a scheme could be submitted to Parliament. He presented details of the exactions of local authorities for street widenings, which, with wayleaves, had cost the company over £20,000 per mile. The company had been compelled to abandon the main proposals of their 1904 Bill because of the prohibitive demands of the local authorities. Replying to a question, he stated that the tramways might well be continued from Shepherd's Bush as far as St. Martin's-le-Grand, and that the Strand was rapidly becoming suitable for tramways by reason of the widening operations. He favoured the appointment of a tribunal somewhat on the lines of the Light Railway Commission, but demurred emphatically to the claim of the London County Council that it should be exempt from the authority of the new tribunal. The Commission will reassemble on the 17th inst.

**Electrical Ore Finding.**—On Monday afternoon last Mr. A. Anderson, the chairman of the Electrical Ore-Finding Company, presided over a meeting of guests invited to hear a description of the Daft and Williams electrical prospecting system. We gave a description of this system in April of last year, in which the full working of the system was described (*Electrical Engineer*, vol. xxxi., p. 480). At the gathering at the Westminster Palace Hotel on Monday

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Mr. Alfred Williams first gave a description of the system and what had been done. Subsequently Prof. Silvanus P. Thompson described the experience he had had with the electrical ore prospector in and around the lead mines at Cwmystwyth, in North Wales. We need hardly say that the description of the method of working given by Prof. Thompson was exceedingly clear, and he spoke most hopefully of this method of locating ore bodies. As we have described the arrangement before, we propose here only to give a few instances in which good work has been done in this country and abroad under the skilful guidance of Mr. Williams. For instance, at Cwmystwyth indications of a conducting schute were observed over a lode which had apparently been worked out at that point. The forebreasts of the lode showed no lead, and were not being worked. The level was continued, and lead found after driving about 18ft, and at a point indicated by the waves. At Alston Moor, Cumberland, several lodes were indicated, and accompanying variations showed the presence of lead. Only one of these has been developed, and two lodes side by side exposed. On Cleator Moor hematite in irregular deposits was successfully worked on. In Western Australia, when prospecting on a mine during the last few months, a parallel lode was indicated, the existence of which was not even suspected by the management, and a cross-cut put in discovered a lode 25ft. wide. On another well-known property indications of three parallel lodes were found with marked and distinct variations. A shaft was put down on the central electrical variation, and a quartz lode found. A diamond drill bore, put in, Mr. Williams believes, horizontally, found the other two lodes. Last autumn Mr. Williams did some work on the goldfields of the Chartered Company of Siberia in the Altai, where the gold occurs in very unique and, electrically, very difficult formation, very unlike the lode-like character of the chief mining countries. The work had to be carried on in severe weather, as winter was setting in. Five indications of mineral were obtained in the receiving telephones. Mr. Gregor Meyer, the eminent Russian engineer, stated that development work on four of these places would probably prove the existence of copper; but as to the fifth, owing to a heavy deposit of subsoil, he could express no opinion. A hand-drill was erected at this point, where the waves showed a marked variation from the normal. After boring through 30ft. of subsoil and 50ft. of chloritic schist a gold-bearing deposit was found.

**Self-Cohering Receiver.**—We take from the *Electrical World* of New York the following description of the Peter's self-cohering receiver, which is described in that journal by Mr. E. Van Winkle. The author attributes a good deal of the trouble in wireless telegraphy to the want of insulation between the wave circuit and the local circuit at the receiving station, which should prevent a loss of wave energy after contact with the vertical wire. It is to overcome this defect that the Peter's receiver has been designed The local circuits are entirely insulated from the wave circuits, and yet capable of duplicating in the local circuits the electrical phenomena taking place in the wave circuit. On several occasions controllable signals have been received over a distance of three miles using only the spark of a single "Mesco" dry cell. Referring to the illustrations, Fig. 1 is a diagrammatic sketch of the receiver, and Figs. 2 and 3 represent sections of the coherer. The coherer includes two electromagnets, 1, placed in reverse with the filing gap, 2, between their ends in a glass tube, 3, sealed by insulating end plates, 4. Both electromagnets have for a core the shaft, 5, around which are placed a number of soft-iron wires secured at the gap end by a ring of soft iron, 6, which is insulated from the soft-iron ring, 7. This latter ring is the terminal of the coil at the gap end, the other terminal of the coil being the discs, 8. The wall of the filing gap is formed of the ends of the core and the insulated terminal ring of the coil, all of which is clearly shown in the illustration. The coherer is rotated by the motor shown diagrammatically. The shaft of the coherer on the left is connected to the antenna, or vertical wire, through the mercury well, 9, and the disc, 10. The other shaft is connected to the earth through the mercury well, $9^2$, and the

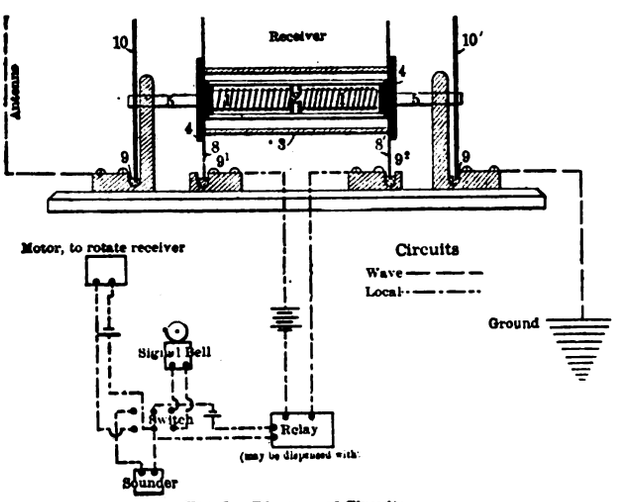
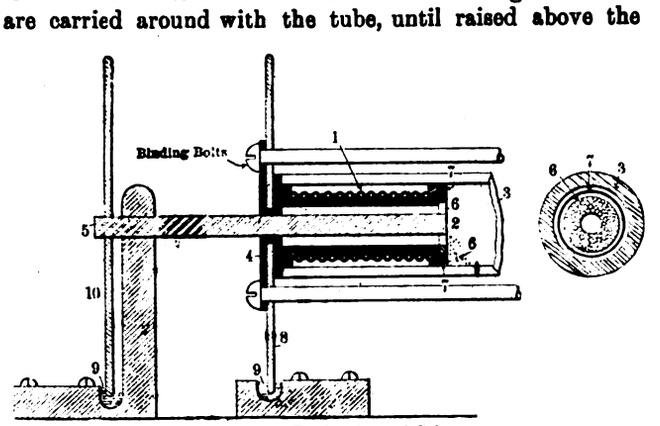



FIG. 1.—Diagram of Circuits.

disc, $10^1$. The coils of the electromagnetic are in relay or local circuit through the discs, 8 and $8^1$. The bell is in circuit when the switch is thrown to the right, and is used only to notify the operator that a message is about to be received. As soon as the filings are magnetised the bell circuit is closed through the batteries and relay, and the bell rings. The operator then throws the switch to the left, which throws both the sounder and the coherer motor in circuit; the coherer then revolves and is ready for message. The iron filings in the gap between the ends of the electromagnet should fill about one-third of the gap, or sufficient to lap the core and coil terminals at all times. When the receiver is in motion the filings as a mass are carried around with the tube, until raised above the




FIGS. 2 AND 3.—Sections of Coherer.

angle of repose, when they break away at the top, and falling over themselves reform again at the bottom, to be carried up again in endless repetition, this being the decohering process constantly maintained by the rotation of the tube. It will also be noticed that between the top of the mass where the filings break away, and the bottom where they reform, is an area of filings never disturbed with respect to their contact with the walls of the gap (coil terminals); this mass of undisturbed filings is always ready to be cohered when a wave of very high potential passes through, notwithstanding their continuous rotation. The advantages claimed for this coherer are simplicity, high speed of working, and capability of responding to a small degree of energy received.

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## LEICESTER CORPORATION ELECTRIC TRAMWAYS.

*(Concluded from page 848.)*

### Cars.

The cars are of the double-deck, single-truck type (Fig. 29), with reversed stairways. They have been supplied to the number of 59 by Messrs. Dick, Kerr, and Co., Limited, and are built mainly to the design and specification of the engineer, while they also embody the very latest improvements which this well-known firm of car builders have introduced, their construction and arrangement being excellent in every detail. The seating capacity of each car is 22 inside and 34 outside, and over-all dimensions 27ft. 6in. over fenders by 6ft. 10in. width over sills. The floor frames are built of well-seasoned oak of such sections as will ensure maximum strength with minimum weight. The platforms are supported on four steel angles, which are bolted to the underside of the main flooring. A system of truss rods is provided to keep the car bodies from hogging, and also to pull up the platforms should they show a tendency to sag The cars are mounted on 21E Brill trucks, each being equipped with two of the contractors' 25A motors (Fig. 30), rated at 25 h.p., which is the output they will give continuously for one hour if required. The controllers are of Dick, Kerr, and Co.'s type, containing a new device for extinguishing the arc which is formed every time circuit is broken. The use of the magnetic shield blow-out causes the arc to be broken practically instantaneously, and in such a manner as to reduce the burning and deterioration of the contacts to the smallest extent possible. The controllers can also be used for converting the motors into an electric brake, and should occasion arise, a car can be stopped within a very short distance, thus giving the motorman entire control and confidence in the carrying out of his work. The braking effect can be graduated, so that while a moderate application only will usually suffice, if necessary, the full effect can be applied instantaneously. A diagram of the connections to this controller is shown in Fig. 31. The wiring throughout the car has been carried out on the "Short" system. The car wheels have wrought-iron centres with steel tyres shrunk on, and were supplied by Messrs. John Baker and Co., of Rotherham. They are 31¾in. diameter. The Hudson and Bowring lifeguard has been fitted under both platforms. It is of the swinging-gate type, and under test was found to be very efficient. As the gradients in Leicester are comparatively slight, the adoption of special brakes has not been found necessary, and the usual hand and electrostatic brakes have been fitted. On several of the cars a new patent type of folding step, to be known as the "Leicester folding step," has been fitted for practical trial to meet the suggestions of the Board of Trade, who point out that the efficiency of the lifeguard is often impaired by the steps, which are liable to strike a person falling in front of the car before the lifeguard can come into action. This step is designed to fold up when the gate is closed, and is so designed

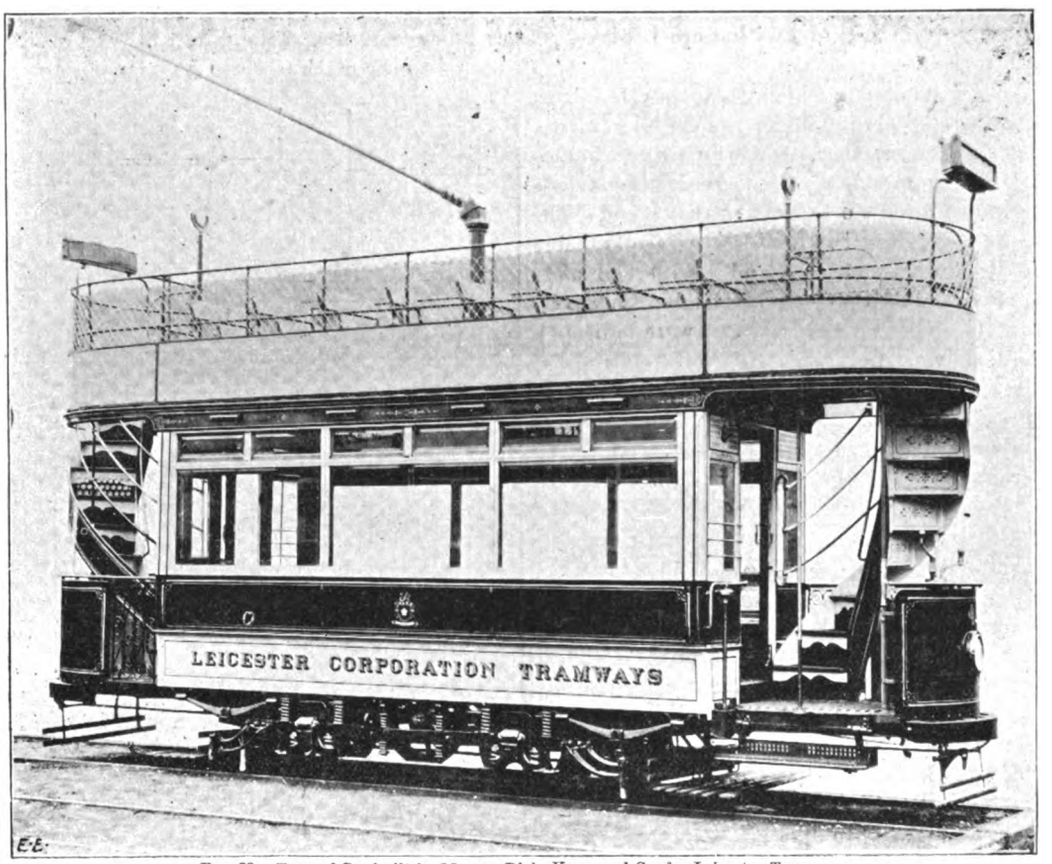


FIG. 29.—Type of Car built by Messrs. Dick, Kerr, and Co. for Leicester Tramways.

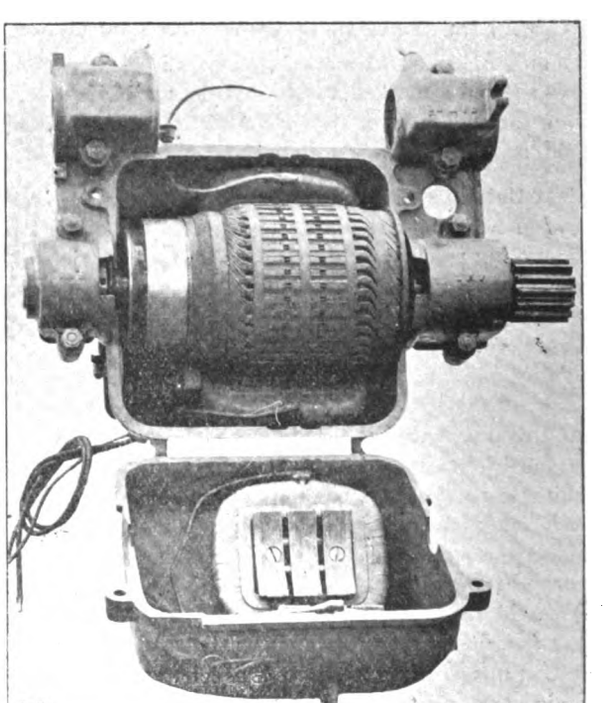


FIG. 30.—Interior of Car Motor, showing Field Coil and Armature.

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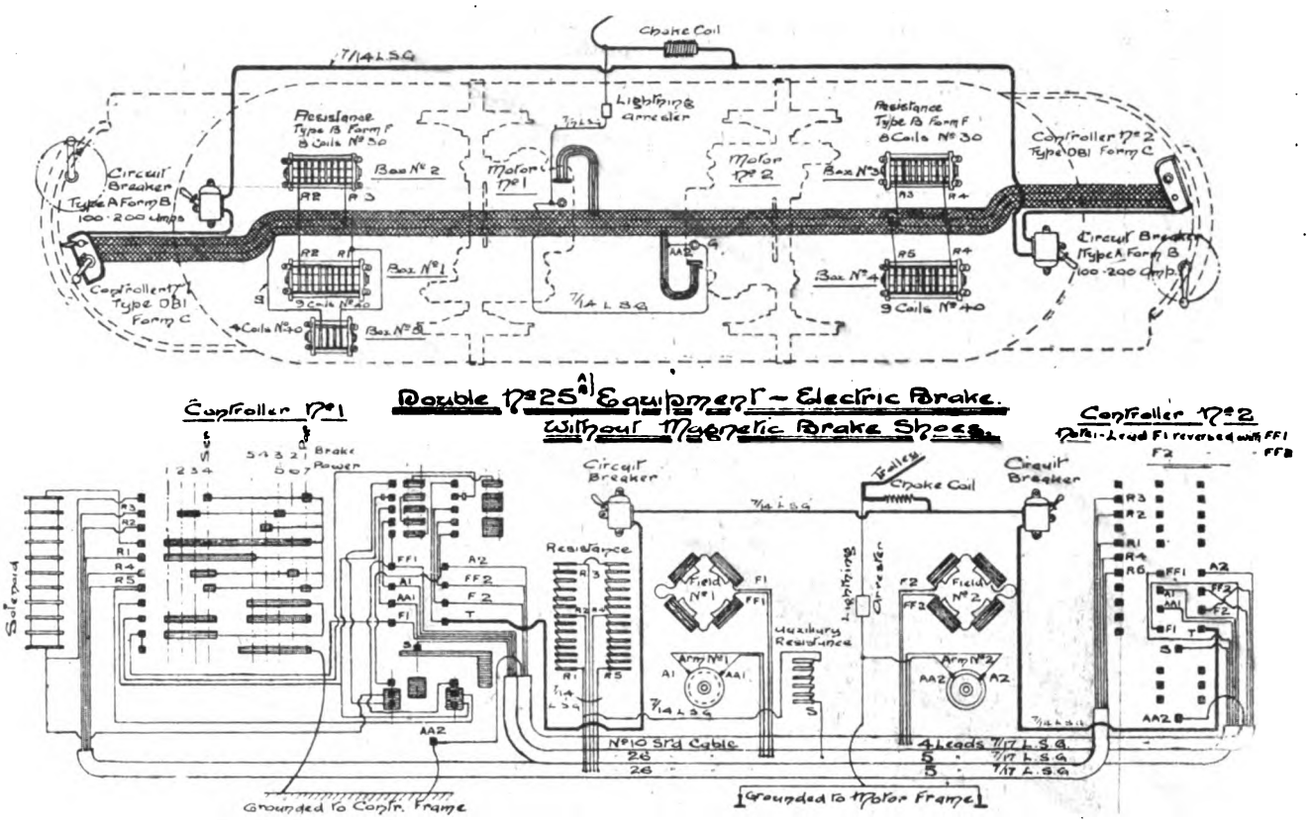


Fig. 31.—Diagram of Connections to Dick, Kerr, and Co.'s Type DB1 Controller, Form C, Leicester Tramways.

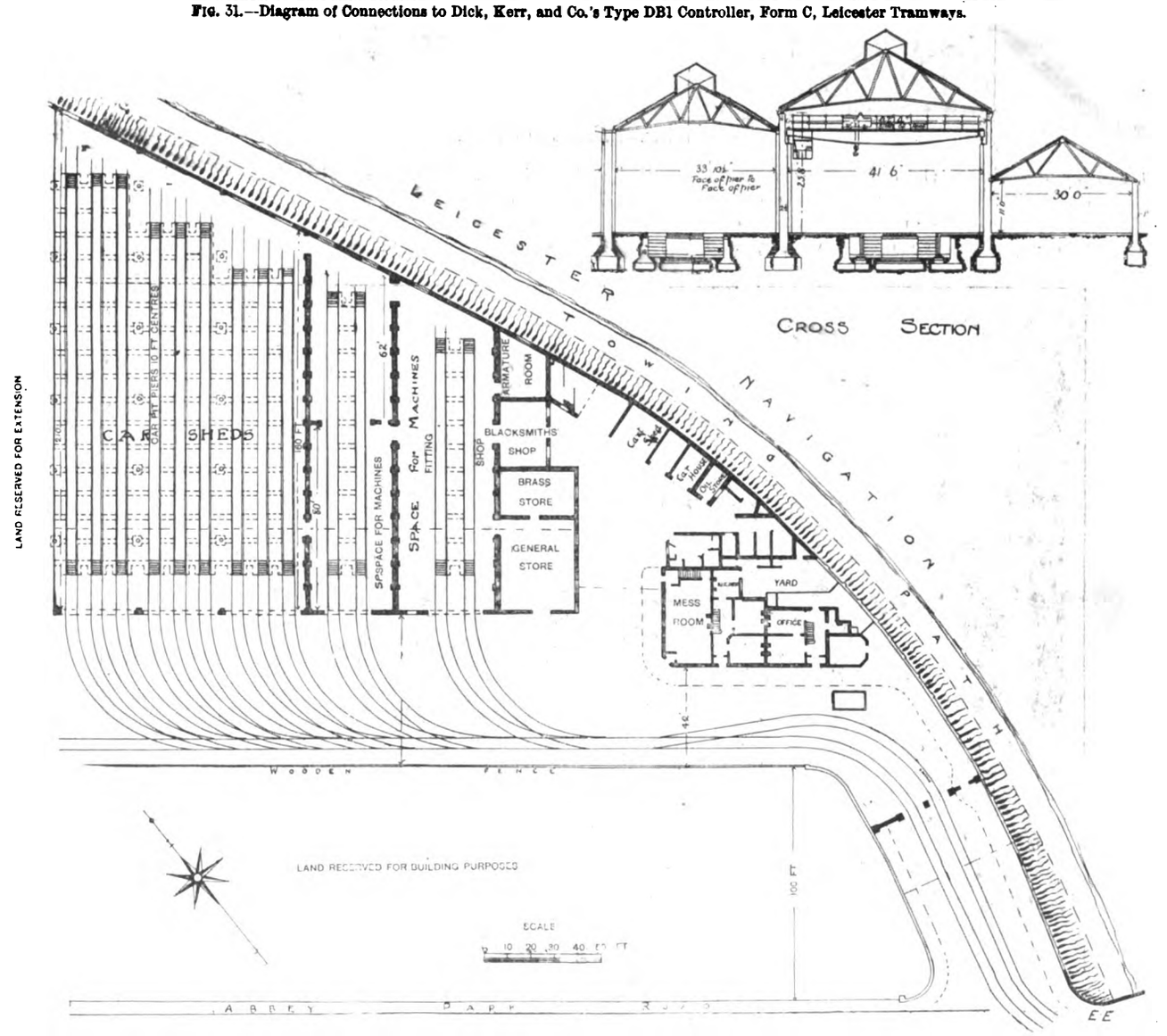


Fig. 32.- Plan and Section of Main Car Depot.

that it is practically impossible for it to be raised when the gate is open, whilst, owing to the automatic device with which it is provided, it is equally impossible to keep the gate closed without having the step raised. This

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arrangement overcomes any difficulty which might arise from passengers attempting to leave the car at the forward end before there has been time to get the step into place.

The interior woodwork of the car is of quartered oak, and the decorations of embossed and quartered oak.

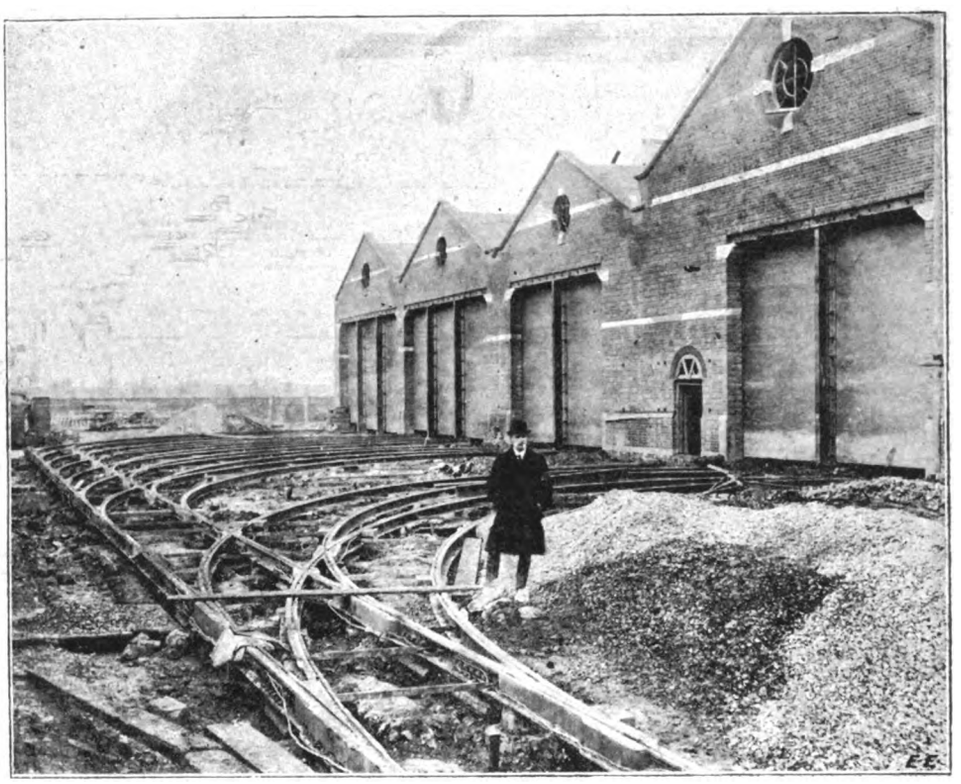

FIG. 33.—Fan at Main Car Depot.

Over the end doors there is an ornamental head-piece extending up to the underside of the roof boards, and on each side of the doors ornamental casings. The ceiling is of three-ply birdseye maple veneer, and the inside

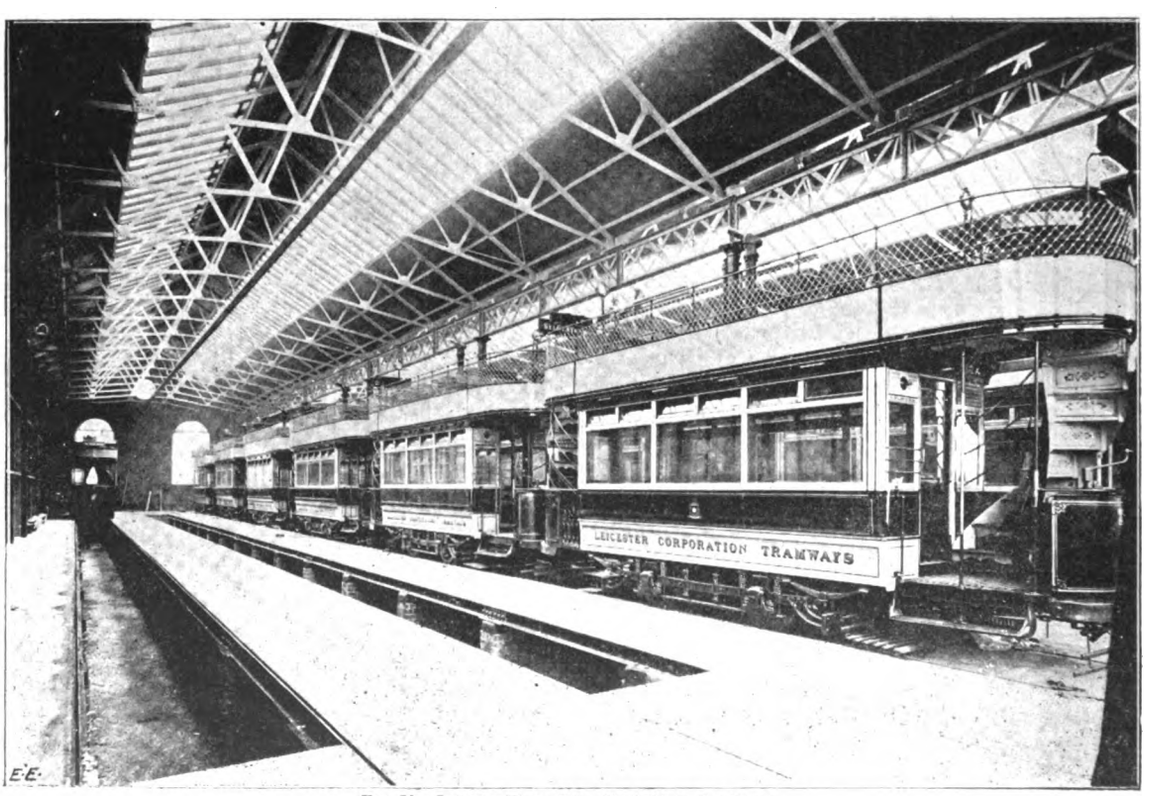


FIG. 34.—Interior View of Car Shed, Main Car Depot.

seats and backs are of three-ply perforated veneer. The seats are left bare without carpeting, as it is considered to be a more cleanly and sanitary arrangement. The windows are of ¼in. bevelled British plate glass set in rubber, and those in the end doors have the Leicester coat-of-arms engraved on them. Mirrors are fixed in the panel work over the end windows. Special means have been adopted to efficiently ventilate the interior of the cars (see Fig. 29). The effect of this construction and arrangement of ventilation is that the interior of the car is constantly provided with a circulation of fresh air, a hinged sash on each side of the end door in each end of the car being provided. These sashes can be opened in exactly the same way as the sashes at the sides when additional fresh air is required. They are also provided with perforated louvre panels, and being in the end of the car, these admit of a large supply of fresh air passing into the car without interfering with the arrangement of coloured signal lenses, and without allowing the admission

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of water in wet weather. An outlet for the foul hot air has been provided by a recess made in the roof of the car, which is just above the hinged windows. The circulation of the foul hot air to the outside is effected through this recess. On the outside of the car on each side, and connecting with this recess, are fixed ventilators, constructed in such a way that no air can pass into the car at these

of interior design and general finish, which adds very largely to the general appearance.

The top deck is fitted with special "dry" seats of the multislat type. The reversed stairways at either end of the cars are of a special improved type, by which the view of the motorman is much less obstructed than in the old form. This and other suggestions of the Board of

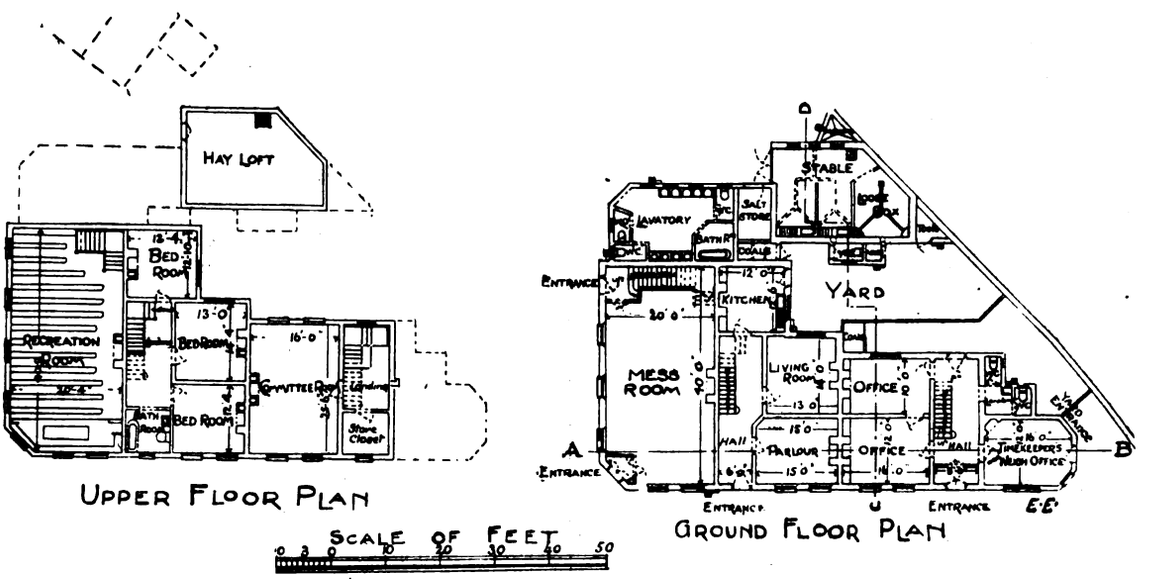


FIG. 35.—Arrangement of Offices, Mess Room, etc., Main Car Depot, Leicester Corporation Tramways.

points, but the ventilators are exhausting or drawing the hot air out when the car is running This recess not only connects direct with the interior of the car, but it also connects with the roof space between the millboard ceiling and the main deck, which in ordinary tramcars is a dead air space. If required, a further outlet for the hot air in the top of the car may be provided by perforating the millboard ceiling to connect with this space and indirectly with the ventilators on the outside of the car. This exhaustion of the air by the ventilators through the recess roof space cannot be closed, so that the escape of the foul hot air must take place continually whenever the car is in motion, and without dangerous or annoying draughts. The application of this method of ventilation lends itself to a very satisfactory treatment in the way

Trade have been complied with generally as far as possible. The cars are lighted by a number of electric lamps mounted in handsome polished brass fittings. Other lamps are erected in destination indicators, so that the point to which a car is travelling can be easily ascertained at night. Mechanical bells are used, operated by means of a brass rod running the entire length of the car, and fitted with lever handles. The bells can also be operated from either end of the top deck. The English Electric Company's route indicators on the illuminated blind principle are also fitted. The cars are painted chocolate and cream, a combination of colour which is at the same time durable and pleasing to the eye; the paint work is relieved with gilt decoration and scroll work, and the centre panel of each car bears the arms of the Corporation.

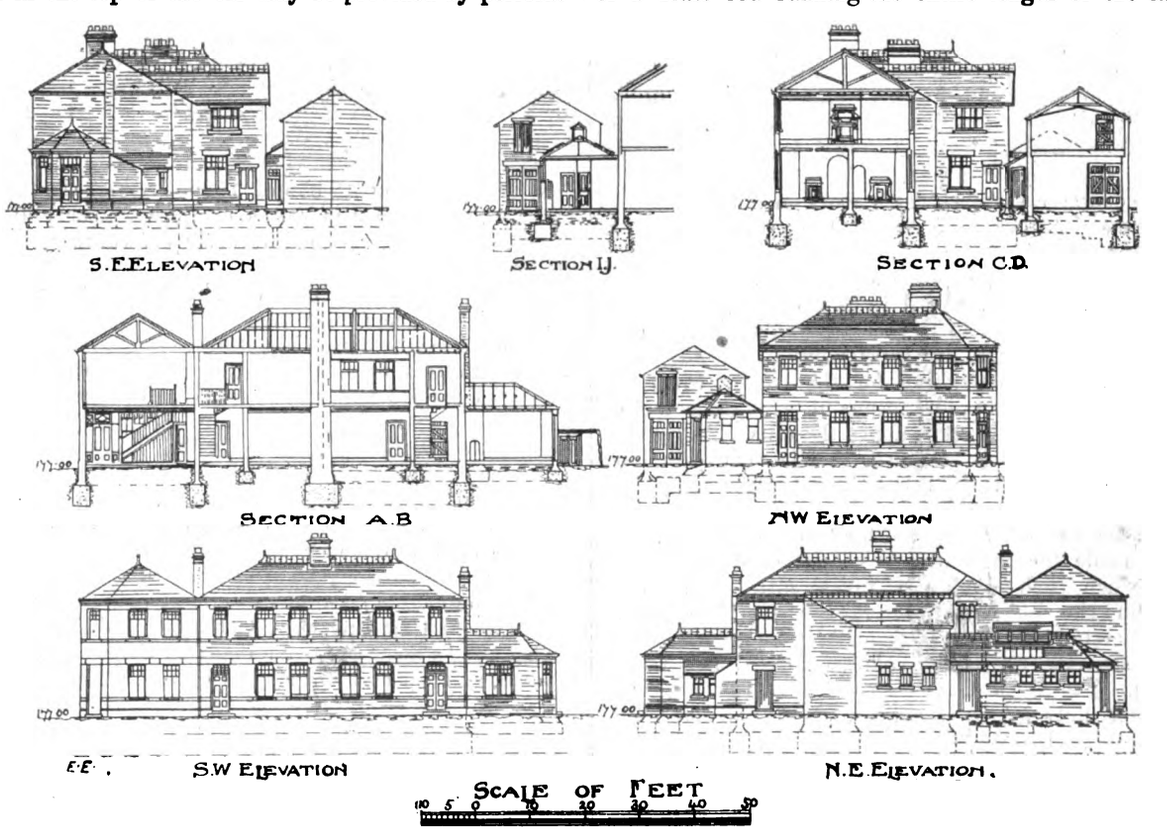


FIG. 36.—Elevations and Sections of Office Buildings, Main Car Depot, Leicester Corporation Tramways.

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### Main Car Depot, Abbey Park-road.

The main car depôt stands on a site of about 4¼ acres, acquired from the Estates Committee, and is in close proximity to the generating station. As will be seen from the plan (Fig. 32), it does not abut on the main road, a space 100ft. deep having been reserved for building purposes. It consists of the car-shed proper, fitting shop, carpenters' shop, painters' shop, armature-room, blacksmiths' shop, brass and general stores, messroom, recreation-room, caretaker's house, offices, committee-room, boiler-house, stables, car-shed, motor-house, men's lavatory, oil stores, etc. In designing this depôt special attention has been paid to the arrangement of the tracks (Fig. 33) laid into the shed with a view to getting the cars out in the morning as quickly as possible. The buildings, which have a very pleasing appearance, without any attempt at expensive artistic effect, are, like the generating station, faced with red sand stock bricks and Derbyshire stone dressings. The car-shed proper (an interior view of which is shown in Fig. 34) consists of three bays, each 35ft. 1½in. span, and containing three tracks, accommodating altogether 55 cars. This shed is 21ft. 6in. high to the eaves. The rails are supported throughout on piers, thus forming pits under the whole area, excepting for a short space at each end. These pits are 4ft. 6in. deep. The entrances to the car-shed proper and to the shops are fitted with Kinnear rolling blinds. The fitting shop averages 130ft. long, 41ft. 6in. wide, and 25ft. high to the eaves. It contains two tracks, the rails for which are supported on piers as in the car-shed. This shop will accommodate eight cars. On one side of these shops, space has been reserved for installing a complete equipment of electrically-driven machine tools, the greater portion of which are to be laid down immediately, including a 12in. and 6in. lathe, wheel-turning lathe, radial drill, etc. Provision has been made for an electrically-driven overhead crane.

The carpenters' shop is 80ft. long and 35ft. 4½in. wide, containing two pits. The painters' shop, which is an extension of the carpenters' shop, is 70ft. long. Space has also been reserved in these shops for a complete equipment of wood-working machines and the necessary benches. These two shops are divided by two Kinnear rolling blinds, and together will accommodate 10 cars, making altogether in these shops a total accommodation for 73 cars. The stores and workshops are heated throughout on the low-pressure hot-water system. This work has been carried out by Messrs. Ashwell and Nesbit, Limited, of Leicester. Both the car-shed proper and the shops are lighted mainly from the roof by means of Rendle's patent glazing. Steel casements have been inserted in the back elevation to obtain additional light. The roof trusses, as in the case of the generating station, are constructed of flat steel bars and plates, and the troughing for the trolley wires has been suspended from these by means of wrought-iron clips at an average height of 22ft. above the rails. As regards the office accommodation provided, this is very complete, as will be gathered from the enlarged plans (Fig. 35), sections and elevations of the same being given in Fig. 36. A large area has been reserved for future extension, and provision made for an entrance at the opposite end of the site when such extension takes place. The contractors for the buildings are Messrs. Hutchinson and Son, of Leicester, the steel roofs and lattice girders being let in a separate contract to Messrs. Cross and Cross, of Walsall. Two small district car-sheds have been erected on the same lines as the main car depôt, one in Narborough-road and one in London-road. Each of these contain two tracks with pits under, and will accommodate six cars; an office and small messroom is attached to each.

Mr. John Scholes has acted as clerk of works for both the generating station and the main car depôt, and Mr. A. Hardy for the two district car-sheds.

In conclusion, we have to express our indebtedness to Mr. Mawbey for his courteous assistance in the preparation of this article, as also for the loan of the numerous drawings and photographs reproduced.

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[ERRATUM.—Referring back to our issue for May 20, our attention has been directed to an inaccuracy on p. 783 in regard to the main building. Messrs. Richardson and Son were, it appears, contractors for the brickwork, foundations, etc., only, while the steel roofs were supplied and erected by Messrs. W. Richards and Son, Phœnix Ironworks, Leicester, under a separate contract with the Corporation. No doubt the error was due to the similarity between the names involved.—ED. *E. E.*]

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 745.)*

*History of Marconi's Success*.—Marconi's first trials of wireless telegraphy were carried out at Bologna, and those being successful, he came to England and applied for a patent on June 2, 1896. He submitted his plans to the Post Office authorities, and they were taken up with the greatest promptitude. His first experiments were from the General Post Office, London, to a station on a roof 100 yards away. Later there were trials at Salisbury Plain, where two miles were accomplished, roughly-made parabolic reflectors of copper being here used. In 1897 the Bristol Channel was the scene of experiments, and between Lavernock Point and Flat Holm 3·3 miles of distance were successfully negotiated. Next near Weston-super-Mare 8·7 miles—in this case the reflectors were not used. On May 11 and 12, 1897, the fate of Marconi telegraphy seemed to some observers to hang in the balance. The experiments were failures. An apparent inspiration, such as comes to the true genius, however, saved it. On the 13th the receiving apparatus at Lavernock Point was carried down to the beach at the foot of the cliff, and the vertical wire was thus lengthened by 20 yards, making 50 yards in all. The result was now a success, as the signals were perfect. Prof. Slaby, who assisted at these experiments, describes graphically the almost painful suspense of the first few minutes after the new and higher wire had been arranged, and whilst the experimenters were awaiting the signal, which, however, came with perfect distinctness a few minutes afterwards, "the Morse instrument visibly printing the signals borne to us by the mysterious ether from the island station, scarcely visible in the distance." This is how the matter appeared to those present, but a glance at Marconi's fundamental patent 12,039 of 1896 discloses the following lines: "The larger the plates of the receiver and transmitter, and *the higher from the earth the plates are suspended*, the greater is the distance at which it is possible to communicate at parity of other conditions." Probably Mr. Marconi was not insensible to the value of dramatic effect. Prof. Slaby has since become, himself, one of the most successful workers in this field, but in his book he handsomely acknowledges his indebtedness to the pioneer work of Marconi. The next trials were at Spezia, by request of the Italian Government, in July, 1897. Fairly good signals were received at a distance of 16 km. (10 miles). The screening properties of iron funnels of ships, and to some extent even of land, were here observed. In these experiments Mr. Marconi worked out more fully his law of distance which he thought proportional to the square of the length of the vertical conductors. Parallel conductors may be employed. The Marconi Company was established in July, 1897, and in that year a distance of 34 miles at Salisbury Plain was reached, and a permanent station established at Alum Bay, Isle of Wight. A director of the Donald Currie line of steamers asked that the passing of the "Carisbrook Castle," a steamer of that line, might be signalled to Bournemouth, and this was done, being the first use of wireless telegraphy in connection with the mercantile marine. Lloyd's now had signalling between Ballycastle and Rathlin Island established (7½ miles). The Marconi Company have since secured a monopoly from Lloyd's for 14 years. Shortly after Mr. Marconi put up a station at Osborne for telegraphing to the Prince of Wales's yacht. The more important events from May, 1898, are given in chronological order.

1898.

*May*.—Experiments in connection with Lloyd's between Ballycastle and Rathlin Island, a distance of 7½ miles.

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*July 20 and 21.*—Experiments in Dublin Bay; Kingstown regatta reported from "Flying Huntress" for *Dublin Daily Express.*

*August 3.*—Wireless communication established between Osborne House and Royal yacht at Cowes, I.W. Mast of yacht 83ft., pole at Ladywood Cottage 100ft., messages transmitted. Communication maintained uninterruptedly for 16 days.

*September*—Bournemouth installation removed to Haven Hotel, Poole Harbour.

*December 24.*—Communication established between East Goodwin lightship and South Foreland lighthouse, 12 miles; 80ft. mast on ship.

1899.

*January.*—Bulwarks of East Goodwin lightship carried away during heavy gale; accident reported by wireless telegraphy to Trinity House.

*March 3.*—East Goodwin lightship run down by s.s. "R. F. Matthews"; accident reported by wireless telegraphy to South Foreland lighthouse, lifeboats promptly put out, and lightship was saved.

*March 27.*—Communication established between Châlet d'Artois, Wimereux, near Boulogne, and South Foreland lighthouse.

*September.*—Chelmsford and Dovercourt installations erected. British Association meeting. Experiments in connection therewith between Town Hall, Dover, and Wimereux. Communication made possible between Wimereux and Dovercourt and Chelmsford, and Chelmsford to Wimereux—85 miles over sea, 35 over land.

*October.*—International yacht race reported between "Shamrock" and "Columbia." After the conclusion of the yacht race, experiments were carried out for the U.S.A. naval authorities, and messages interchanged between cruiser "New York" and battleship "Massachusetts," over a distance of 35 miles. On the return journey from America, Mr. Marconi fitted the s.s. "St. Paul" with wireless telegraph apparatus, and on Nov. 15 established communication with the Needles station when 35 miles distant. The progress of the war in South Africa was reported by wireless telegraphy, and communications published on board the s.s. "St. Paul" in a leaflet entitled the *Transatlantic Times.*

*October 31.*—Agreement entered into with Mr. F. J. Cross for the connection by wireless telegraphy of five Hawaiian islands—viz, Oahu, Kauai, Molokai, Maui, and Hawaii. This work was begun in 1900, and completed successfully by the commencement of 1901.

1900.

*March.*—The Marconi system was adopted by the Norddeutscher-Lloyd Steamship Company, and by agreement with this company Marconi apparatus installed on the Borkum Riff lightship and Borkum lighthouse, and on board the L.M.S. "Kaiser Wilhelm der Grosse."

*April 25.*—The Marconi International Marine Communication Company, Limited, incorporated with offices in London and Brussels, and agencies in Paris and Rome, for the maritime working of the Marconi system of wireless telegraphy.

*July 2.*—Contract entered into with the Admiralty for the installation of the Marconi apparatus on 28 of H.M. ships and four coast stations.

Many plants have since been installed on ships of H.M. navy and at Admiralty coast stations. In addition to these installations, the six installations supplied to the War Office for field operations in South Africa were transferred to H.M navy and are still being employed by the latter in South African waters.

*October*—High-power station at Mullion commenced.

*November.*—The Belgian Royal Mail Steam Packet "Princess Clementine," plying between Ostend and Dover, fitted, and a Marconi wireless telegraph station installed at La Panne, on the Belgian coast, near Ostend.

1901.

*January 1.*—"Princess Clementine" reported barque "Modora," of Stockholm, waterlogged on Ratel Bank.

*January 8*—Wireless telegraph experiments on "Princess Clementine" carried out during storm, communication being maintained the whole way from Ostend to Dover.

*January 19.*—"Princess Clementine" ran ashore at Marikerke during a thick fog; intelligence of the accident conveyed to Ostend by wireless telegraphy.

*February.*—Communication established between Niton station (Fig. 41), St. Catherine, I.W., and the Lizard station, a distance of 106 miles. The Marconi system of wireless telegraphy was largely used during the voyage of the Duke and Duchess of Cornwall and York to Australia in 1901.

*March 1.*—Marconi system began to work commercially throughout Hawaiian Islands

*April.*—Demonstration of the Marconi system arranged for the French Government, communication being successfully established and maintained for some time between a station at Calvi, Corsica, and another at Antibes, in the Riviera. The Prince of Monaco's yacht also fitted with Marconi apparatus at the same time for the purpose of demonstrating to the delegates of Congres International de l'Association de la Marine the value of the Marconi system for maritime communication. Order received from the Canadian Government to instal Marconi apparatus at two stations on the Straits of Belle Isle.

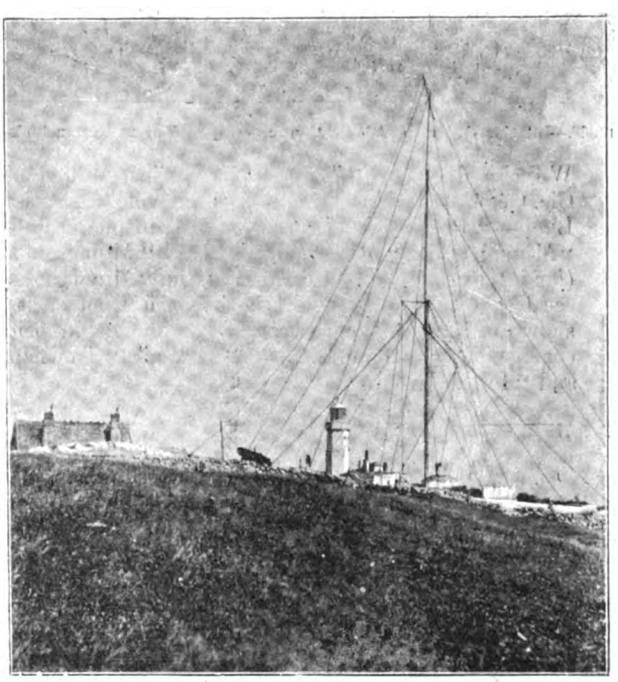

FIG. 41.—Marconi Wireless Telegraph Station at Niton, Isle of Wight.

*May 21.*—A series of Marconi wireless telegraph stations having been erected round the coasts of Great Britain and Ireland, the following were opened on this date for commercial telegraphic communication with ships at sea: Crookhaven, co. Cork; Rosslare, co. Wexford; Holyhead; Withernsea, near Hull; Caistor, near Yarmouth; and North Foreland.

Marconi stations have also been opened for communication with ships at sea at the following places: Borkum Riff lightship and Borkum lighthouse, Germany; La Panne, near Ostend, Belgium; Belle Isle and Chateau Bay, Canada; Nantucket Shoals lightship and Siasconsett, Mass., U.S.A.; Oahu, Molokai, Kauai, Hawaii, and Maui, Sandwich Islands. Stations are being erected at Banana in the Congo Free State and at Ambrizette (St. Paul de Loando) in Angola. Other stations are also to be erected in various parts of the world to meet the requirements of the large shipping companies, and in accordance with the agreement entered into by the Marconi companies with Lloyd's.

The first vessel of the British merchant navy to be fitted with wireless telegraph apparatus was the Beaver line s.s. "Lake Champlain," which left Liverpool on her first voyage fitted with wireless telegraph

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apparatus on May 21, 1901. The apparatus was transferred from this vessel when she was chartered for transport service, and is now on board the s.s. "Lake Simcoe," belonging to the same line. The Marconi apparatus is installed on the following steamers: Cunard Line—"Lucania," "Campania," "Umbria," "Etruria," "Ivernia," and "Saxonia"; Beaver Line—"Lake Simcoe"; Royal Belgian Mail—"Princess Clementine"; Norddeutscher-Lloyd—"Kaiser

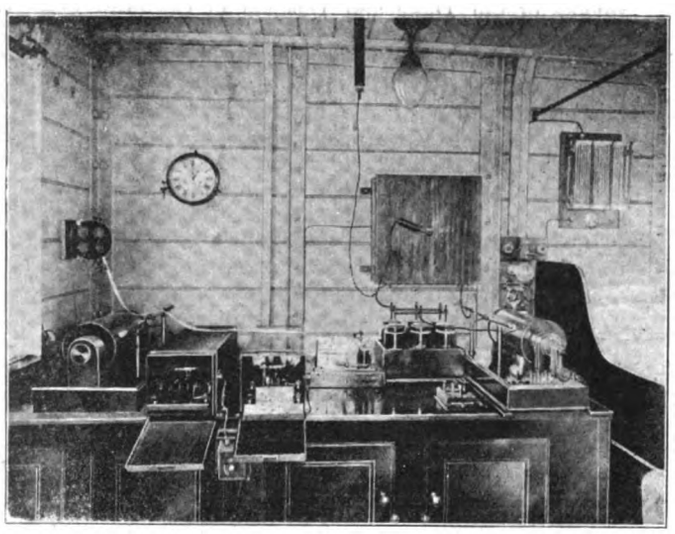

FIG. 42.—Interior of Marconi Cabin, Atlantic Transport Line s.s. "Minnetonka."

Wilhelm der Grosse" and "Kronprins Wilhelm"; Cie. Générale Transatlantique—"La Savoie"; American Line—"Philadelphia"; Atlantic Transport Line—"Minnehaha," "Minneapolis," and "Minnetonka" (for interior of signalling cabin of the "Minnetonka" see Fig. 42. The fore deck with aerial from sprit is shown in Fig. 43, the Marconi signalling cabin being conspicuous); Allan Line—"Parisian," "Tunisian," and "Ionian."

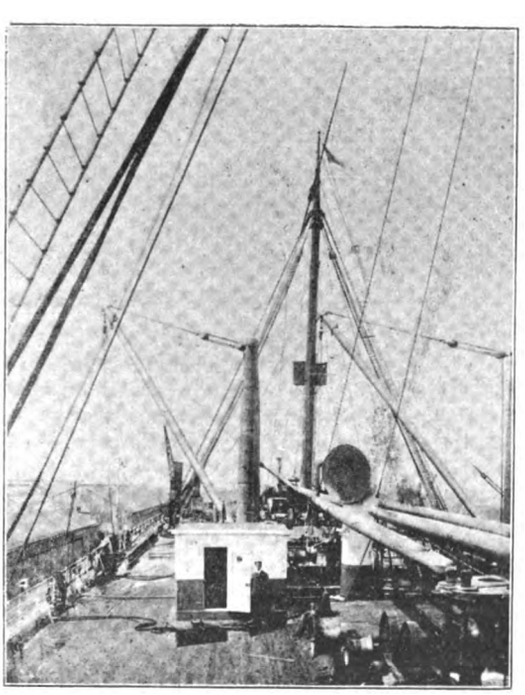

FIG. 43.—Fore Deck of Atlantic Transport Line s.s. "Minnetonka," showing Marconi Cabin and Aerial Sprit on Foremast.

*June 1.*—Agreement entered into between Marconi Wireless Telegraph Company, Limited, and the *New York Herald* Company for the installation of Marconi apparatus at Siansconsett lighthouse, Nantucket Island, and on the Nantucket Shoals lightship for communication with ships at sea, interchange of shipping and other news between ships at sea and *New York Herald* Office, and transmission and receipt of service and passenger telegrams.

*June.*—Wireless communication established between Poldhu station, Mullion, Cornwall, and Crookhaven, co. Cork.

*July 23.*—Agreement made with the Government of the Congo Free State for the installation of Marconi wireless telegraph stations at Banana in the Congo Free State and at Ambrizette in Angola, the Congo Free State undertaking for 10 years to use no system of wireless telegraphy other than the Marconi system.

*August 8.*—Agreement with Associated Press of New York for the reporting of international yacht races in September and October between the "Columbia" and "Shamrock II."

*August 16.*—Nantucket wireless station commenced working commercially.

*September.*—The company opened school for training its technical staff at Frinton-on-Sea.

*September 26.*—Agreement entered into with Lloyd's for the installation of Marconi system of wireless telegraphy at Lloyd's stations throughout the world, and whereby Lloyd's agree for a period of 14 years not to use or permit to be used at or in connection with any of their stations any system of wireless telegraphy other than the Marconi system.

*October 1.*—Stations for commercial wireless telegraph communication opened at Niton, St. Catherine, Isle of Wight, and Lizard, Cornwall.

*October 26.*—La Compagnie de Télégraphie formed, with its head office in Brussels, to develop and work the Marconi system on the Continent.

*November 7.*—Agreement made with the Government of Newfoundland for installation of wireless telegraph stations in Newfoundland and Labrador.

*December 12.*—Signals received by Mr. Marconi at Signal Hill, St. John's, Newfoundland, from Poldhu station, Cornwall, a distance of 1,800 miles across the Atlantic.

*December 21.*—Stations for commercial wireless telegraph communications opened at Malin Head and at Innistrahull.

*(To be continued.)*

## A NEW TYPE OF DIRECT-CURRENT DYNAMO.*

The type of machine described below is made by the Schüttorfer Maschinenfabrik (A Leyman und Co.) in accordance with patents taken out by Koppelmann.† The armature consists of a number of radially arranged groups of sheet-iron stampings, *a* (Fig. 1), held together by the tightening heads, *b*. The path of the flux is shown by the arrow, and its direction is principally parallel to the shaft. The flux is produced by pairs of magnet poles standing side by side. The groups of sheet iron naturally spread out fan-wise at the periphery, and the gaps, *p*, so left are partly filled up by the armature conductors. The machines are built with four or more pairs of poles according to the size. Fig. 2 shows the arrangement of the armature winding, Fig. 3 the finished armature, Fig. 4 a section of a machine tested by the writer.

The principal dimensions of this machine were as follows: armature diameter outside, 420mm.; armature diameter inside, 180mm.; magnet bore, 429mm.; number of armature conductors, 398; section of wire, 1·5mm. × 12mm.; number of slots, 100; commutator diameter, 330mm.: commutator length, 120mm.; number of commutator segments, 199; number of pairs of poles, 4; number of ampere-turns per magnet coil = 700 × 4 5; weight of machine complete, 1,055 kg; weight of armature (including commutator), 389 kg.; weight of armature iron stampings, 145 kg; weight of armature copper, 57·5 kg.; weight of pulley, 43 kg.; weight of magnet system with coils, 370 kg.; weight of bedplate bearings, etc., 253 kg.

As the driving arrangements were not suitable for running the machine as a dynamo, it was tested continuously as a motor at 244 5 volts, 151 amperes, 607·7 revolutions, and was separately excited with 601 watts.

* Translation in abstract of an article by W. Winkelman in *Elektrotechnische Zeitschrift*, May 19, 1904.

† German Patent No. 120,625.

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The temperature rise of the armature was only 28·7deg. C., and that of the field coils 59deg. A light load test was made for the separation of the losses, with the following result: armature $C^2R$ loss at 151 amperes, 2,160 watts; hysteresis loss, 260 watts; eddy-current loss, 440 watts; friction losses at 607 7 revolutions, 420; excitation loss,

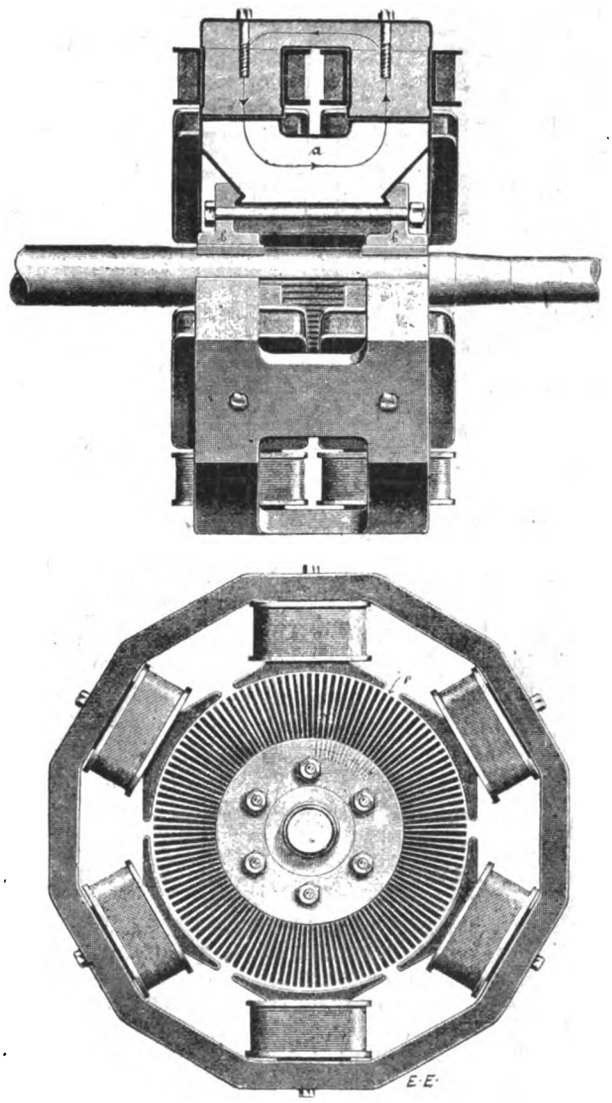

FIG. 1.

601 watts; brush losses, 100 watts—total losses, 3,981 watts. The efficiency worked out at 89 2 per cent., so that the output as a motor was 33 kw.

Owing to the presence of the numerous air-gaps in the armature (across the path of the self-induction flux of the winding), the self-induction is greatly reduced as compared with the ordinary construction, and the machine ran abso-

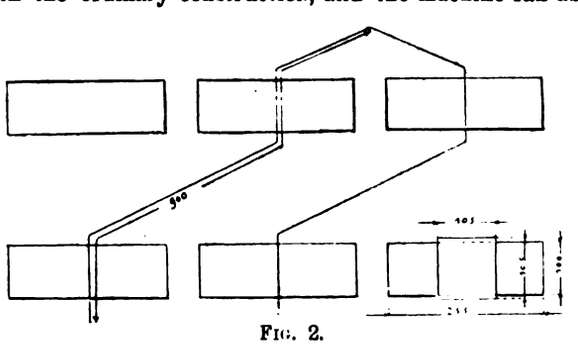

FIG. 2.

lutely sparklessly both at full load and no load. No brush shifting was necessary, and the brushes remained fixed at the neutral point. In this way all voltage drop due to armature back ampere-turns was avoided.

Since the armature temperature only rose 28·7deg. at 151 amperes, the current might safely have been increased to 190 amperes, and the machine could be rated as a generator for 220 volts, 190 amperes, at 608 revolutions, or 41·8 kw. The weight of machine per kilowatt is then 25 2 kg., whilst the weight of active material is 3·34 kg. of copper and 10·1 kg. of iron per kilowatt, which is a very low figure considering the moderate speed.

A further reduction in weight has since been obtained by employing six pairs of poles. This not only reduces

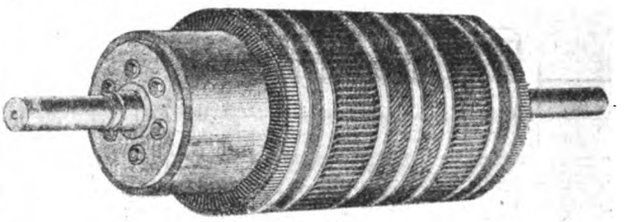

FIG. 3.

the length of armature end connections, but also shortens the armature as a whole. Circular poles instead of square ones were also employed, and the air-gap was reduced from 4·5mm. to 2 5mm. The armature conductors were made slightly larger in section, so that the machine could do 50 kw., thus reducing the weights of active material to 2 kg. of copper and 8 kg. of iron per kilowatt

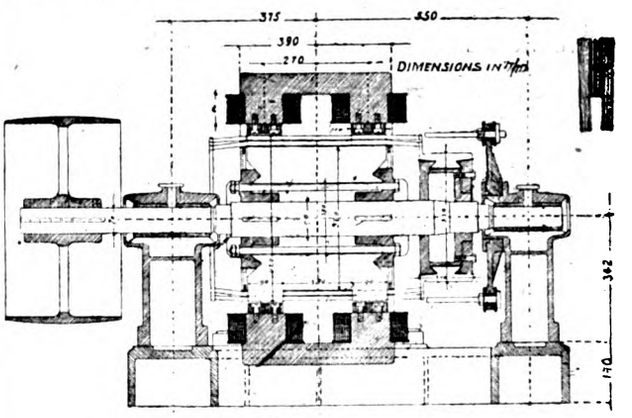


FIG. 4.

output. The arrangement of armature stampings in accordance with Koppelmann's patent is also applicable to alternators, the high magnetic resistance to the leakage lines across the slots permitting a low voltage drop on inductive loads to be obtained.

## THE NATIONAL TELEPHONE COMPANY'S NEW HOLBORN EXCHANGE.

On Tuesday last this new exchange, situated in the Birkbeck Building, Holborn, was opened for inspection. This exchange replaces the one in the building at the corner of St. Andrew-street and Holborn-circus. The service was transferred to the new exchange last month, some 5,443 subscribers' stations being affected by the change. In changing over the service from an old exchange to a new one, it is necessary to effect the change at a given instant, in order to avoid any interruption of the service. This involves branching all the cables containing the subscribers' lines to the new switchboard, an operation necessitating months of carefully organised work beforehand. For a time all the lines are connected to the two switchboards, the new and the old. At the appointed hour the service is taken up at the new exchange and discontinued at the old; the lines are then gradually disconnected from the old switchboard and the connections to the new are made permanent. The new exchange must be complete in every detail before the old one can be put out of use, as it is essential that the service suffer no interruption. In fact, if it were not for differences in methods of working introduced by improvements, and the impossibility of avoiding minor troubles, the subscribers would never know that their lines had been transferred.

In the new Holborn exchange the method of working is the central battery system. The essential feature of the system is that all the power for operating the signals, for

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energising the subscribers' telephone transmitters, and for ringing the subscribers' bells, is supplied by a power plant in the exchange. A conspicuous feature of this power plant is a large storage battery. The power plant—a compact assemblage of dynamos and accumulators—replaces several thousand small hand generators and individual batteries formerly placed at the subscribers' stations.

The new switchboard is 223ft. long, and is served at the present time by 99 operators. The switchboard is at present fitted for 4,600 direct subscribers' lines, and is in course of being fitted for 1,000 additional direct lines. When this work is completed there will be 827,894 working contact points on the board, all of which must be electrically and mechanically perfect. There will also be

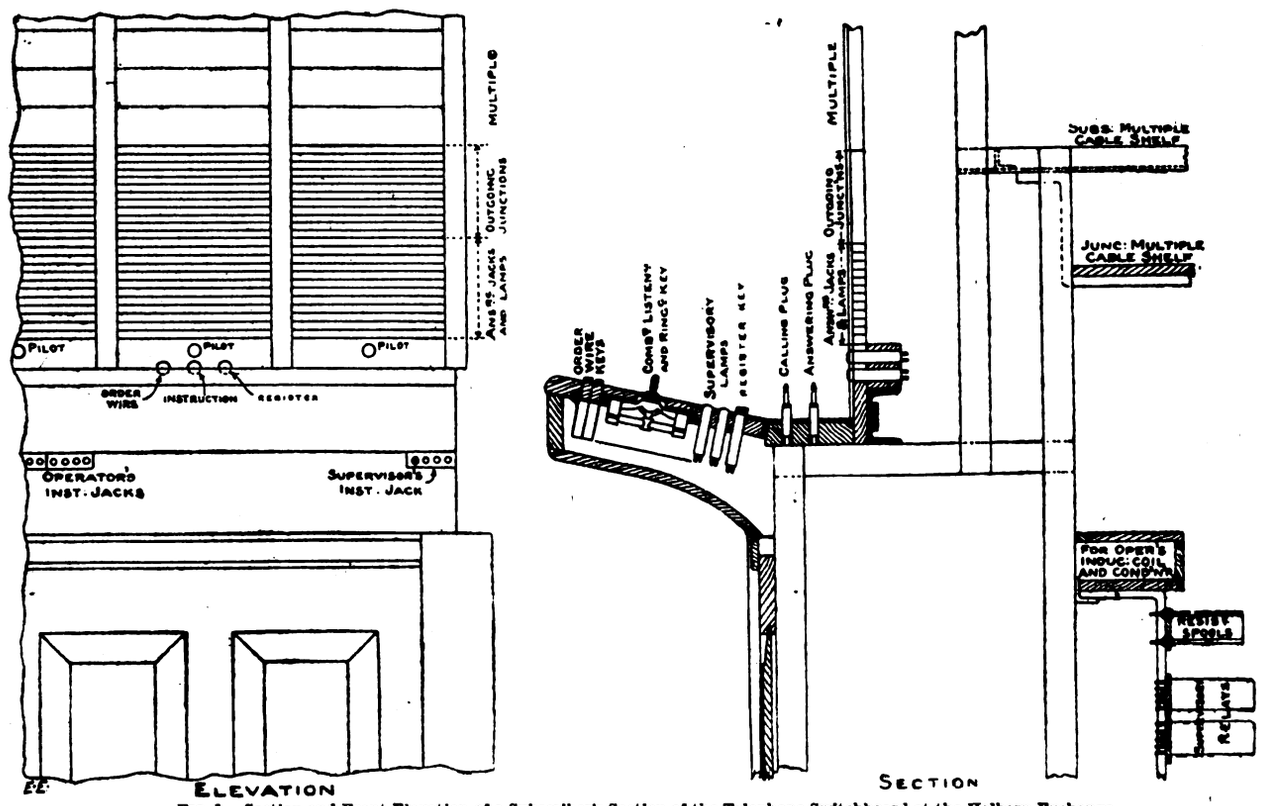


FIG 1.—Section and Front Elevation of a Subscriber's Section of the Telephone Switchboard at the Holborn Exchange of the National Telephone Company.

Lamp signals in place of indicators have been adopted, and these effect many improvements in telephone switchboards. The small size of the lamp enables them to be placed immediately beside the switch or plugs they relate to, instead of in a different part of the switchboard. This increases both the rapidity and the accuracy of the operating. Whenever a signal lamp lights, another larger lamp, conspicuously placed, also lights; this "pilot" lamp serves to call the attention of the supervisor should a call remain unanswered. Managers' and monitors' desks are fitted with signals and switches for the general supervision of the service, and for handling difficult calls involving special enquiries or attention that would block the work of the regular operator.

on the board 2,900 miles of wire in cables sufficient, if extended, to reach from Queenstown to Sandy Hook. The ultimate capacity of the switchboard is 15,000 subscribers' lines. Each subscriber's line, when the board is finally completed, will be connected to 39 switches, so that it may be accessible to all operators at regular intervals along the switchboard. In the power plant department are found the dynamos and batteries for operating all the telephones and signals. In the test-room are the relays which govern the lamp signals and the distributing frames by means of which the subscribers' lines can be grouped together in the most convenient way. Thus all newspaper lines are grouped to one part of the board, so as to be conveniently worked at night. If these were distributed over

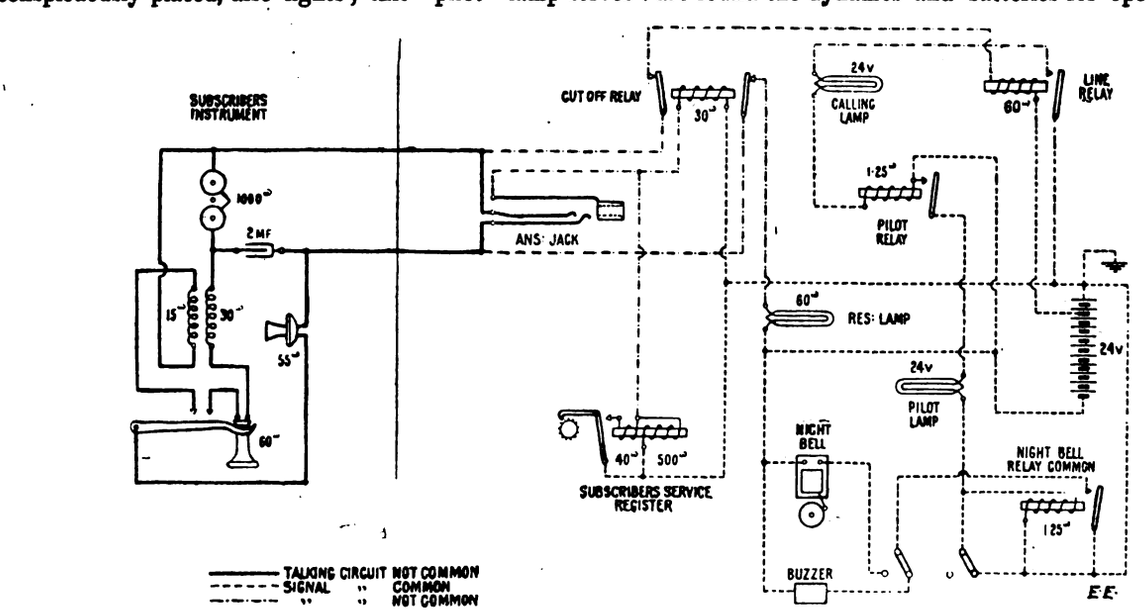


FIG. 2.—Diagram of Connections for a Subscriber's Line Circuit on the Central Battery System.

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the whole board, it would involve many more operators during the night shift.

The exchange is situate on the upper floors of the building, with power room in the basement. Spacious quarters are provided for the operators, including dining-room and reading-room.

The Holborn exchange forms part of the National Telephone Company's London system of 57 exchanges, covering an area of 634 square miles. These exchanges are all connected together by a network of junction lines. Some of the London exchanges are 30 miles apart, but each one requires facilities for communicating with every other, as the greater part of the traffic has to pass through two exchanges. Junction lines have also to be provided to enable the subscribers of the company on any exchange in London to be connected by means of the trunk wires of the Postmaster-General with the company's subscribers in all the provincial towns of the United Kingdom. The number of messages which pass through the company's various exchanges in London now number upwards of 154,000,000 per annum.

With the view to securing uniformity of system and consequent efficiency of service, the company is engaged at the present time in reconstructing most of its large exchanges in London for central battery working. New central battery switchboards are at present in course of construction for the London-wall, Barnsbury, Hop, Eastern, Brixton, and Sydenham exchanges; London-wall, with an equipment for 9,500 subscribers' direct lines, being nearly finished, while Kensington and Battersea exchanges are already working on this system.

The cost to the company of converting to central battery working in London will exceed £500,000. The cost of the new Holborn exchange is upwards of £50,000.

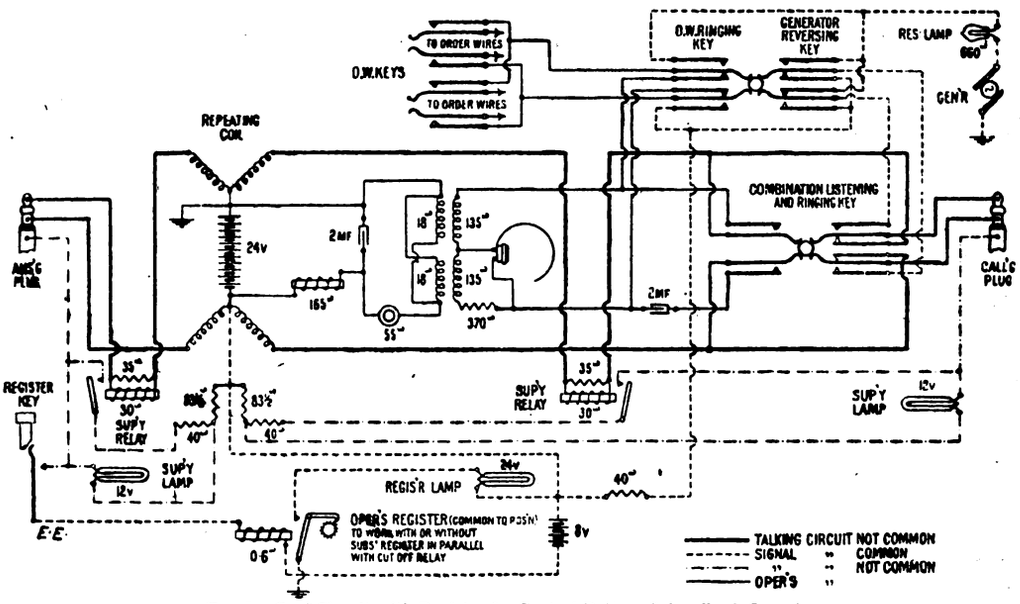


FIG. 3.—Cord Circuit with Register for Central Battery Subscriber's Operator.

Through the courtesy of the company we are able to reproduce herewith some typical diagrams of the connections used in the above exchange.

## ELECTRICITY SUPPLY BILL, 1904.

### SHOREDITCH CONFERENCE.

At the conference on the above Bill held in the Shoreditch Town Hall on Monday last, 13 borough councils owning electricity supply undertakings were represented. The town clerk of Shoreditch, Mr. H. Mansfield Robinson, was appointed secretary to the conference, which then passed the following resolutions:

1. "That this conference is of opinion that Clause 6 of the Electricity Supply Bill, 1904, is very detrimental to

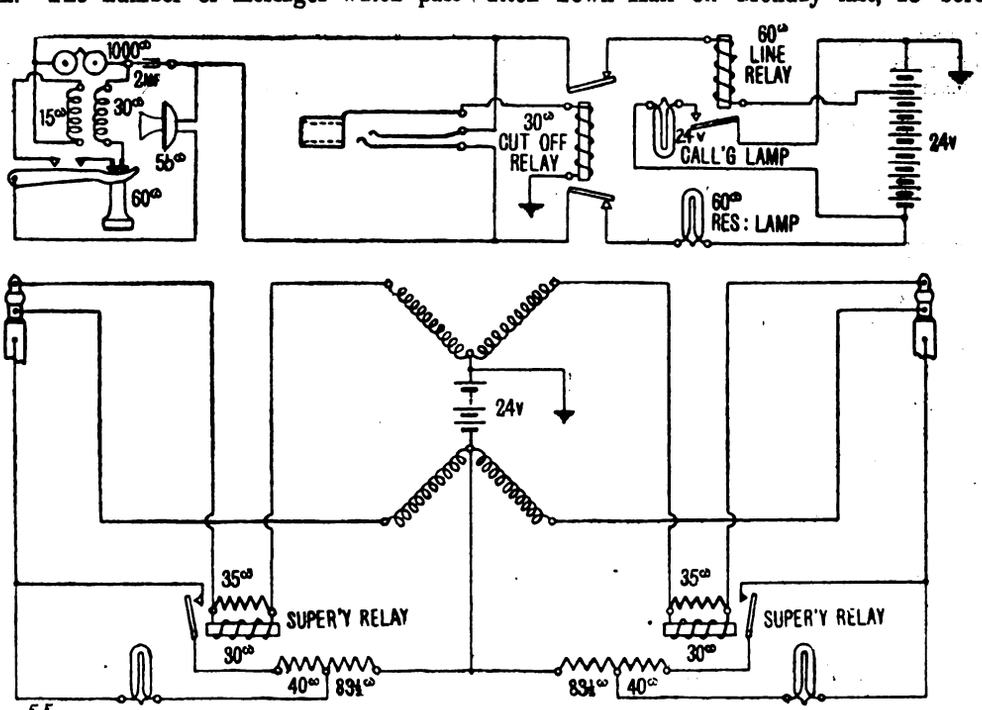


FIG. 4.—Line and Cord Circuit Diagram.

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the interests of borough councils who have already been granted provisional orders, and who have expended large sums of ratepayers' money, which will be jeopardised if the consent of local authorities be dispensed with, by the unfair competition of companies having a larger area of supply."

2. "That delegates be appointed from this conference to wait upon the President of the Board of Trade to ask the Board to amend the Bill by deleting Clause No. 6 therefrom."

3. "That the delegates attending this conference be appointed as delegates to wait upon the President of the Board of Trade."

4. "That the town clerk of Shoreditch be appointed spokesman for the deputation to wait upon the President of the Board of Trade."

5 "That a copy of the minutes of proceedings at this conference be forwarded to each of the metropolitan borough councils."

6. "That a sub-committee of seven representatives of this conference be appointed to prepare evidence for submission to the House of Lords if necessary."

The Mayor of Shoreditch, Councillor E. G. Eldridge (Shoreditch), and the town clerks of Bermondsey, Fulham, Hammersmith, Hampstead, Woolwich, and the town clerk of Shoreditch *ex officio* were elected members of this committee. The conference concluded with a vote of thanks to the Council of Shoreditch, and to the Mayor for presiding.

## TRADE NOTICES AND NOVELTIES.

### Motorcar Accessories.

We have received a copy of the new list of motorcar accessories which is now being issued by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C. This list deals with ignition coils, sparking plugs, contact breakers, switches, batteries, small motor-generators for charging accumulators, instruments for testing, and other requisites called for in connection with the electrical arrangements of the motorcar or cycle. Considerable attention has evidently been given to the designing of ignition coils to suit the requirements of users of high-speed engines. They are supplied in various forms and sizes, with or without tremblers. A number of sparking plugs are shown, special attention being drawn to the "protected" pattern, which is designed to give absolute protection against leakage in wet weather. Of the accumulators listed, prominence is given to the well-known "Geeko" type. These are supplied in two qualities, and fitted with celluloid cases with splash-proof vents. In addition they have corrugated celluloid separators, which serve to prevent the possibility of a short-circuit taking place. Two other forms of battery are illustrated and described—viz., the "Geeko" dry cell and the sack form of Leclanché. The latter form can be carried dry for use in emergency. Several useful measuring instruments are shown, one of the pocket forms of which should be of great service to motor cyclists. The dial is fully protected, and the scale covered with celluloid. The accumulator-charging apparatus consists of a small motor-generator set designed to run from the electric lighting mains. Two machines are illustrated to suit alternating and continuous current supplies. They can be left running any length of time without attention. Charging boards with lamp resistances and special adapters of a new form are also shown. The latter is for attaching to any lampholder, and is so arranged that the lamp remains alight whilst charging is going on. Of the remaining items mention may be made of the several kinds of flexible wire for high and low tension, also portable hand lamps and batteries, complete sets for cyclists and inspectors, etc. Lastly, there are several forms of carriage lamps suitable for interior and exterior lighting, and "Robertson" high efficiency electric lamps for all purposes.

### Electric Power.

From Messrs. Johnson and Phillips, Old Charlton, Kent, we have an illustrated brochure which deals at some length with the economies to be effected by the adoption of electric transmission and distribution of power. It is pointed out that the question as to whether a mine will prove a dividend-paying property depends, in many instances, upon whether electricity is adopted or not. This view is borne out by the results obtained at the various mines which Messrs. Johnson and Phillips have equipped with electrical plant, and since the firm have long specialised in this branch of industry, the weight of evidence which they have collected from all parts of the world may be regarded as conclusive. At the same time the numerous successes recorded speak well for the general excellence of the plant supplied. No better testimony in this respect could be desired than that the proprietors of such mines as the Sheba, Burma Ruby, Raub, and Rezende have nothing to complain of as regards the application of electricity on their respective properties. Those interested would do well to apply for a copy of the brochure under notice, especially as it includes data enabling reliable comparisons to be made with existing plants of, perhaps, obsolete types.

### G.E.C. Progress Sheet.

The progress sheet issued by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., for May illustrates several improvements in watertight electric light fittings for ships, mines, mills, and factories; new pattern cigar lighter of ornamental design; a special ceiling rose with a brass fibre-lined cover; a watertight floor plug provided with a cap which can be screwed into its place when the plug is withdrawn, thus rendering the whole watertight; and a special form of foot press intended for use in places where a table or wall push is inconvenient or undesirable. We also note that the company are now prepared to supply solid-drawn enamelled steel conduit in various sizes to those who desire something still heavier than the braized joint "Union" conduit.

### Protected Rail-Bonds.

The Forest City Electric Company, Piccadilly Corner Chambers, 3, Gore-street, Piccadilly, Manchester, have recently published a new and voluminous edition of their catalogue. One instinctively associates the above firm with protected rail-bonds, and, needless almost to say, the information given about these bonds in the catalogue under notice is most complete. Not only are the different patterns of bonds themselves described and illustrated, but also the methods of fixing same. It is within a comparatively recent date that proper value has been set upon the efficient bonding of rails for electric traction. Great attention has obviously been bestowed upon the subject by the Forest City Company, whose catalogue will be found a splendid medium for reference, including, as it does, a mass of useful data.

### Safety Valves and Alarms.

Messrs. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester, have sent us a copy of Part 10 of their sectional catalogue, No. 1 of "Useful Inventions," for engineers. This part deals with safety valves and alarms of the spring, dead-weight, and lever pattern; it covers 28 pages. The reputation of the firm for the class of goods in question is too well established to need fresh testimony here.

### Nernst Lamps for Street-Lighting.

Those who may be yet in doubt as to the success of the Nernst lamp for street-lighting should obtain a copy of the circular just issued by the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C., containing a collection of testimonials from prominent users. The results recorded are certainly encouraging in a high degree.

## PHYSICAL SOCIETY.

At the meeting of this society on May 27, Mr. J. Swinburne, vice-president, in the chair,

A paper, entitled "**The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers,**" was read by **Dr. C. Chree.** Starting with the general formula for the action between two magnets perpendicular to one another, in Lamont's first position, the paper discusses how observations should be combined when the higher terms usually neglected in magnetometer reductions are taken into account. It considers the effect of errors in setting the deflecting magnet, or in the values assigned to the graduations of the deflection bar, and of errors in the deflection angles, according as observations are made at one, at two, or at three distances. Assuming a simple magnet to be replaceable by poles, and making use of formulæ due originally to Lamont and Börgen, calculations are made as to the size of the several coefficients, P, Q, R, in the deflection formula for hypothetical values of the pole distance in the magnets of the more usual English magnetometer types. These calculated values are compared with the mean values observed at Kew in past years in magnetometers of the several types, and conclusions are drawn as to the mean ratio of the pole distance to the total length of the magnets. The question of variation in the pole distance with time is discussed in connection with recorded mean annual values of the P coefficient for the observatory magnetometers at Kew, Batavia, and Mauritius. The paper concludes with the results of some experiments on the degree of uniformity in the pole-distance of magnets of the same size and pattern. The method consisted essentially in employing two magnets alternately as deflector and deflected in the same magnetometer. Instrumental peculiarities are in this way largely eliminated.

**Dr. W. Watson** said that the author had referred in the course of his remarks to a statement which he (Dr. Watson) had made at a

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former meeting of the society, to the effect that the limit of accuracy in the setting of the magnet carriage upon the deflection bar was 0·1mm. Although it might be possible, when working under favourable conditions at an observatory, to make the setting with greater precision, he thought that 0·1mm. was as much as could be expected or obtained in ordinary work in the field. He pointed out that the number of settings in a deflection experiment was a safeguard against inaccuracies in individual settings, and that it was probable that there was no source of constant error. He expressed his interest in the author's experiments on pole distances, and said that when the magnetometers were being designed for the Indian Survey, he had expressed the opinion that it might be advantageous to make the coefficient Q equal to zero by choosing suitable pole distances for the magnets. Probably Dr. Chree's experiments will enable us to settle whether it is sufficiently accurate to make Q as small as possible and work with a value of P only, determined in the ordinary way.

**Dr. P. E. Shaw** pointed out that brass, which is used for the deflection bar, has a specially large thermal expansion, and if 50cm. of it rises 3deg. C., the increase in length would be about 25 microns, which Dr. Chree stated to be the error in setting the magnet carriage on the scale. Possibly some alloy—*e.g.*, some form of invar—would be preferable to brass.

**Prof. H. L. Callendar** said that some time ago he made some experiments upon the distance between the poles of magnets, and the conclusion he came to was that it was impossible to express the pole distance as a definite fraction of the length of the magnet. He had found that, among other things, the pole distance depended upon the shape of the magnet, the intensity of magnetisation, and the kind of steel of which the magnet was composed. There was also a variation of the pole distance with time.

**Mr. Skinner** said it might be possible to fix the position of the poles by using magnets similar to those used by Mr. Searle in many of his experiments. These magnets consisted of long thin needles with steel balls at the ends, and it was found that the poles were very close indeed to the centres of the balls.

**Dr. Chree** said that the limit of accuracy in the setting of the magnet carriage which he had mentioned—0·03mm.—was that which was obtainable when working under the most favourable conditions. With regard to the material of the deflection bar, he pointed out that a sufficiently accurate temperature correction was always employed to correct for thermal expansion. There was no invar which was sufficiently non-magnetic to be used in accurate work with a magnetometer.

A paper **"On the Ascertained Absence of Effects of Motion through the Ether in Relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis,"** by **Prof. J. Larmor,** was taken as read. In consequence of recent misapprehensions—*cf.*, D. B. Brace, *Phil. Mag.*, March, 1904—the argument on this subject, as given in "Ether and Matter" (1900), is briefly restated. The absence of effect of convection, to the first order, was demonstrated by Lorentz. Absence of effect to the second order of the ratio of the velocity of convection to that of radiation has now been experimentally established, as regards optical interference with long path, by Michelson; as regards mechanical action on a charged electric condenser, by Trouton; as regards double refraction, by Lord Rayleigh and by Prof. Brace. This suggests strongly a complete correspondence in detail between the material system connected with the earth's motion and the same system at rest in the ether, so that their internal relations are indistinguishable. Theoretically, such complete correspondence, up to the second order, exists, involving the FitzGerald-Lorentz shrinkage, provided a purely electrical constitution of matter (as regards its physical relations) is granted, but apparently not otherwise. Thus it is held that these phenomena point consistently in one direction.

A paper on **"Coherence and Recoherence,"** by **Dr. P. E. Shaw** and **Mr. C. A. B. Garrett,** was read by **Dr. Shaw.** In a paper in the *Phil. Mag.* (March, 1901) Dr. Shaw described a method of investigating coherence by measuring the forces required to sunder the cohered surfaces. It was there shown that forces of the order of one dyne were required for a copper-copper contact of two single wires. Further, there seemed to be evidence of a change of state at the place of coherence, possibly orientation of the particles at the contact. In the present paper the authors follow the same method of investigation, adducing evidence that coherence can be explained, and only explained, by Lodge's original theory of fusion; and further establishing the after-effect, whether orientation or otherwise, mentioned in the former paper. When electrical radiation falls on a contact of two wires under suitable conditions, coherence occurs. On applying a small measured force the cohered surfaces separate. On bringing them into contact again at the same places coherence will often, but not always, occur without the incidence of electric radiation. This can be repeated two or three times, but the power to cohere spontaneously soon vanishes. This spontaneous coherence is called recoherence. Like coherence, its presence is indicated by the forces required to sunder the surfaces. Several tables of these results are given. Allowing that coherence itself is due to fusion, for which the evidence is abundant, recoherence may be due to (1) fusion, (2) molecular or intra-molecular change, brought about during coherence by the locally violent surgings at the contact. As to fusion, Prof. J. J. Thomson has suggested that the opposed spikes formed when the surfaces are torn asunder may be so fine as to be fused together by the small circuit current when the surfaces meet again. Without such spikes it is obvious the surfaces would be normal, and no spontaneous coherence could occur. Against the spike theory it is pointed out that recoherence never recurs more than a few times, which indicates some unstable condition of the surfaces. The orientation seen in magnetism can be destroyed by reversals of decreasing currents, by mechanical shock, and by heating. On adopting these methods to destroy recoherence, the authors obtained no definite results. Recoherence is therefore still unexplained. Two surfaces can be pressed together with small but measurable forces by two methods: (1) by a boom attached to a galvanometer suspension—a current in the galvanometer regulates the pressure between a wire on the boom and a fixed wire, these two forming the contact; (2) by a light balance of aluminium rendered only just stable—the pressure is regulated by a current in a solenoid, which acts on a magnet attached to one end of the balance. Both these methods are used by the authors to bring the surfaces into contact and to tear them apart again. The forces operating can easily be measured by a subsequent calibration.

**Dr. W. Watson,** referring to the fact that when recoherence ceases to occur with a direct current it may be re-established by reversing the current, suggested that it might be due to the effect of the oscillations set up in the circuit at the make and break.

**Dr. C. Chree** asked whether the authors could indicate approximately the relative number of cases in which recoherence failed when the current was not reversed, but occurred when the current was reversed. He suggested that the fragmentary remains of the bridge which the authors described as existed during coherence, might sometimes be so shaped as to make it easier for the current to pass in one direction than the other.

**Prof. Trouton** asked if recoherence would occur without a current running through the contact. He suggested that one side of the contact might be a point and the other side approximately plane, so that the current would flow more easily in one direction than the other.

**Mr. R. S. Whipple** asked if the effect depended upon the materials. In the case of a Callendar recorder with a boom contact, the contact-pieces being made of platinum, it was found that the sensitiveness of the instrument depended upon the direction of the current.

**Dr. R. S. Clay** asked if the reversal of the current which established recoherence took place when the substances were in contact.

**Dr. P. E. Shaw,** in reply to various questions, said that mere reversal of current would not produce the recoherence phenomenon. It only occurs as a sub-permanent effect following coherence, and cannot therefore be attributed to sparking caused by rapid reversals. As to the action of platinum and other materials as contact surfaces, he found platinum singularly apt at coherence, but recoherence has not been looked for except in a copper-copper contact. Any explanation offered for recoherence must take account of the observed effects—viz., that it is a sub-permanent effect following coherence, is unstable to various influences, and arises most often by reversal of current, but sometimes without such reversal.

## PERSONAL.

The members of the Leicester Corporation Gas and Electric Lighting Rugby Football Club held their first annual dinner last week at the Pelican Hotel, when about 60 of the supporters of the club attended. The hon. secretary, Mr. J. Barker, occupied the chair.

Considerable interest was evinced in the marriage, on the 1st inst., at St. Clement's Church, Ilford, of Mr. Arthur Henry Shaw, M.I.E.E., electrical engineer to the Ilford Urban District Council, younger son of the late Mr. Wm. Henry Shaw, solicitor to the Great Eastern Railway Company, and Miss Hilda Mary Cassidy, eldest daughter of Mr. and Mrs. Thomas Cassidy, of The Curatage, Ilford. On the preceding Friday, when the staff presented Mr. Shaw with a carved oak chiming clock, as a slight token of their goodwill, Mr. Allen presided over the gathering, and Mr. Bond, who made the presentation, paid a high tribute to the esteem and regard in which Mr. Shaw is held by the whole of the staff.

Mr. A. R. Bacon, chief assistant at the County of London Electric Supply Company's station at Wandsworth, has been appointed resident engineer at the County of London Electric Supply Company's City-road station.

The Exeter Electric Lighting Committee have recommended that Mr. A. G. H. Davis, Wallsend-on-Tyne, be appointed shift engineer at the new station.

The Rotherham Corporation have increased the salary of Mr. W. Grant, tramways manager, by £50 per annum.

We regret to hear of an accident, which was, however, without serious consequences, on Monday at Leicester, Messrs. Councillor Flint (chairman of the Tramways Committee), Alderman Smith (vice-chairman), and the borough surveyor (Mr. E. George Mawbey) being the occupants of a carriage which was overturned.

Mr. H. Eberl, late of the Windsor electric lighting works, has been appointed, out of 70 applicants, chief assistant engineer at Aldershot electric lighting works.

The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board have appointed Mr. H. Taylor as chief inspector at a salary of £100 per annum.

The salary of the electrical engineer at Bangor has been increased by £40 per annum.

Mr. John D. W. Stewart, manager of the Aberdeen district of the National Telephone Company, has been promoted to the charge of the Edinburgh district, and will take up his new duties about the beginning of July. He is to be succeeded by Mr. Stockens, of the Canterbury district. During the years Mr. Stewart has had charge in Aberdeen the telephone system has been greatly extended and efficiently conducted.

**Newton Lifeguard.**—The Board of Trade have approved the Newton lifeguard, which has now been adopted on the Dublin and Lucan electric railway.

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THE

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## THE SUPPLY OF ELECTRICITY BILL.

In our issue for May 6 we gave in a leading article a *résumé* of the provisions of the Supply of Electricity Bill, which has now passed the second reading in the House of Lords, and is being considered by a select committee. In the conclusion to that leading article we said that this Bill would provide means for overcoming objections in detail in older legislation on the same subject, and that it would, if passed, do much to simplify procedure and to extend the industry of electrical engineering. Finally, we expressed the hope that the Bill "will be considered by local authorities in a reasonable light, as they may be sure that the inhabitants of any district will be properly protected by the Board of Trade veto." This hope has not been fulfilled, as there was a conference on the same called by the Shoreditch Borough Council for Monday last. In the letter inviting representatives from other boroughs having electricity undertakings the view was expressed that the provisions of the Bill, if they became law, would seriously prejudice the existing powers of the metropolitan borough councils in controlling the electric lighting in their boroughs. This conference has met, and is, we believe, taking common action on the matter. The chief clause to which objection is brought is that numbered six in the Bill, which reads as follows: "The Board of Trade shall, on considering whether any provisional order should or should not be granted, take into consideration the views of the local authorities affected on the subject, but, whether the consent of any local authority is or is not given, may grant the order or not at their discretion." The rest of the clause makes corresponding modifications in the Electric Lighting Act of 1888. It is argued by the representatives of the metropolitan borough councils owning electric lighting undertakings that this clause will be prejudicial to them, because it will allow the Board of Trade to issue a competing order to a company, which by supplying over a larger area may be able to do so at a less price than they are able to. The whole facts shown by the electric lighting returns for undertakers within the London area are against this latter conclusion, as they show lower costs for the municipal stations. Also one can say without fear of dispute that to grant an order which would allow a company to compete against the local authority would be a reversal of parliamentary precedent. The nearest case to this occurred last year, when the Somerset and District Electric Power Distribution Company was granted a Bill which included in its area the city of Bristol. A proviso was added that the power company should not have rights of supply within the city until the Board of Trade had been convinced that the Corporation of Bristol were not supplying the power required by consumers at reasonable rates. One effect of this Bill has been to make the Corporation of Bristol exceedingly keen to give some power consumers every facility, and we see little or no hope for the power company within the city area. This should reassure the members of the Shoreditch conference, but they seem to have little faith in the *bonâ fides* of the Board of Trade advisers. We are forced to admit that the Bill, if it becomes law, will be an evidence that the Government has not implicit faith in the *bonâ fides* of all municipal electric supply undertakers. The authorities at Shoreditch, Stepney, Hackney, Hammersmith, and several other London areas are above reproach in this respect. An instance we have in mind where the matter is not so satisfactory is that of Southwark, where party politics are put before the interests of the electrical undertaking. This we referred to last week in general terms, but have now more details from a long

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letter contributed by the late town clerk, Mr. L. J. Dunham, on the subject. From this it seems that the Council refused in 1900 to make the necessary arrangements for the extension of the plant, and in consequence it became impossible to continue the connection of consumers. In January, 1901, there were actually five thousand more 8-c.p. lamps connected with the mains than could be safely supplied. This was playing into the hands of the competing company, and contributed, without doubt, to delay the period at which the undertaking will become remunerative. Our contention is that should the council of some other area adopt a similar policy of starving the electrical undertaking, or of misconducting it for party reasons or otherwise, then the new Bill will provide an adequate protection to the inhabitants. We hence think it quite unnecessary for the municipal boroughs owning electrical undertakings to object to the wholesome tonic which the Board of Trade may prescribe under the new Bill to those undertakers who may prefer talk to work.

## CORRESPONDENCE.

### LIGHTNING.

SIR,—I beg to enclose the following paragraph from to-day's *Standard*, which would seem to refer to ball lightning:

During the height of a heavy thunderstorm which passed over the Wallingford district soon after noon yesterday, the hostelry known The Bell, at Sotwell, was struck by an aerolite, which crashed through the chimney to the ground floor, where it spun round a room in which the landlady was at dinner, and eventually exploded. The landlady had a narrow escape, and the house was considerably damaged.—*Standard*, June 2, 1904.

If some electrician would be kind enough to go to the house, ask permission to see the room and the chimney, make some enquiries of anybody who actually saw the phenomenon, and would then write a detailed account of his visit, I believe it would be extremely interesting to many of your readers. It would be interesting to learn whether the house was struck by lightning, and what evidence there is outside the house to prove this. Had there been a fire in the grate recently? Was the chimney sooty? Was the fireplace thrown out of its setting? What was the apparent path of the "aerolite," where did it "explode," how did it "explode," what induced it to "explode," and if it did "explode" why were not the windows blown out and the landlady killed? Was the door open? However, probably the most important question is what made it appear to spin round the room, because probably reflection lent "enchantment to the view." May I venture to suggest that this is a fanciful description of an ordinary case of lightning stroke and no more. Its recentness should facilitate enquiry, and I hope will enable us to decide this interesting point.—

Yours, etc.,
F. GRAHAM ANSELL.

Wickwar, Glos., June 2, 1904.

## FORTHCOMING EVENTS.

FRIDAY, JUNE 10.

**Physical Society.**—At 8 p.m., "Projection of the Indicator Diagrams of a Petrol Motor," by Prof. Callendar; "A Model Illustrating the Propagation of a Periodic Electric Current in a Telephone Cable, and the Simple Theory of its Operation," by Prof. Fleming; and "Exhibition of a Gyroscopic Collimator," by Mr. M. E. J. Gheury.

SATURDAY, JUNE 11.

**British Association of Waterworks Engineers.**—Visit to Belgium.

**Association of Municipal Engineers.**—At Newport (Mon.), Western Counties District Meeting.

WEDNESDAY, JUNE 18.

**Royal Meteorological Society.**—At 4.30 p.m., "Effects of a Lightning Stroke at Earl's Fee, Bowers Gifford, Essex, April 13, 1904," by Rev. C. F. Box; "An Instrument for Determining the True Direction and Velocity of the Wind at Sea," by Mr. A. Lawrence Rotch.

SATURDAY, JUNE 18.

**Crompton and Co., Limited.**—Inspection of Arc Works, Chelmsford, followed by annual athletic meeting. Train leaves Liverpool at 10.55 a.m.

## THE PIOUS VESTRYMAN'S CREED.

BY "SIMPLEX."

(*Dedicated to the Councillors of Southwark.*)

I dew believe thet Science is
A thing thet I may take my seat on.
My Engineer jest keeps his phiz
For me to wipe my dirty feet on.
I am opposed to ignorance
Of every natur an' condition,
But reckon thet to gently dance
On people's feelins is my mission.

I dew not study grammar's laws
In writin' ignorant reports,
For I believe in such a cause
I should express my inmost thoughts.
I dew not need to study "facs"
When I my jedgements am awardin';
I finds out where to grind my axe
And then I goes and acts accordin'.

I never yet made a mistake,—
Thet is, I never yet owned up to it,—
I tell My Staff what move to make;
If wrong—I hoof them out of it!
I cannot tell 'twixt "volts" and "amps,"
(And "Wright's Demand" doth me confuse),
Nor know if a consumer's lamps
Are "eights," "sixteens," or "thirty-twos,"

Yet I can work up a complaint
By *viva voce* questionings,
And then with lurid language paint
The Engineer's neglect of things.
This doth my Bumbledom appease;
This lays my flattered soul to rest.
I calculate thet this will please
The party thet supports me best.

I am not skilled in worldly arts
Of business or of education.
But oh! I show my rarer parts
When I essay vituperation!
This heth my tender Shepherd been
To save me from deserved correction,
And this will keep the people green
To vote for me at the Election.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

695. Please give detailed description of the various steps taken to prevent explosions in underground conduits for electric wires. Have any improvements been made in insulators, has glass been substituted anywhere for earthenware with advantage, and is it possible to do without ventilation? One central station using bare copper strip conductors forces hot air into the conduit to keep it dry. Has this been found successful and generally adopted? Are bare conductors now employed underground, or are they now superseded in best practice by insulated conductors? Is bitumen laid in wooden or earthenware troughs found satisfactory insulation, or does the conductor sag too much?—WATER.

696. It is stated that boilers fitted with superheaters (steam) should not take their feed through an injector. Why is this?—H. B.

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## ANSWERS.

*Question No.* 688.—It is proposed to equip a colliery with an electric winding plant, the data being as under: depth of pit, 450 yards; output per day of 10 hours, 2,500 tons; coal raised per wind, four trams, with 25cwt. each = five tons coal; tare of each tram, 10cwt.; weight of each cage, 2 tons; weight of hauling rope, 2 tons 10cwt.; of balance rope, 2 tons 10cwt., the cages, trams, and rope being balanced at all stages. The following information is required, also give calculations for same: horse-power required to start load and accelerate same up to top speed; time required to accelerate load; maximum winding speed; horse-power required to wind at top speed; time winder will run at top speed; time of retardation. Assuming the winding will be done on the Ilgner system, give the horse-power of the motor and weight of flywheel and speed of same.

*Best Answer to No.* 688 (*awarded* 10*s.*).—In 10 hours 2,500 tons of coal are raised in five-ton lifts. Each lift must be complete in 72 seconds, and of this 20 seconds must be allowed for the stop, leaving 52 seconds for the actual time of lift. The total weight moved in the pit is: coal, five tons; cages, two (ascending and descending), four tons; trams, eight, four tons; ropes (hauling and balance), five tons—total, *18* tons. But in accelerating and retarding, there are also the heavy winding pulley and the hoisting motor to be considered, the latter being preferably direct coupled, without gearing; the inertia of these will depend on the type of plant used, but may be taken as equivalent to another 18 tons upon the ropes, making the total mass to be accelerated and retarded 36 tons. Owing to all being balanced, the force of gravity to be overcome is simply that upon the coal—*i.e.*, five tons—but the frictional resistance in bearings and in stiffness of ropes, etc., is dependent considerably upon the mass being moved, and may be taken as equal to a load of two tons—*i.e.*, a force of seven tons must be exerted to raise the five tons of coal, the mechanical efficiency of the winding gear being thus 71½ per cent.

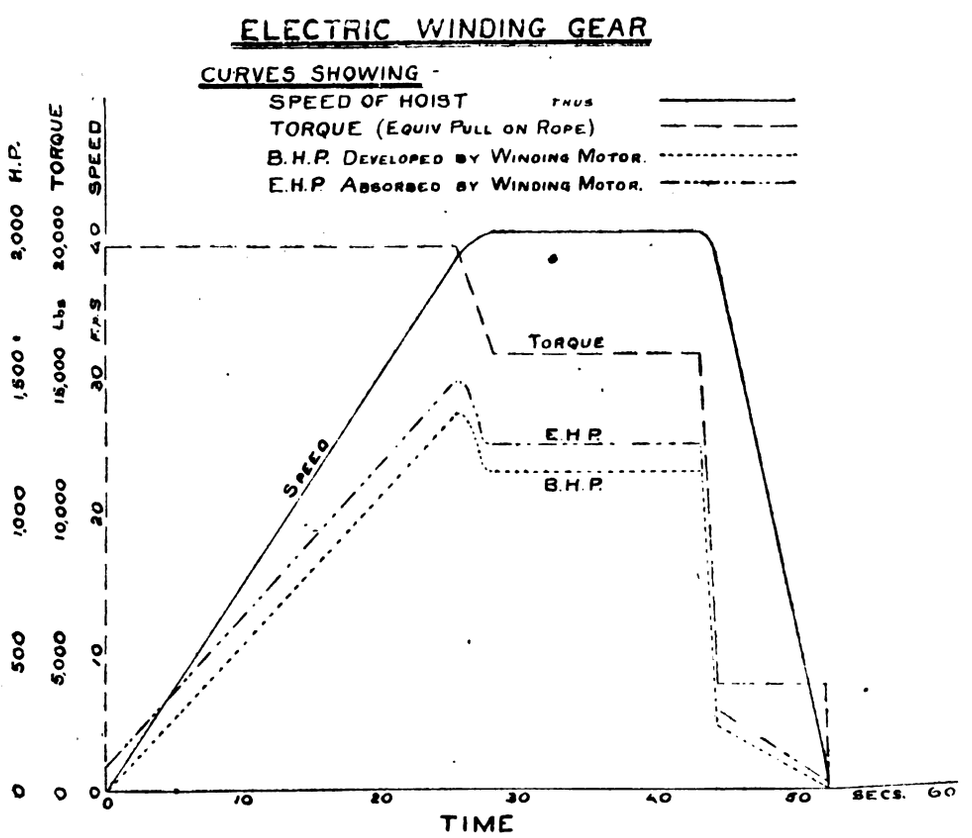
*Retardation.*—The gross load in motion has a mass of 36 tons, and the pull to maintain steady speed is seven tons. Hence, if current is switched off when at full speed, the retardation will be $32\,2 \times \frac{7}{36} = 6\frac{1}{4}$ft. per second$^2$. It is preferable not to use habitually too rapid a retardation, so we may adopt five foot-seconds$^2$ as standard. This means that current is not cut off the motor until the last moment, and the winding is in complete control right up to the end.

*Acceleration.*—Various rates may be used, each requiring a particular maximum speed to complete the run in 52 seconds. In the present instance an acceleration of *1·5 foot-seconds*$^2$ and a maximum velocity of *40ft.* per second are suitable, each figure being within the limits of safe practice. The run is then as follows:

| | | | |
|---|---|---|---|
| Acceleration ... | 28 secs. at 1·5 foot-seconds$^2$. | Height ascended, | 588ft. |
| Steady running | 16 secs. at 40 foot-seconds. | ,, ,, | 640ft. |
| Retardation ... | 8 secs. at 5 foot-seconds$^2$. | ,, ,, | 160ft. |
| Pause ..... | 20 secs. | | |
| | 72 secs. | | 1,388ft. |

The pit is 1,350ft. deep, so we have a little margin to allow for the fact that the acceleration falls off as full speed is approached, the figure of 1·5 foot-seconds being maintained for about 25 seconds, and falling to zero during the next three.

*Horse-Power Required.*—At full speed the motor must exert upon the winding pulley a torque equal to a pull of seven tons, or 15,700lb., in the rope, and the speed of this being 40 foot-seconds, the horse-power developed by the motor is $\frac{15,700 \times 40}{550} = 1,140$ b.h.p. At starting, in addition to this torque, there must also be that necessary to impart an acceleration of 1·5 foot-seconds$^2$ to a mass of 36 tons—*i.e.*, a torque equivalent to a pull on the rope of $\frac{36 \times 2,240}{32\,2} \times 1{\cdot}5 = 3,800$lb. The gross (equivalent) pull is therefore 19,500lb., or 25 per cent. above the normal full-speed pull, and this must be maintained as long as the acceleration of 1·5 foot-seconds$^2$ is required.




The expression "horse-power required to start" is a misnomer, since horse-power involves motion. The *torque* required at the start, as shown above, is 25 per cent. above that at full speed, and hence if the control is ordinary rheostatic, with either polyphase induction or direct-current shunt motor, the power taken from the mains will be about this percentage above that at full speed, the greater part being wasted in the rheostat. If the Ilgner or similar system is used, the power taken at the start is but small, being simply the amount of the motor losses. The horse-power transmitted to the pulley by the motor is proportional to the product of the torque and the speed, and hence steadily rises as the cages get under way. The torque should be kept constant (at 19,500lb.) until a speed of 38 foot-seconds is reached, at which moment the brake horse-power will be $\frac{38 \times 19,500}{550} = 1,350$ h.p. By this time the controlling lever is in the last (working) notch,

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and the acceleration will fall off to nil, the cages ascending at a speed of 40 foot-seconds (and with a brake horse-power of 1,140) until the period of retardation is to commence. At a retardation of five foot-seconds, the torque exerted by the inertia of the 36-ton mass is $\frac{36 \times 2{,}240}{32{\cdot}2} \times 5 = 12{,}500$lb., so that as 15,700lb. is needed to raise the coal, the motor must supply the difference, 3,200lb. This corresponds to a brake horse-power of 230 at 40 foot-seconds, falling to nil as the speed slackens.

The annexed figure shows graphically these results plotted against a base of time; the speed, torque, and brake horse-power being as above set out, and possible with any type of motor and control, though more particularly suitable for the Ilgner system. (If the control were rheostatic, it would be preferable to increase the acceleration run at maximum speed for a longer position of the hoist and retard by gravity only.) The curve of electrical horse-power—the electrical horse-power supplied *to* the winding motor—has been plotted for the Ilgner system only, and this may now be considered more closely.

So much has appeared recently about this system that a detailed description is unnecessary. In brief, it consists in utilising a separately excited direct-current motor to drive the winding pulley, the motor being fed at any voltage, from its normal pressure downwards, by a special direct-current generator and exciter. These two are mounted upon a shaft carrying a heavy flywheel, and to this is also coupled the motor—single-phase, polyphase, or direct-current—which draws its supply from the general power mains. This "main" motor runs steadily at full load, an automatic governor adjusting a rheostat—in its field if direct-current, and in its rotor circuit if induction—so as to render it independent of speed fluctuations within certain limits. The control of the winding motor is effected entirely upon the field of the generator; and the difference between the uniform mechanical power developed by the "main" motor and the ever varying power required by the generator is taken up or supplied by the flywheel, with corresponding increase or diminution of its speed. With a direct-current source of supply the speed variation of the flywheel may be 25 to 30 per cent., but on a polyphase system the variation is restricted to about 10 per cent., since it can only be brought about by a corresponding reduction in the efficiency of the motor.

The overall efficiency of the Ilgner system, assuming a polyphase supply—*i.e.*, the ratio of the foot-pounds of work done upon the coal raised to the electrical power taken from the supply mains—is about 47 per cent., made up as follows:

| | |
|---|---|
| Efficiency of main motor, including rheostatic losses | 89 per cent. |
| Efficiency of generator, exciter, and connections | 85 ,, |
| Efficiency of winding motor | 87 ,, |
| Efficiency of hoisting gear | 71½ ,, |
| | 47 ,, |

The net work done per day of 10 hours is 2,500 tons raised 1,350ft., or $7{\cdot}55 \times 10^9$ foot-pounds—*i.e.*, per second, $2{\cdot}1 \times 10^5$ foot-pounds, or 382 h.p. The input of the main motor will, therefore, be 810 e.h.p., or its rating may be 750 b.h.p.

Turning now to the winding motor, this will be of the slow-speed type, direct coupled to the winding pulley, and running at from 60 to 75 revolutions per minute at full speed. It may be rated at 900 b.h.p., but must be capable of carrying a 50 per cent. overload without sparking. Its "rating" is a matter of name-plate only, as the motor must be specified to do the work shown in the curve continuously for 10 hours, the cycle repeated every 72 seconds, without injurious heating. The motor when developing 1,350 h.p. at full speed will have an efficiency of 92 per cent., or losses of 120 h.p. During the acceleration period—while the motor is carrying the current corresponding to this horse-power, but at a low speed and voltage—the losses in field and armature coils will be at full speed, but iron losses will be much smaller. As an approximation, we may put the losses at 90 h.p. at moment of start, increasing to 120 h.p. as the speed is raised to the full (40 foot-seconds on the rope). Also, when developing 1,140 b.h.p. at full speed the efficiency will be about 92½ per cent., and the losses, therefore, about 95 h.p. It is from these figures and the already obtained curve of brake horse-power that the curve of electrical horse-power on the figure has been plotted, the electrical horse-power of the winding motor being simply the sum of its brake horse-power and its internal losses, since its control is not rheostatic, but effected on the voltage of its supply, and this curve of electrical horse-power required by the winding motor enables us to determine the size of the flywheel, as under.

We have seen that the input of the main motor is to be constant at 810 e.h.p., and that of this 89 × 85 per cent., or, say, 610 h.p., reaches the winding motor. Thus as soon as the latter requires this amount of power—9½ seconds after the commencement of the lift—the flywheel begins to supply energy, and continues to do so until the demand falls again to this figure, which takes place 44 seconds after the start, or when the flywheel has been supplying energy for 34½ seconds. During this time the energy required by the winding motor will be 40,000 horse-power-seconds (deduced from the curve), while of this $610 \times 34\frac{1}{2} = 21{,}000$ horse-power-seconds are supplied by the main motor, and the balance, 19,000 horse-power-seconds or 10,500,000 foot-pounds, must be derived from the flywheel. Allowing for the generator's efficiency, this requires that 12,500,000 foot-pounds of energy should be liberated by the flywheel. If a built-up steel flywheel of good design is used, its peripheral velocity may be very high, 16,000ft. per minute being allowable. The speed of revolution should be high, to prevent too great a diameter, but with polyphase supply this is to some extent dependent on the periodicity, and at 25 cycles a suitable speed for this size of motor would be 290 revolutions at full load, falling to 260* by aid of the regulator as the flywheel yields its stored energy. At 290 revolutions a diameter of 16ft. 6in. will give a peripheral velocity of 15,000ft. per minute, which will be suitable in the present instance.

The energy liberated by a flywheel as its peripheral velocity falls from $V_1$ to $V_2$ is

$$\frac{W}{2g} K^2 (V_1^2 - V_2^2),$$

where W is the weight and K the ratio $\frac{\text{radius of gyration}}{\text{radius of wheel}}$

Here, expressed in feet per second, $V_1 = 250$, $V_2 = 225$, while $K^2$ may be taken as ·85.

$$\therefore \frac{W}{2 \times 32{\cdot}2} \times {\cdot}85 \{250^2 - 225^2\} = 12{,}500{,}000,$$

or $$W = 80{,}000\text{lb.} = 35\tfrac{3}{4} \text{ tons.}$$

To have something in hand, we may make the wheel 40 tons in weight. This gives a margin of 12 per cent., without counting the stored energy in the motor and generator that are also mounted upon this shaft.

The total stored energy in the flywheel is

$$\frac{W}{2 \times 32{\cdot}2} \times {\cdot}85 \times 250^2 = 74{,}000{,}000 \text{ foot-pounds,}$$

which is sufficient to run two complete hoists, so that there is no likelihood of a sudden stoppage of the electric supply causing the cage to be left half way up the pit.

In conclusion, the following, in summarised form, are the answers to the particular points asked:

| | |
|---|---|
| Time of acceleration | 28 seconds. |
| Time of steady running | 16 seconds. |
| Time of retardation | 8 seconds. |
| Maximum winding speed | 40ft. per second. |
| Brake horse-power required at top speed | 1,140 b.h.p. |
| Horse-power required at start (?) | Torque equivalent to 1,420 b.h.p. |
| Maximum brake horse-power during acceleration | 1,350 b.h.p. |

On Ilgner system with polyphase supply:

| | |
|---|---|
| Brake horse-power of induction motor | 750 b.h.p. |
| Weight of flywheel | 40 tons. |
| Diameter of flywheel | 16ft. 6in. |
| Speed of flywheel | 290 revolutions per minute. 15,000ft. per minute. |

C. E. C.

* *i.e.*, a 10 per cent. drop. If the supply is direct current, and a 25 per cent. drop of speed is possible, the flywheel may be much lighter.

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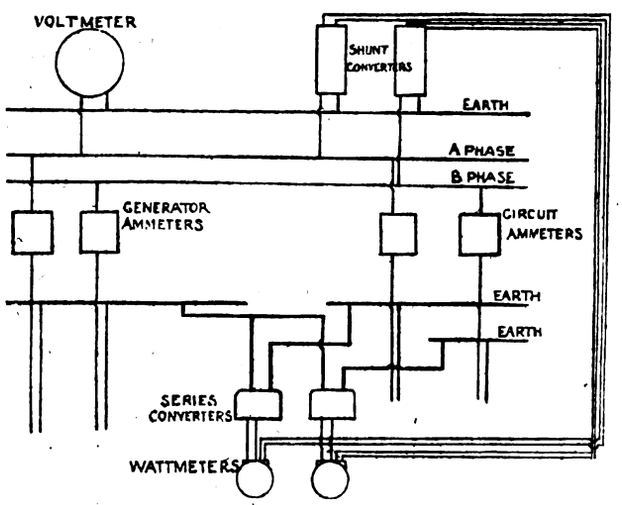
689. On a central-station two-phase switchboard of the Ferranti type two Westinghouse wattmeters, with series and shunt converters, were placed between the earth bar of the generators and the circuits, the bar being cut between generators and circuits for one phase, and an additional bar being added for the other as per




sketch; but the reading obtained on the wattmeters varied considerably at times in comparison with the output as compared with switchboard ammeters, and the maximum reading only amounted to about one-half the total output for each phase. How is this?—S. F. R.

*Best Answer to No.* 689 (*awarded* 10*s.*).—The measurement of power supplied by means of alternating currents is not so simple a mater as with continuous currents. The

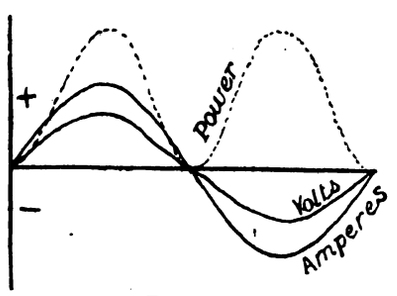



FIG. 1.

phase relationship of the current and the voltage affects the question. In Fig. 1 is shown the volt curve, current curve,

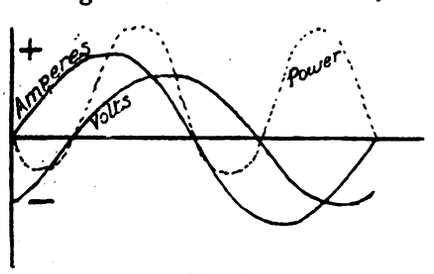



FIG. 2.

and power curve during one cycle, assuming that there is a condition of resonance in the circuit. The power curve

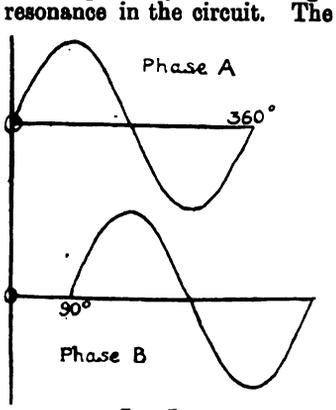



FIG. 3.

is plotted from the product of the instantaneous values of the volts and amperes. In Fig. 2 the current is shown leading by 60deg. It will be seen that at the commencement of the cycle the P.D. is negative and the current positive, the resultant power being negative. In both Figs. 1 and 2 the power curves are drawn on a reduced scale.

In considering a two-phase system with a common

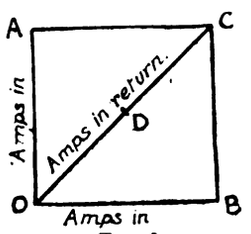



FIG. 4.

earthed return as shown in "S. F. R.'s" sketch, the fact that the current curve of one phase is 90deg. behind the current curve of the other phase must be taken into account. In Fig. 3 is shown the current waves of both A and B phase for one cycle. The current flowing in

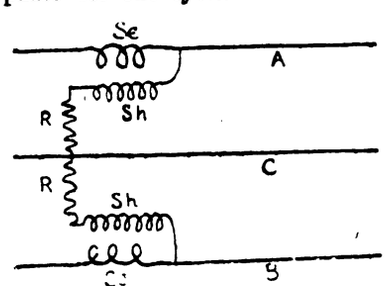



FIG. 5A.

the common return is not twice the current flowing in both phases, but 1·41 times the current in the outer wires, being the sum of the instantaneous values. Fig. 4 shows how to easily find the amount of current flowing in the return wire by graphical methods. O A shows the value of current

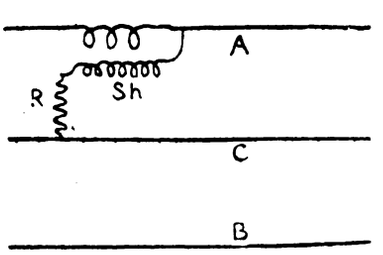



FIG. 5B.

flowing in phase A, O B value in phase B; draw B C parallel to O A and A C parallel to O B. Join O and C, and the length of O C indicates the amount of current in the common return wire. Owing to the way the two meters are connected up, half the return current will flow through

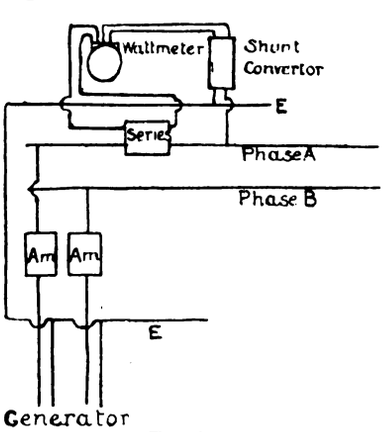



FIG. 6

each series converter. Taking any particular instant of time, if O A in Fig. 4 is drawn to indicate amount of current in phase A, and O B current in phase B, then each meter will read $\frac{O\ C}{2} = O\ D$ amperes times the voltage at that instant. It will thus be seen that it is no wonder that

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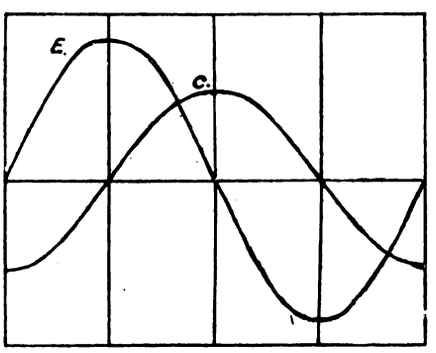
the readings on the wattmeters are found to be inaccurate (Fig. 5 A and B).

A good way of connecting up the meter is shown in Fig. 5 A and B. If the currents in phase A and phase B are always equal, then only one wattmeter is required, connected up as shown in Fig. 5B. Multiply the reading by two to get the total power given out by both phases. If, however, the system is an unbalanced one, the two wattmeters should be connected up as in Fig. 5A, and their readings added together to get the total power. In sketches, Se represents the series turns of wattmeters, Sh the shunt turns, and R the resistance in series with shunt coils to compensate for heating errors.—W. A. T.

*Answer to No.* 689 (*awarded* 5*s.*).—Provided that the wattmeters are correctly calibrated, and are connected as shown, the only difference which should exist between their readings and the products of the voltmeter and ammeter readings is that due to the inductiveness of the load on the feeders. The wattmeter reading, of course, represents the true watts supplied, whilst the ammeter and voltmeter give the apparent watts. If the load consists of incandescent lighting through fairly fully loaded transformers, the ratio of true to apparent watts—*i.e.*, the power factor—would not usually be less than ·95, and the wattmeter measurement should then be only 5 per cent. lower than the product of the voltmeter by the ammeter readings.

If, however, the load consists of very highly loaded transformers, the power factor might fall to ·7 or ·8, whilst if it consists entirely of small sized induction motors working below, say, half load, the power factor might fall to ·5, or even less. In these cases the wattmeter readings would be respectively ·7 to ·8, or ·5 of the products of the ammeter and voltmeter readings, and in this way the discrepancy noticed might be accounted for, though a power factor as low as ·5 is quite unusual on any central station supplying an ordinary lighting and motor load.—Q.

*Answer to No.* 689 (*awarded* 5*s.*).—The connections, as shown in the sketch, appear to be perfectly correct, and the fact of the watts, as calculated from the ammeters, being greatly in excess of the wattmeter readings is only a result that might be expected. In alternating-current work we are continually meeting with phenomena of this kind, which often puzzles the purely direct-current man more than enough. In direct-current stations the output can readily be arrived at by simply multiplying the volts by the amperes, and we have the answer in watts; but in an alternating station these readings when multiplied together may give anything but watts, for although the meters are reading virtual volts and amperes, they say nothing about the phase relationship. Two separate currents starting from zero and rising to a maximum together, then returning to zero again, reversing and reaching a maximum in the opposite direction and finally returning to zero, both currents performing the same operation at the same instant, would be said to be in phase. Now, instead of considering two currents, we have in this case to consider E.M.F. and current. In the same way, then, if an E.M.F. and current went through the cycle just described, keeping perfectly in step throughout, they would be said to be in phase, and in such a case the watts developed in the circuit would be virtual volts multiplied by virtual amperes. In practice, however, the pressure and current are not quite so united, and often prefer to go through their journey with one or the other leading the way, sometimes the E.M.F. leading and sometimes the current, depending entirely on the nature of the outside circuit. In cases where the current is found to lag behind the E.M.F., the cause may be traced to inductance. If we suddenly switch the current off from an electromagnet—such as the field magnets of a dynamo, for instance—a flash is noticed at the switch contacts, which is much greater than if the same amount of current were switched off from a load of incandescent lamps, for instance. The cause of this is well known. It is brought about by induction, due to the sudden change in the number of lines passing through the windings. Thus we say we have an induced E.M.F. The same thing would happen if a coil were connected across any source of supply and the current simply varied, the induced E.M.F. would then be proportional to the rate at which the change took place; it would also be in opposition to the E.M.F. applied to the ends of the coil, thus we should say it is a back E.M.F. of self-induction. Even straight conductors when carrying alternating currents possess some self-induction or inductance, although it is not nearly so great as in electromagnetic apparatus. It will be obvious from what has been said that the mains running from an alternating station must have inductance owing mainly to the number of transformers that are connected to them, and it is not at all difficult to see that this opposing pressure will momentarily hinder the setting up of a current in the circuit; thus we get the current lagging behind the impressed volts. The




curves show the current lagging by a quarter of a period, a condition that is never quite fulfilled in practice, although it is possible to come very near it. If we divide this cycle into four as shown, it will be seen that during the first quarter of the cycle the E.M.F. is above the time base while the current is below. Taking all values above the time base as positive and all below as negative, the sum of the values in the first quarter of the cycle will obviously be negative. Referring to the second division, we have volts and current both positive, therefore the product will be positive. In the third division we again have the current positive while the volts are negative, thus the product is negative. In the last division they are again both positive, which gives a second positive product. So we see that in this cycle four separate items of work have been done, and, further, it will be noticed by the symmetry of the curves that the sum of the products in each of the four divisions are the same, but two are positive and two negative; therefore, two equal positive quantities added to two equal negative quantities must give 0. From this reasoning we see that if we have the current lagging by a quarter of a period, no matter how many volts and amperes we may have showing on the meters, the useful work done in the circuit is nil. As I have said, in practice we never reach this extreme, but it may be taken for granted that whenever a lag exists, either in the current or pressure, a wattless current exists also. It is quite possible to have several thousand watts according to the volt and ammeters, whereas the true watts expended in the circuit may only be two or three. In cases where the current is found to lead and the E.M.F. consequently lag, the cause is due to the presence of capacity in the circuit; but, as a rule, the current more often lags than leads, owing to most circuits having more inductance than capacity, but if both are present one will tend to neutralise the other, and if in the right proportion they will entirely succeed in doing so. It should be understood that although wattless currents are wattless so far as doing useful work is concerned, it will develop heat in the circuit to the same extent as a useful current, and also adds to the ohmic drop in the usual manner. The power developed in an alternating circuit can be calculated for a given case, where the conditions remain perfectly constant, from the formula,

$$\text{True watts} = E^v C^v \cos \lambda,$$

where $E^v$ = virtual volts, $C^v$ virtual current, and $\lambda$ the angle of lag or lead; but in the present case it would be quite impossible to calculate $\lambda$, as it varies with any alteration in the condition of the circuit and also with the frequency. This is why the true watts do not always bear the same ratio to the apparent watts, or, in other words, it is why the power factor of a station is not constant. To answer the question in a few words, we should say that the difference is due to watt-

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meters reading true watts, while a portion of the amperes shown on the ammeters are wattless, due to a lag or lead of the current.—E. AUSTIN.

[N.B.—Will E. Austin kindly send his full address to us.—ED. *E. E.*]

## WEST BROMWICH ELECTRICITY ACCOUNTS.

The accounts of the West Bromwich electricity department for the year ended March 31, 1904, show a total expenditure on capital account to that date of £56,506. Appended are abstracts of the revenue account, general balance-sheet, etc

| Dr. | Revenue Account. | £ | s. | d. |
|---|---|---|---|---|
| Coal, waste, water, and stores | | 2,247 | 0 | 6 |
| Wages at generating station | | 776 | 11 | 2 |
| Repairs to buildings, machinery, mains, etc. | | 867 | 15 | 0 |
| Rents, rates, taxes, and insurance | | 246 | 12 | 6 |
| Engineer's and clerks' salaries and commission | | 375 | 14 | 0 |
| Auditors' fees (two years) | | 33 | 12 | 0 |
| Stationery, printing, and general establishment charges | | 106 | 9 | 11 |
| Reserve for debts and management of stock | | 47 | 0 | 0 |
| Bank commission and interest | | 299 | 17 | 10 |
| Interest on loans, less interest on free wiring | | 1,474 | 3 | 5 |
| Sinking fund instalments | | 1,198 | 13 | 11 |
| Lamps, work done, etc. | | 19 | 1 | 1 |
| Rentals of motors and apparatus credited in error last year | | 79 | 17 | 4 |
| Balance, being profit for year | | 1,545 | 17 | 3 |
| | | £9,318 | 5 | 11 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter | 2,651 | 6 | 9 |
| Sale of current for tramways | 6,502 | 17 | 4 |
| Sale of current for public arc lighting | 161 | 1 | 10 |
| Rent of farm | 3 | 0 | 0 |
| | £9,318 | 5 | 11 |

| Dr. | Balance-Sheet. | £ | s. | d. |
|---|---|---|---|---|
| Amount raised by loan as capital account | | 45,000 | 0 | 0 |
| Sundry creditors for work done and goods supplied | | 1,697 | 10 | 4 |
| Creditors for interest | | 677 | 9 | 2 |
| Rents, rates, and taxes, due and unpaid | | 4 | 3 | 4 |
| Balance due to bank | | 12,246 | 15 | 4 |
| Profit for year, less last year's deficit | | 1,110 | 5 | 1 |
| | | £60,736 | 3 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Capital account | 56,506 | 6 | 0 |
| Stock of coal, stores, coal, and other materials | 681 | 11 | 10 |
| Arc lamps for hire | 296 | 15 | 1 |
| Sundry debtors for current supplied | 3,229 | 17 | 0 |
| Rents and insurance paid in advance | 13 | 16 | 10 |
| Cash in hand | 7 | 16 | 6 |
| | £60,736 | 3 | 3 |

Statement of Electricity Generated, Sold, etc.

| | | | |
|---|---|---|---|
| Quantity generated in Board of Trade units | | | 1,253,188 |
| Quantity sold | Public lamps | 42 557 | 1,105,006 |
| | By contract for tramways | 791,353 | |
| | Private consumers by meter | 271,096 | |
| Quantity used in works and stores | | | 19,039 |
| Total quantity accounted for | | | 1,124,045 |
| Quantity not accounted for | | | 129,143 |
| Number of public lamps | | | 80 |
| Total maximum supply demanded (kilowatts) | | | 788 |

## BATH ELECTRICITY ACCOUNTS.

The accounts of the Bath electricity department for the year ended March 31, 1904, show a total expenditure on capital account to that date of £137,226. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc, are given below.

Revenue Account.

| Dr. | Expenditure. | £ | s. | d. |
|---|---|---|---|---|
| Generation of electricity | | 5,563 | 3 | 3 |
| Distribution of electricity | | 659 | 7 | 3 |
| Attendance and repairs to public lamps | | 456 | 10 | 9 |
| Rents, rates, and taxes | | 405 | 3 | 6 |
| Management expenses, salaries, etc. | | 1,712 | 11 | 5 |
| Special charges, insurances, etc. | | 170 | 6 | 3 |
| Total expenditure | | 8 967 | 2 | 5 |
| Amount carried to net revenue account | | 7,652 | 19 | 0 |
| Balance to provide for bad debts | | 45 | 8 | 5 |
| | | £16,665 | 9 | 10 |

| Cr. | Income. | £ | s. | d. |
|---|---|---|---|---|
| By sale of current by meter | | 16,102 | 9 | 7 |
| Sale and repairs of meters, apparatus, etc. | | 507 | 14 | 2 |
| Rents receivable and discounts received | | 55 | 6 | 1 |
| | | £16,665 | 9 | 10 |

General Balance-Sheet.

| Dr. | Liabilities. | £ | s. | d. |
|---|---|---|---|---|
| Capital account—amount received | | 124,075 | 0 | 0 |
| Sundry creditors | | 13,889 | 11 | 2 |
| Balance at credit of net revenue account | | 1,068 | 12 | 2 |
| Reserve fund account | | 813 | 12 | 2 |
| Bank overdraft | | 4,383 | 17 | 0 |
| | | £144,230 | 12 | 6 |

| Cr. | Assets. | £ | s. | d. |
|---|---|---|---|---|
| Capital account—amount expended for works | | 137,226 | 5 | 0 |
| Stores on hand | | 586 | 17 | 9 |
| Sundry debtors for current supplied | | 5,223 | 13 | 9 |
| Other debtors | | 194 | 10 | 8 |
| Cash at bank and in hand | | 999 | 5 | 4 |
| | | £144,230 | 12 | 6 |

Statement of Electricity Generated, Sold, etc.

| | | | |
|---|---|---|---|
| Quantity generated in B.T. units | | | 1,357,292 |
| Quantity sold | Public lamp | 381,155 | 963,145 |
| | By contract | 1,600 | |
| | Private consumers by meter | 580,390 | |
| Quantity used on works | | | 52,312 |
| Total quantity accounted for | | | 1,015 457 |
| Quantity not accounted for | | | 341,835 |
| Number of public lamps | | | 190 |
| Total maximum supply demanded (kilowatts) | | | 8,287 |

## BOLTON ELECTRICITY ACCOUNTS.

The following are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., taken from the accounts of the Bolton Corporation electricity accounts for the year ended March 31, 1904.

Revenue Account.

| Dr. | Expenditure. | £ | s. | d. |
|---|---|---|---|---|
| Generation—Salaries and wages | | 2,527 | 19 | 1 |
| Fuel | | 6 949 | 5 | 4 |
| Oil, waste, water, etc. | | 1,080 | 17 | 10 |
| Repairs and maintenance of plant, etc. | | 1,463 | 17 | 6 |
| Distribution—Wages | | 139 | 8 | 3 |
| Maintenance of mains, fuses, etc. | | 93 | 10 | 5 |
| Management expenses—Salaries and wages | | 966 | 12 | 11 |
| Stationery and printing | | 141 | 1 | 10 |
| Miscellaneous expenditure | | 374 | 4 | 10 |
| Rents, rates, and taxes | | 1,186 | 15 | 9 |
| Total expenditure | | 14.913 | 14 | 3 |
| Balance carried to profit and loss account | | 24 395 | 7 | 8 |
| | | £39,309 | 1 | 11 |

| Cr. | Income. | £ | s. | d. |
|---|---|---|---|---|
| Sale of current for private lighting | | 17,172 | 11 | 5 |
| Ditto public lighting | | 131 | 18 | 8 |
| Ditto power | | 3,843 | 14 | 9 |
| Ditto tramway traction | | 16,136 | 18 | 7 |
| Profit on fittings trade account | | 794 | 10 | 3 |
| Rental of hired meters | | 739 | 7 | 5 |
| Rental of hired motors | | 490 | 0 | 10 |
| | | £39,309 | 1 | 11 |

Balance-Sheet.

| Dr. | Liabilities. | £ | s. | d. |
|---|---|---|---|---|
| Mortgage debt, less repayments | | 222,302 | 14 | 6 |
| Sundry creditors | | 5,117 | 12 | 7 |
| Reserve fund account | | 998 | 11 | 4 |
| District funds | | 6,818 | 0 | 0 |
| Profit and loss account | | 1,986 | 10 | 2 |
| | | £237,223 | 8 | 7 |

| Cr. | Assets. | £ | s. | d. |
|---|---|---|---|---|
| Expenditure on works | | 200,502 | 4 | 11 |
| Accounts owing to electricity department | | 15,673 | 14 | 10 |
| Investments, etc. | | 17,900 | 15 | 7 |
| Stores on hand | | 3,146 | 13 | 3 |
| | | £237,223 | 8 | 7 |

Statement of Electricity Generated, Sold, etc.

| | | | |
|---|---|---|---|
| Quantity generated in B.T. units | | | 6,012,782 |
| Quantity sold | Private lighting | 1,198,144 | 5,056,898 |
| | Public lamps | 9,547 | |
| | Tramways | 3,098,292 | |
| | Motors | 750,915 | |
| Quantity used on works | | | 498,652 |
| Total quantity accounted for | | | 5,546,550 |
| Quantity unaccounted for | | | 466,232 |

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# LEGAL INTELLIGENCE.

## BOMBAY TRAMWAY COMPANY v. CORPORATION OF BOMBAY AND OTHERS.

This was an appeal in the House of Lords, before Lords Macnaghten, Davey, Robertson, and Lindley, by the plaintiff company from a decree of the High Court of Bombay, dated Feb. 18, 1902, varying a judgment of the Indian primary tribunal.

Mr. Jardine, K.C., and Mr. G. E. A. Ross appeared for the appellants; and Mr Arthur Cohen, K.C., Mr. Haldane, K.C., and Mr. A. Phillips for the Bombay Corporation; and Mr. G. D. Lynch for the other respondents.

The arguments for the appellants—the other side not being called on—were recently heard before a Board composed of Lord Macnaghten, Lord Lindley, and Sir Arthur Wilson, when judgment was reserved.

The proceedings related to the purchase by the Corporation of the company's undertaking. The transaction was conducted under Section 30 of the Bombay Tramways Act, 1874 (Act 1 of that year), which gave the defendants power to acquire the tramways after the expiration of 21 years from March 12, 1873, on giving notice within six months from that date, with a renewal of the privilege at septennial periods on giving similar notice, the purchase price to be the actual value of the property (exclusive of goodwill or compensation), to be settled by arbitration if necessary, plus an amount for goodwill and compensation equal to 21 years' purchase, calculated on the average profits of the three years preceding the transfer, after deducting 4 per cent. per annum on the actual value of the property. On March 11, 1901, the Corporation served notice of intention to purchase, but as there was some doubt as to whether this notice was in order as regards date, two other notices, dated respectively March 12 and 13, 1901, were also served, and it was now admitted that there could be no objection in that respect. The contention of the plaintiff company was that the Corporation had acted *ultra vires*, as they were seeking to obtain a transfer of the undertaking, not on their own account, but on behalf of a private individual named Bingham, which rendered their notice invalid. On investigation, however, it appeared that, although the Corporation had made arrangements with Bingham by which the latter was to find the purchase-money and work the tramways, the Corporation were acting as principals, not as Bingham's agents. The Judge of First Instance and the Chief Justice of Bombay had pointed out that there was nothing in the Tramways Act which expressly or impliedly prohibited such a transaction; nothing to show that if the Corporation exercised the power conferred on them by Section 30 and acquired the tramways they were bound to keep them in their own hands and to work them themselves. Whether they could carry out their agreement with Bingham without obtaining further powers was a matter which did not concern the company. Another question raised by the company was that the date to be fixed as the date of purchase ought to be later than that mentioned in the judgment. The Judge of First Instance had held that the proper date was when the relation of vendor and purchaser was definitely created by the service of a proper notice. It appeared, however, that both parties were aggrieved at this decision. The company further contended that the track rent payable to the Corporation should cease on March 14, 1901.

**Lord Lindley,** in delivering judgment, said that their Lordships entirely concurred with the decision of the courts below, that the company had no cause of action in respect of the validity of the Corporation's notice. Having regard to the course taken by both parties in the Indian Courts, their Lordships did not consider that either party was now entitled to insist that the date fixed by the Judge of First Instance as the date of purchase should be adopted. Under these circumstances their Lordships saw no reason for disturbing the date fixed by the Appellate Court—*i.e.*, the date of the award fixing the value of the corporeal property of the tramway company. As pointed out by the Indian Courts, to fix the date of the execution of the conveyance would lead to great practical difficulties. The profits would vary from day to day, and the average profits for three years could never be ascertained. As to track rent, it was expressly agreed between the company and the Corporation that the company would continue to work the tramways pending the ascertainment and payment of the purchase-money on the understanding that they received "the income and profits of the tramway business during such period." So long as the company took the profits they must pay the ordinary expenses of working, including the track rent. The findings of their Lordships amounted to a dismissal of the appeal, and the company will therefore have to pay the costs of the Corporation.

# COMPANIES' MEETINGS AND REPORTS

## CHADBURN'S (SHIP) TELEGRAPH.

For the year ended March 31 last the directors report that the balance at the credit of the profit and loss account is £16,974. Managing directors' remuneration, directors' fees and expenses, and depreciation on properties and plant absorb £7,998, leaving £8,976. From this amount £5,400 must be deducted, being dividends which have been paid at the rate of 6 per cent. per annum on the preference shares, and an interim dividend of 6 per cent. per annum on the ordinary shares, leaving £3,576. This sum, together with a balance carried forward from last year, makes a total of £10,926 to be dealt with. The directors propose to pay a dividend on the ordinary shares of 12 per cent. per annum, less income tax, for the half-year ended March 31, 1904, making, with the interim dividend already paid, a dividend of 9 per cent. per annum for the 12 months, carrying forward a total balance of £7,326. The directors have thought this a favourable opportunity to write off a larger sum than usual under the head of depreciation in reduction of the amount appearing in the balance-sheet for goodwill, patents, etc.

## GEORGE M. CALLENDER AND CO.

The report for the year ended March 31 last, to be submitted to the meeting on the 14th inst., shows a trading profit of £10,371 and a balance at credit of profit and loss of £8,641. From this must be deducted managing directors' salary, £1,000, and income tax, £166, also dividend on preference shares of £1,100, leaving an available balance of £6,365. It is proposed to pay a dividend on the ordinary shares at the rate of 8 per cent. per annum, whereof 4 per cent. has been paid, to write off preliminary expenses £1,100, and to carry forward £1,548. The new works at Bow have been in operation for six months, and the saving effected for this period has amounted to £1,252, representing the difference in the price paid previously to the Callender Cable and Construction Company, Limited, by the vendor under his old arrangement and the actual cost to this Company in manufacturing the materials itself. The wet weather of the last six months has materially interfered with outside work and increased the cost. A large number of specifications and orders are in hand, so that the prospects for next year are encouraging. The Continental business has been started, and in view of the fact that most European countries have a heavy protective duty it has been found impossible to export from England. The directors have, therefore, thought it advisable to start sub-companies, and as a first step towards carrying out this idea they propose to transfer the concession for manufacturing the materials in the various countries in Europe to a new company to be called "George M. Callender Continental, Limited," full particulars concerning which will be laid before the shareholders at the meeting. The amount of capital required for this company will be small, and it is proposed to keep it entirely in the hands of the shareholders of George M. Callender and Co., Limited. The first sub-company, which relates to Italy, has been arranged on satisfactory terms, and it is hoped that the work will be started there before the end of June. The reason for separating the Continental business is that a certain amount of money will be necessary to start and develop these sub-companies, for it is hoped that in the majority of cases (as in the Italian company) the bulk of the capital will be found locally. It is the directors' intention to proceed very slowly with the formation of these companies in the first case, so as to ensure that each one of them is started on a proper footing, and will have every prospect of being placed on a paying basis.

## WEST AFRICAN TELEGRAPH.

The report of the directors for the year ended Dec. 31 last states that the revenue amounted to £62,514, from which are deducted £15,578 for the ordinary expenses and £9,809 for expenditure relating to repairs of cables, leaving a balance of £37,127, to which is added £1,238 brought from the preceding year, making a total available balance of £38,365. The sum of £1,459 has been provided for income tax, £25,000 transferred to general reserve fund, and an interim dividend of 1 per cent., absorbing £2,310, was paid in January last. The directors recommend the payment of a final dividend of 6s per share (free of income tax), making, with the interim distribution, 4 per cent. for the year, the balance of £2,663 being carried forward.

# NEW COMPANIES REGISTERED.

**"Vernon" Mechanical and Electrical Registers, Limited.**—Capital, £25,000. Objects: to acquire the various inventions of Albert Marsh relating (*inter alia*) to delivering, receiving, and registering tickets and checks with the British-American patents and rights obtained or applied for in respect thereof, to adopt an agreement with the said A. Marsh and S. Ford, and to carry on the business of manufacturers of and dealers in mechanical and electrical indicating and registering appliances, turnstiles, gates, tickets, and checks, etc. Registered office: Eldon-street House, E.C.

**Penmachno, Corwen, and Bettws-y-Coed Light Railway Company, Limited.**—Capital, £3,000. Objects: to construct or acquire light railways and tramways in the counties of Carnarvon, Denbigh, and Merioneth, or elsewhere, to equip, maintain, and work the same by horse, steam, electrical, or other animal or mechanical power, and to carry on the business of railway and tramway proprietors, etc.

**Telephos, Limited.**—Capital, £10,000. Objects: to adopt a certain agreement (the parties to which are not named), to acquire the property mentioned therein, and to carry on the business of suppliers of electricity, electrical and mechanical engineers, manufacturers and dealers in electrical, magnetic, telegraphic, telephonic, and other apparatus and appliances, etc.

## Liens Registered.

**British Electric Calibrated Fuse Company, Limited, London, E.C.**—Lien registered May 18, for £300 5 per cent. debentures, part of £3,000; amount previously issued, £1,050; no trustees; charged on the undertaking and all the property, including the uncalled capital for the time being.

**Motor Agencies, Limited.**—Registered with a capital of £5,000 in £10 shares. Object: to carry on the business of motor agents, etc. No initial public issue.

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## APPOINTMENTS VACANT.

**Draughtsman,** Metropolitan Asylums Board. Salary, £125 per annum. Applications by June 11.

**Permanent-Way Superintendent,** Leeds. Salary, £300 per annum. Applications by June 16.

**Assistant Lecturer in Engineering.** Swindon Education Committee. Salary, £150 a year. Applications by June 11. See advertisement in former issue.

**Charge Engineer,** York. Salary, £100 per annum. Applications to Mr. C. A Midgley, city electrical engineer, by 13th inst. See advertisement in last issue.

**Instructors, etc.,** Northampton Institute, session 1904 - 5. Instructor in mathematics, engineering departments, salary £100 per session; junior demonstrator, junior technical assistant, junior lecture assistant, electrical engineering department. Applications by June 11. See advertisement in last issue.

**Charge Engineer,** Woolwich Electricity Works. Salary, £109. 4s. per annum. Applications by June 20.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Amelia (Perugia, Spain).**—The Municipality require tenders for an electric light installation. Tenders by Aug. 18.

**Villanueva de la Serena.**—The Municipal Authorities require tenders for the electric lighting of the town by June 25.

**Lincoln.**—The Corporation invite tenders for eight electric tramcars. Specifications, etc., may be obtained from the Electrical Engineer. Tenders by 10 a.m. on June 13.

**Leigh.**—The Corporation invite tenders for (1) one 350-kw. steam-driven set, (2) switchboards. Specifications may be obtained from the Town Clerk. Tenders by June 21.

**Talavera de la Reina (Province of Toledo, Spain).**—The above municipality require tenders for public lighting by electricity from July 1, 1904, to Dec. 31, 1908.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao, including supply of material and rolling stock, by July 6.

**Limoges (France).**—Tenders are invited for lighting the town hall by electricity. The estimate is £600. Tenders by 21st inst. to Préfecture de la Haute-Vienne, Limoges.

**Manchester.**—The Tramways Committee invite tenders for the supply of car wheels and axles. Specifications, etc., may be obtained from the Tramways Manager. Tenders by 18th inst.

**Quantanamo (Cuba).**—Tenders are required for the establishment and working of a telephone system. Deposit, 200dol. Particulars from Direction Générale des Communications, Havana.

**Almeria.**—The Harbour Commissioners require a motor launch. The estimate is 29,000 pesetas, and the deposit required 1,450. Particulars from the Secretary of the above. Tenders by July 6.

**Portsmouth.**—The Town Council invite tenders for pump, pipes, etc. Specifications, etc., can be obtained at the Town Hall, Portsmouth. Tenders by June 11. See advertsement in former issue.

**Colchester.**—The Corporation invite tenders for electric light installation at the car depôt and offices. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by 13th inst.

**Isle of Thanet.**—The Electric Tramways and Lighting Company, Limited, invite tenders for 12 months' supply of electricity meters. Specifications, etc., may be obtained from the Manager, Power Station, St. Peter's, Kent.

**Erith.**—The Urban District Council invite tenders for additions and alterations to the electric light station. Specifications, etc., may be obtained from the Quantity Surveyor, 12, Queen's-road, Erith. Tenders by June 15.

**Erith.**—The Urban District Council invite tenders for (1) rails, fishplates, and bolts; (2) permanent-way construction. Specifications, etc., may be obtained from Mr. C. H. Fry, Council Offices. Tenders by 12 noon on July 11. See advertisement.

**Dudley.**—The Electric Lighting Committee invite tenders for extension of offices and erection of workshops. Specifications, etc., may be obtained from Mr. R. P. Wilson, 66, Victoria-street, Westminster, S.W. Tenders by 12 noon on June 15.

**Loughborough.**—The Gas and Electric Lighting Committee invite tenders from manufacturers for electric cables (including laying), switchboard, steam, feed, blow-off, and other piping, and feed pumps, including erection, by 25th inst. See advertisement.

**Maidstone.**—The Electricity Committee of the borough invite tenders for the supply and delivery of coal to their electricity works, Fair Meadow, Maidstone, until June 1, 1905. Specifications, etc., may be obtained from the Borough Electrical Engineer.

**Madrid.**—The Public Works Department require tenders for the concession to construct (including supply of material and rolling stock) and work an electric tramway from Sarria to the foot of Mount Vallvidrera, in the province of Barcelona. Tenders by July 15.

**Suakim.**—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

**Manchester.**—The Electricity Committee invite tenders for various stores for 12 months, including incandescent lamps, rubber goods, etc. Specifications may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. Tenders by 18th inst.

**Edinburgh.**—The Edinburgh and District Tramways Company, Limited, invite tenders for 12 months' supply from July 1 of various stores, including electric light supplies. Specification, etc., may be obtained from the office of the company. Tenders by 11th inst.

**Finchley.**—The Council invite tenders for supply and erection of one 350-kw. high-speed engine and dynamo combined, with spare armature and spare parts. Specifications, etc., may be obtained from the Council's Electrical Engineer. Tenders by 5 p.m. on 20th inst.

**Warrington.**—The Corporation invite tenders for the supply, delivery, and laying of steel rail, paving, etc., forming permanent way. Specifications, etc., may be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by 12 noon on June 14.

**Wimbledon.**—The Urban District Council invite tenders for two water-tube boilers, economisers, feed pump, and pipework for the electricity works. Specifications, etc., may be obtained from Mr. H. Tomlinson-Lee, chief electrical engineer. Tenders by June 17. See advertisement in last issue.

**Deptford.**—The Borough Council invite tenders for the supply, delivery, and erection of (1) two 25-kw. steam dynamos and a booster, (3) switchboard. Specifications, etc., may be obtained from Messrs. F. H. Medhurst and Lloyd, 13, Victoria-street, S.W. Tenders before 4 p.m. on June 21.

**Cheshire.**—The Committee of Visitors of the Parkside Asylum, Macclesfield, invite tenders for (1) electric light wiring and fittings, (2) electric light plant. Specifications, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 78, King's-street, Manchester. Tenders by June 20.

**Amsterdam.**—A dispatch has been received at the Board of Trade from H.M. Consul at Amsterdam, reporting that on June 15 the Netherlands Minister for the Colonies will be prepared to receive tenders for the supply of (359) zinced iron wire, (360) zinced iron supporters for insulators, and other materials.

**London, E C.**—The Metropolitan Asylums Board invite tenders for supply of builders', engineers', smiths', plumbers', gasfitters', and miscellaneous ironmongery, engineering supplies, and electrical accessories. Particulars may be obtained from the office of the Board, Embankment, E C. Tenders by 15th inst.

**Bridgend.**—The Committee of Visitors invite tenders for supply and erection of complete telephone and fire-alarm installation for the Angleton and Parc Gwyllt Asylums. Specifications, etc., may be obtained from Mr. W. E. R. Allen, Glamorgan County Council Offices, Cardiff. Tenders by 18th inst. See advertisement.

**Philippopolis (Bulgaria).**—The Municipality require tenders for the concession to instal and work the electric lighting of the town and electric tramways in the town and to Stanimako for 50 years. A guarantee of £6,000 is required. Conditions (16s.) may be obtained from the Municipal Secretary. Tenders by Aug. 16.

**Stepney.**—The Borough Council invite tenders for laying on a complete electric light installation at their public baths in Goulston street, Whitechapel, E. Specifications, etc., may be obtained from the Borough Engineer, 15, Great Alie-street, Whitechapel, E., on and after June 6, between the hours of 10 a.m. and 12 noon. Tenders by June 20.

**West Ham.**—The Education Committee invite tenders for the electric wiring and fittings for an installation of electric light at the West Ham Park Elementary Schools, Stratford, E. Specifications, etc, may be obtained from Mr. W. Jacques, A.R.I.B.A., 2, Fencourt, E.C., before the 9th inst. Tenders by 5.30 p.m. on the 20th inst.

**Greenwich.**—The London County Council invite tenders for the supply and erection of two continuous coal and ash conveyors of the gravity bucket type, at the electricity generating station, Greenwich, and for the maintenance of the same for 12 calendar months. Specifications, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on June 14.

**Walthamstow.**—The Urban District Council invite tenders for three Westinghouse gas-engines, starting appliances, piping and accessories, and three continuous-current dynamos, and a spare armature with usual measuring instruments and switchboards to take the same. Specifications, etc., may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on 23rd inst.

**Erith.**—The Urban District Council invite tenders for a steel trough-floored road bridge, with brick and concrete abutments, etc., over the South-Eastern and Chatham Railway at the Lower-road level crossing, Erith, together with making up the approaches, fencing, kerbing, etc. Specifications, etc., may be obtained from Mr. Charles H. Fry, clerk of the Council, District Council Offices, Erith, Kent. Tenders by June 13.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Madrid.**—Tenders are required for the maintenance, preservation, and working of the submarine cables at present in use between Cadiz

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and Teneriffe, as well as certain inter-insular cables in the Canary Islands, for the laying of three new cables—one between Barcelona and Mallorca, another between Tangier and Ceuta, and another between Charafinas and Nemours—and also for the repair of the present cable between Tangier and Tarifa. Tenders for these contracts will be received up to June 14 at the office of the Directorate-General of Posts and Telegraphs, 10, Calle de Carretas, Madrid. A deposit of £2,860 is required. Specifications of the cable required is given in the *Gaceta* of April 16, which may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Reichenberg (Austria Hungary).**—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

## RESULTS OF TENDERS.

**Colchester.**—The Council have accepted the tender of Messrs. Mather and Platt to supply and fix a 360-kw. dynamo for £840.

**Torquay.**—The tender of T. L. Harding and Co., Market-street, has been accepted for the equipment of the Imperial Hotel for electric lighting.

**Sunderland.**—The Electricity Committee recommend the acceptance of the tender of the Electrical Company of Berlin for the supply of rubber cables.

**Middlesbrough.**—The Electric Lighting Committee have accepted the tender of Mr. McNaughton, at £3,370, for the buildings and superstructure of the new electric lighting station.

**Ilfracombe.**—The electric light company's estimate for illuminating the outside of the pavilion, including the laying of the cables and all fittings, at £140, has been accepted by the Council.

**Acton.**—The Urban District Council have placed with the St. Helens Cable Company, Limited, Warrington, an order for the supply of dialite insulated cables, etc., amounting to £31,536.

**South Africa.**—The tender of the Hart Accumulator Company, Limited, Stratford, has been accepted for the supply of a storage battery of 256 central-station type cells required by the Town Council of Aliwal North, South Africa.

**Aston.**—The Town Council have accepted the tender of the Electrical Company, London, for 100 extra time switches at £292. 10s., and for 100 meters, 50 from this firm and 50 from the Reason Manufacturing Company, at a total cost of £340.

**Canterbury.**—The City Council have accepted the tender of the Western Electric Company, at £902, for the supply of cable for the additional feeders from the electric light works to the corn exchange, and from St. Martin's-hill to Bar on Fields.

**Battersea.**—The Council have accepted the tender of Graham, Morton, Limited, at £298, to provide seven 5cwt. measuring boxes complete with revolving shutes, so as to connect up the coal-conveying plant with the coal store provided at the central electric generating station.

**St. Annes-on-Sea.**—The Urban District Council have received the following tenders for the supply of leadless cable for laying solid: Callender's Cable Company (accepted) St. Helens Cable Company, W. T. Glover and Co., British Insulated and Helsby Cables, Anchor Cable Company.

**St. Annes-on-Sea (Lancs.).**—The Urban District Council have received the following tenders for the construction of a concrete tank foundation for a proposed cooling tower at the electricity works, St. David's-road North:—F. Wilson (accepted); Steeden and Co.; J. Monaghan; J. Cheetham; J. Miles, Blackpool; J. Sott, Stafford; J. Farrell, Blackpool; R. Greaves, Derby; Hodkin and Jones, Sheffield; Cook. Rest of St. Annes.

**Wandsworth.**—The Guardians have received the following tenders for wiring electric bells and fire alarms at the infirmary:—

| | | | |
|---|---|---|---|
| Bakewell and Co., King William-street (accepted) | £129 | 10 | 0 |
| J. Wilson, North-street, Wandsworth | 139 | 7 | 0 |
| Clements, Booker, and Co., Victoria-street, Westminster | 147 | 10 | 0 |
| Keeling, Teale, and Co., Hammersmith | 168 | 10 | 0 |
| C. Ross, Walsall | 170 | 0 | 0 |
| G. and H. Turner, High-street, Harlesden | 175 | 14 | 0 |
| Tucker and Co., High-street, Putney | 179 | 10 | 0 |
| Comyn Ching and Co., Castle-street, Long-acre | 205 | 0 | 0 |
| Private Wire and Telephone Installation Company, 5, Falmer-street, Westminster | 216 | 9 | 0 |
| Electrical Engineering and Maintenance Company, 5, Eastcheap, E.C. | 226 | 0 | 0 |
| E. Streather, Tamworth-road, Croydon | 275 | 0 | 0 |

**Mexborough.**—The Urban District Council have received tenders for two 100-kw. direct-driven steam sets from Mavor and Coulson,* Electrical Company; Browett, Lindley, and Co.; Witting Bros., Bruce Peebles, Harding-Churton, Indiarubber Company, Sunderland Forge Company, Bergmann, British Westinghouse Company, Thos. Parker, Lancashire Dynamo Company, Morley Electrical Company, Dewhurst and Co., McClure and Whitfield, Hall and Co., Phœnix Dynamo Company, Alliance Electrical Company, British Thomson-Houston Company, J. Fowler, British Electric Plant Company, Bush Company, General Electric Company; Vickers, Sons, and Maxim; Electric Construction Company, Parsons, Bumsted and Chandler, Industrial Engineering Company; Allen, Sons, and Co.; Mather and Platt, International Electrical Company, Johnson and Phillips, Fullerton, Siemens Bros., Crompton and Co., Skedding. *Accepted with engines by Willans and Robinson, subject to a satisfactory time delivery.

**Middlesex.**—The Visiting Committee of Napsbury Asylum have received the following tenders for wiring and plain fittings required for about 2,500 points:

| | | | |
|---|---|---|---|
| Jones and Spence | £3 200 | 0 | 0 |
| T. Potter and Sons | 4,496 | 0 | 0 |
| H. H. and J. Pearson, Limited | 5,022 | 0 | 0 |
| Wells, Rayner, and Co. (accepted) | 5,343 | 0 | 0 |
| Belshaw and Co. | 6,000 | 0 | 0 |
| W. J. Fryer and Co. | 6,163 | 0 | 0 |
| Wenham and Waters | 6 549 | 0 | 0 |
| D. Hulett and Co., Limited | 7 062 | 0 | 0 |
| Strode and Co. | 7,287 | 0 | 0 |
| Simmonds Bros., Limited | 7,438 | 0 | 0 |
| Comyn Ching and Co. | 7,700 | 0 | 0 |
| Allom Bros. | 7,769 | 14 | 0 |
| Wippell Bros. and Row | 8,000 | 0 | 0 |
| F. Suter and Co., Limited | 9,274 | 0 | 0 |
| Hampton and Sons | 11,955 | 0 | 0 |

**Fulham.**—The Guardians have received the following tenders for fire-alarm systems at the infirmary and workhouse:

| | Infirmary. | | | Workhouse. | | |
|---|---|---|---|---|---|---|
| F. J. Mudford | £155 | 0 | 0 | £295 | 0 | 0 |
| Merryweather and Sons | 176 | 0 | 0 | 377 | 5 | 0 |
| Private Wire and Telephone Installation Company | 82 | 6 | 0 | 302 | 19 | 0 |
| Electrical Accessories Supply Company | 114 | 15 | 2 | 255 | 17 | 1 |
| Wright Bros. and Co. | 70 | 0 | 0 | 210 | 0 | 0 |
| Electrical Engineering and Maintenance Company | 67 | 16 | 0 | 200 | 0 | 0 |
| Albany Engineering Company | 60 | 0 | 0 | 200 | 0 | 0 |
| G. and H. Turner | 57 | 10 | 0 | 183 | 0 | 0 |
| Tamplin and Makovski, Limited | 64 | 3 | 0 | 187 | 4 | 0 |
| J. Bakewell and Co., Limited | 75 | 10 | 0 | 154 | 10 | 0 |
| J. Sax and Co., Limited | 65 | 0 | 0 | 177 | 10 | 0 |
| J. Bolding and Sons, Limited | 32 | 0 | 0 | 167 | 10 | 0 |
| J. Wilson | 52 | 10 | 0 | 157 | 12 | 6 |
| Lea, Son, and Co. | 35 | 5 | 0 | 125 | 0 | 0 |
| Veritys Limited | 37 | 0 | 0 | 122 | 0 | 0 |
| Donnison, Sillem, and Co. | 54 | 0 | 0 | 70 | 0 | 0 |
| Clements, Booker, and Co., 3, Victoria-street, Westminster (accepted) | 22 | 15 | 0 | 96 | 10 | 0 |

# BUSINESS NOTES.

## TRACTION.

**Bath.** — Repairs to the track on Bathcaston-road have been commenced.

**Pembrokeshire Light Railways.**—Public meetings are to be held to discuss the proposed light railways.

**Stockton.**—The Town Council have instructed the town clerk to lodge a petition against the Imperial Tramways Bill.

**Saddleworth and Springhead Tramway.**—The company have abandoned the scheme of tramways authorised in 1902.

**Folkestone.**—The Corporation are petitioning the Board of Trade for an extension of time in which to construct the tramways.

**Watford.**—The company have deposited plans with the Urban District Council, who are considering the question of paving.

**Keighley.**—The proposal to lay double lines in the construction of the route from the railway station to Stockbridge has been rejected.

**Tramway Equipment.**—Messrs. S. Dixon and Son, Limited, have registered the air-gap section insulator shown on p. 17 of their catalogue.

**Wakefield.**—It is stated that a company project a line to Thwaite Gate, and propose to approach the Leeds Corporation with a view to through running.

**Perth.**—It is stated that the plans and specifications for the reconstruction of the tramways electrically have now been definitely approved by the Town Council.

**Bankfoot (Perth).**—A public meeting was held last Saturday, which supported the light railway scheme, and appointed representatives to canvass the district.

**Blackburn.**—At its last meeting the Town Council adopted a proposal that bonuses should be paid to drivers with the object of inducing them to effect a saving in current by careful control of the cars.

**Tyneside Tramways.**—During the week one of the Tyneside Tramway Company's cars made a trial trip along a section of the new line which is being laid from the end of Ashburton-terrace, Gosforth, to Gosforth Park main entrance.

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**Great Western Railway.**—It is reported that the Great Western Railway are contemplating the electrification of their branch line which connects Oswestry with the main line at Gobowen. The branch consists of a single line three miles in length.

**Darlington.**—The first car on the new tramways carried only one passenger, but during the day the service was well patronised, the eight cars carrying 8,000 passengers. The Cockerton route was opened on Saturday, and the remainder will shortly follow.

**Willesden.**—The Middlesex County Council have instructed the county solicitor to serve notices to treat for the property required for the widening of the road in connection with the construction of a tramway authorised between Market-place, Acton, and Willesden.

**Heywood.**—At a special meeting of the Corporation Tramways Committee a petition from the inhabitants of Birch was presented. It asked that the trams should run to the Heywood boundary at Birch. The petition is signed by over 400 persons. The consideration of the petition was left over to the next meeting.

**Raworth's Traction Patents.**—Orders have been received during the week for one demi-car with regenerative control for the Glossop tramways, and for three new cars (full size) for the Scarborough tramways. The number of corporations and councils that have decided to introduce regenerative control is now raised to 10.

**Corwen.**—The Bettws-y-coed Urban Council, whose action in regard to the line to Beddgelert we have noticed, is not opposed to light railways in principle. They passed a resolution in favour of a light railway to Corwen, and have appointed a committee to consider the plans which the company will shortly submit.

**Crewe.**—The Corporation having received a letter enquiring whether they would be willing to allow a company to obtain powers and construct the tramways in agreement with the Corporation, as the latter had abandoned the project, replied that they had not abandoned but only postponed their application for a light railway order.

**Blackpool.**—The Whitsun traffic largely exceeded that of last year, the record number of 51,116 passengers being carried on one day. Notwithstanding this, the receipts showed a considerable decrease over the corresponding period of last year, due to the introduction of 1d fares. The Corporation have now decided to revert to 2d. fares.

**Broughty Ferry.**—It is reported that the Caledonian and North British Railway Companies have withdrawn their opposition to the Tramway Bill, which will receive the Royal assent in August, when the work of construction will be at once commenced. It is expected that the line will be ready for traffic by the beginning of next summer.

**Brighton.**—It is stated that a conference has taken place between the Mayor and Messrs. Macartney and McElroy with a view to avoiding further litigation. The sum suggested in settlement is, however, said to have been considered quite inadequate by the contractors, and a considerable increase will probably be required to prevent further proceedings.

**Coseley.**—The District Council have received a letter from the South Staffordshire Tramway Company stating that they propose to close the tramway from the 15th inst., after which an inspection of the line would be made. It was decided that a deputation should wait upon the company with a view to ascertaining the future intentions of the company.

**Newport (Mon.).**—The report of the first year's working of the Corporation tramways shows total revenue £23,653, with a gross profit of £8,119. 16s. 8d., but of this there has to be paid to sinking fund and interest £7,719. 18s. 11d., leaving a net profit of £399. 17s. 9d. The earning per mile per car is about 9d. There is no Sunday running.

**Curtis Turbines for Japan.**—The Tokyo Railway is constructing a tramway system in Tokyo which is to be operated by electricity. It has been decided to use turbines for the generating plant, and the order has been given for four 1,500-kw. and two 500-kw. Curtis turbine units, together with the necessary switchgear, and 800 G.E. 54 motors for the equipment of the tramcars.

**Wigan.**—At the last meeting of the Town Council it was stated that the tramway reconstruction was proceeding rapidly, and might be completed before the lines in Pemberton were ready. The Council are urging expedition with the Pemberton contractor, so that they may be able at least to run from Wigan to Adams Bridge, if not to the Pemberton terminus, at the very earliest moment.

**Colne.**—The Colne and Trawden Light Railway Company having intimated their intention of applying to the Board of Trade for a further extension of time in which to complete the Laneshaw Bridge route, the Town Council resolved to oppose. Subsequently the Council received a letter from the company's solicitors, giving satisfactory reasons, and it was decided not to offer any opposition.

**Parliamentary Bills.**—The London United Tramways and the Middlesbrough, Stockton, and Thornaby Bills have been read a third time in the House of Commons. The following Bills, which have passed the Lords, have been read a second time: Bournemouth Corporation Tramways, Holywood Tramways, North Wales Electric Power, and Portmadoc, Beddgelert, and South Snowdon Railway.

**Hadley Castle Car Works.**—It is reported that the works at Hadley for constructing electric cars, etc., have been purchased by Mr. G. F. Milne. The works were built five years ago at a cost of over £100,000, and were offered for sale by public auction in London last week, when the highest bid was £26,000, at which price the property was withdrawn. The price now paid for the works is very much in excess of this sum.

**Bettws-y-coed.**—Æsthetic considerations caused the Urban Council to pass a resolution at their last meeting that the Light Railway Commissioners should be approached with a view to requiring the company, in the construction of the railway to Beddgelert, to modify the height of the embankment, and to run through a tunnel at certain points, so as to cause as little interference with the scenery as possible. The Earl of Ancaster is to be requested to support the movement.

**Wednesbury.**—The company has not yet commenced the electrification of the service from Dudley, and the Town Council have adopted a resolution calling upon the company to start operations. Representations on the subject were made to the Board of Trade some weeks ago, and the Town Council have written to the Board asking for a reply. The company state that they have given instructions to their mining engineer to report upon the subsidences along the line of route.

**Salford.**—A resolution to reduce the number of cars in the out districts with a view to economy was rejected by a large majority, it being pointed out that such a step would greatly depreciate the convenience offered by the service. It is reported that the Corporation will commence laying the tramway track between Whitefield Station and Unsworth boundary within a few days, and that on the completion of that line the track for Bury Old-road to Heaton Park will be laid.

**North-Eastern Railway.**—The electric service from Newcastle to Monkseaton has been opened, the system working punctually and smoothly. It is reported that one of the electric cars which the company propose to run between Hartlepool and West Hartlepool has arrived at the latter place, and that several satisfactory trial runs have been made. It is further stated that an electric service will shortly commence running from the Central Station, Newcastle, to Tynemouth, *vid* Riverside.

**London County Council.**—The extension from the present terminus in High-street, Plumstead, to Abbey Wood has involved negotiations between the London County Council and the Bexley Urban District Council as to the purchase of that portion of the Bexley tramways in High-street, Plumstead. It was arranged that the London County Council should give Bexley Council running powers as far as Bereseford-square at intervals of not less than 7½ minutes, the Bexley Council to pay an agreed sum per car mile for the electrical energy.

**Llandudno.**—The Llandudno and Colwyn Bay Electric Traction Company having intimated their intention of applying to the Board of Trade for a year's extension of time for completion of the light railway, the Council have resolved to oppose any extension, and to write to the Local Government Board claiming a proportion of the deposit of £3,000 made by the company as a condition of the granting of the last extension of time, on the ground that the Council have laid down plant at the electricity works in anticipation of the requirements of the company under their contract.

**British Electric Car Co.**—At an adjourned meeting of creditors it was agreed "that, having heard the reports of the liquidator and the committee of creditors, this meeting resolves that the matter remain in the hands of such committee, with the request that they formulate a scheme for the purchase of the business, and ascertain by way of letter the willingness or otherwise of the creditors to subscribe thereto; and if sufficient support be not obtained, the scheme be abandoned." It was stated that efforts had been made to sell the business as a going concern, but up to the present time without success.

**North Wales Bill.**—At a special meeting of the Llandudno Urban District Council it was resolved to ask Mr. W. Jones, M.P., the parliamentary representative, to take such steps as he thought advisable in opposition to the North Wales Power and Traction Bill unless the company agreed not to enter the town without the consent of the Council. The Council object to overhead wires, and they have a large electric supply station of their own. The company submitted certain proposals for a compromise, which the Council considered quite useless. In other parts of North Carnarvonshire the inhabitants favour the company's scheme.

**Kingsland Surface-Contact System.**—This mechanically-operated system of energising street contacts when a tramcar is over them, has been laid down experimentally at Messrs. Maple's depository in Camden-street. A number of representatives of municipal authorities have been shown the system, which was described in our columns some years ago. It will be remembered that with this system a mechanical switch, operated by a trigger on the car, is placed under the track. The trigger projects down into a slot, where it engages with a star wheel on the switch spindle. The depth of slot required is, of course, much less than with the conduit system.

**Belfast.**—At the last meeting of the Corporation it was unanimously resolved: "That words be added to Clause 64 enabling the Corporation to take out of revenue an annual sum equal to that paid to the Corporation by the tramway company; and if at any time the accumulated surplus shall amount to over £20,000, giving the Corporation power to apply the money over that amount to public purposes." The Corporation will endeavour to obtain an amendment to their Bill on the lines of this resolution when the measure, which has already been dealt with by the Lords Committee, comes before the House of Commons Committee. The friction arises owing to the action of the County Down Railway Company, and the Corporation state that the clause as it at present stands is more rigorous than the "Aberdeen" clause.

**Bury.**—The arbitration proceedings in connection with the acquisition of the undertaking of the Bury, Rochdale, and Oldham Tramways Company by the local authorities through whose districts the tramways run were continued in London on Monday before Mr. Graham Harris. Mr. Platt, engineer to the Rochdale Corporation, stated in the course of his evidence that he considered the rails which had only been kept going by patching were worn out. Mr. S. B. Cottrell, manager of the Liverpool Overhead Railway, gave evidence as to the value of the permanent way. He put the present value at £62,042. He had only allowed a life of 20 years for the rails because experience had shown that the lines in that district had not lasted longer than that period.

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The rails were now worn out, and the engines and cars were running on the flanges. The proceedings were adjourned for a fortnight.

**Stalybridge, Hyde, etc., Tramways.**—The Electricity Board have decided to inform the Ashton Corporation that the Board will be in a position on the 13th inst. to run their own cars on the Stamford-street length, and the agreement for running through cars will then cease. The Board are prepared to run alternate cars with the Corporation on the terms already submitted by the Board—viz., equal service of cars, and each authority to take its own receipts—and failing the acceptance of these terms Ashton must cease running their cars to Stalybridge on the 12th inst. A further resolution read: "In the event of the Ashton Corporation not accepting the terms, the sub-committee are instructed to make arrangements for running the Stalybridge traffic to Scotland Bridge *via* Park-road on the 13th inst."

**Poole.**—The arbitration in connection with the purchase of the company's undertaking by the Bournemouth Corporation is proceeding. The company's claim amounts to £427,619, composed of: sum agreed to be paid by the Corporation under the agreement with the company, £5,500; cost of Poole line, £224,800; estimate for increased traffic, £53,916; value of the 1903 extension order, £38,370; value of the running powers over the Bournemouth lines, £41,471; value of the feeding effect of the projected Canford Cliffs tramway, £2,500; value of the feeding effect under the 1903 extension order, £35,550; value of the feeding effect of the projected line to Poole Quay, £4,175; estimated value of the Christchurch rights, £54,750; cost of land at Bargates, Christchurch, £350; estimated value of parcels traffic, £2,776—less capital expenditure, £36,530. The Poole line is 3¾ miles in length.

**Newcastle.**—The House of Commons Committee has taken evidence upon the inter-running question between the Corporation and the company. Mr. Wm. McLellan (the company's engineer), Mr. Gerald Stoney, Mr. Stephen Sellon (consulting engineer to the British Electric Traction Company, who said his company had no connection with the Tyneside Company), and other witnesses have given evidence on behalf of the promoters. Mr. A. E. Le Rossignol, manager of the Corporation tramways, gave evidence on behalf of the Corporation, comparing in detail the undertakings of the Corporation and the tramways company. Out of an average of 40 passengers carried per car on the Wallsend route, only 10 per car arrived at the break between the systems, and out of that 10 only two transferred to the company's cars, the eight not wanting to go beyond Wallsend. The councils of Willington, Willington Quay, and Gosforth favour a through service. The committee has adjourned.

**Sheffield.**—The tramways manager recommends that the service to the Midland Station, which has latterly yielded average receipts of only slightly more than 2d. per car mile, should be discontinued, as he is convinced that any service restricted to this route will not pay working expenses. The service he recommends for the Shoreham-street route, which, with the Snighill line, will be completed shortly, provides for the Midland Station district. At the last meeting of the Council it was stated that the Tramways Committee have the proposed extension from Hillsborough to Malin Bridge in view, but do not propose to commence operations at present, as it did not promise sufficient revenue. Notice has been published on the cars and upon the backs of the tickets limiting the liability for accidents to £25. A councillor considered this illegal, and intimated at the last meeting of the Council his desire to be prosecuted next time he rode on a car, as he should refuse to produce his ticket to the inspector by way of protest. The chairman of the Tramways Committee thought that this wish could be gratified.

**Leeds.**—The "split turn" system having proved unpopular, the Tramways Committee received a deputation of the employés, who requested that the "double-shift" principle should be reverted to. The committee are making enquiries, and will hold another meeting on Monday. The Rawdon, Yeadon, and Guiseley Councils have desired a further interview with the Leeds Tramways Committee on the question of the extension of the city tramways through their boundaries, and have expressed their willingness to make some contribution towards the cost of the maintenance of the roads. The Leeds Committee have appointed representatives to meet a deputation from the Rawdon, Yeadon, and Guiseley District Council, and to discuss the matter. The tramway project of Horsforth has not been abandoned. The provisional order which was obtained last year by the Horsforth District Council for the construction of tramways within their area has been taken over by the Leeds Corporation, and that body are only awaiting powers from Parliament to work tramway lines outside the city boundary before commencing the works of construction.

**Nottingham.**—At the last meeting of the Council a recommendation was submitted for an extension to Sneinton. The city engineer has prepared plans of the proposed route. There was also a proposition that the construction of the tramway along Forest-road be commenced. The following is a summary of the revenue and expenditure for the years ending March 31, 1903 and 1904, respectively: total receipts, £115,223. 0s. 1d. (£128,205. 5s.); total expenses, £60,873. 0s. 9d. (£71 258. 15s. 2d.); interest on stock and loans, £13,664. 1s. 5d. (£15.333. 4s. 10d.); contributions to sinking fund, £5,830. 18s. 4d (£5 830. 18s. 4d.); instalment for repayment of loans, £2,666. 13s. 4d. (£9,297. 5s. 10d.); contribution in aid of rates, £18,000 (£13,000); transferred to reserve fund, £12,984. 3s. 10d. (£13,482. 0s. 10d.). It appears that the cars ran 2,512,000½ miles, an increase of 394,799½ miles over the previous year; but, in consequence of the bad weather and the increased mileage run by the cars owing to improved services, the average receipts fell from 13·06d. to 12·24d. per mile, notwithstanding that there was an increase in the receipts of £12,962. 4s. 11d.

**Glasgow.**—The Caledonian Railway Company have now decided to issue cheap weekly season tickets to the suburbs. The zone system of season tickets is being tried experimentally, and, commencing on the 6th inst., the tickets are issued between Glasgow and Cambuslang at fares of 2s. 6d. first class and 1s. 6d. third class. Similar tickets are also to be issued between Port Glasgow and Greenock and Gourock. The districts selected are well suited to the test. The laying of the tramway lines in Finnieston-street, North-street, and St. George's-road, forming a cross connection between Keppochhill-road and Stobcross Ferry at the foot of Finnieston-street, is nearing completion, the only piece of work remaining to be done being the junction at St. George's Cross. Meantime, a portion of the route will be opened for traffic. The official statement of the working for the past year, which has just been issued, shows: passengers carried, 188,962,610—an increase over the preceding year of 11,783,060; car mileage, 16,285,654 miles—increase, 2,176,904; traffic revenue, £717,893. 4s. 2d.—increase, £64,693. 6s.; average traffic revenue per car mile, 10·58d.—decrease, ·61d.; and average track mileage open during the year, 135 miles—increase, 16 miles.

**Birmingham.**—The report of the Tramways Committee recommends that they be authorised to promote a Bill in Parliament in the session of 1905 to enable the Council to construct tramways along the 16 different routes mentioned in the report. It is proposed to take powers to construct the tramways for any form of electrical or mechanical traction. The total length of tramways now proposed, reckoned as single track, is about 39¼ miles, and the cost, if constructed on the electric overhead system, is estimated at £295,000. The sum is exclusive of the cost of street widening, power sheds, depôts, or rolling-stock. The committee are unable to report at present as to the cost of the necessary street widenings. This will be brought before the Council at an early date, but as a general principle they consider that where a widening is wholly for the purposes of tramway extension the cost should be charged to that department. Where, however, a street widening is probably anticipating or extending a public works improvement, they suggest that the cost should be apportioned between the public works and tramways department. The cost of the extension of the tramways in Coventry-road was £7,610. 17*s*. 3d. The estimated cost of the alteration of the Small Heath route, as approved by the Council at the last meeting, based for the most part upon actual tenders, is £32,000, and the committee recommend that the Finance Committee should be instructed to borrow these amounts.

**Aberdeen.**—At the last meeting of the Town Council the Tramways Committee reported that they had under consideration a report by the burgh surveyor as to the condition of the permanent way of the track between Merkland-road and the Bridge of Don, and also between Bloomfield-road and the Bridge of Dee. The cost of doubling the line between Merkland-road and Bridge of Don for permanent way was estimated at £12,800, and that between Bloomfield-road and Bridge of Dee at £7,150. The committee recommended that these two sections of the lines should be doubled, the cost, as estimated, being £19,950. In connection with the doubling of the line on the Bridge of Dee section, it was proposed to lower the road at Holburn-street Bridge to the extent of 2ft., with the view of enabling cars with top covers to pass under the railway bridge, the estimated cost being £350. The cost of the alteration of the overhead wiring will be £500. For the 52 weeks ended on Saturday last the revenue from passenger fares amounted to £62,794. 10s. 4d., compared with £50 003. 6s. 1d. for 52 weeks last year, being an increase of £12 791. 4s. 3d. For the same period the expenditure on electricity and wages amounted to £26,530. 3s. 3d., against £15 120. 6s. 11d., being an increase of £8,409. 16s. 1d. For the three days not included in the official return the additional income may be set down at about £500, and the expenditure at about £350. Besides the charges for electricity and wages, the department has to provide for maintenance and repairs, general charges, and depreciation, which last year amounted to over £9.000, when the balance carried to next revenue account was £23,414. The estimated income for the year just closed was £63,700, and the estimated expenditure under all the heads, including depreciation, interest, and sinking fund, was £48,938, leaving a balance to renewal account and reduction of capital of £14,262.

## LIGHTING AND GENERAL.

**Wednesbury.**—Applications for 1,000 lamps have already been received.

**Camborne.**—The Urban Electric Supply Company are carrying out extensions to their mains.

**Maidenhead.**—The borough surveyor is about to report as to the cost and type of dust destructors.

**Warrington.**—Sanction has been received to the borrowing of £5,000 for purposes of electric lighting.

**Cheshunt.**—The Urban District Council are taking steps to obtain telephonic communication, call office, etc

**North Wales Electric Power Bill.**—This Bill was read a second time in the House of Commons on Tuesday.

**Bexhill.**—The engineer is about to lay a cable to the sewage lift at Little Common at an estimated cost of £380.

**Dawlish.**—The amended agreement with Messrs. Crompton and Co. has been adopted by the Urban District Council.

**Stockport.**—The price of current is now 4d. per unit for lighting and from 1½d. to 3d. per unit for power purposes.

**Paignton.**—The old mill buildings are to be utilised as a generating station in connection with the new electric light scheme.

**Rotherham.**—Sanction has been received to the application of the Corporation to borrow £14,670 for electric light purposes.

**Longton.**—The output of electricity during May was 6,971 units, being an increase as compared with last year of 20 per cent.

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**Huntington.**—A telegraph line is to be laid to Huntington, which lies about the same distance from York, Haxby, and Strensall.

**Commercial Cable Co.**—The directors have declared a quarterly dividend at the rate of 8 per cent. per annum, payable on July 1.

**Aspull.**—The District Council are corresponding with the Lancashire Electric Power Company regarding the proposed charges for electric current.

**Carnarvon.**—Sanction has been received to a loan of £17,000 for the purpose of supplying the town with a scheme of electric lighting and power.

**Southend.**—The demand for electricity for lighting purposes is increasing so much that additional machinery is being put down at the Corporation electricity works.

**Liverpool.**—The Dock Board have decided to spend £1,500 on electric lights at the new Brunswick Dock river entrance and at the 100ft. passages to the Coburg Dock.

**Erith.**—The following have been appointed members of the Electric Lighting and Tramways Committee: Messrs Johnston, Masson, Stallwood, Everett, Grey, Vickery, and Wren.

**Newcastle.**—It has been decided to allow the lighting of Welbeck-road by means of overhead wires. The permit is limited to five years. A number of 120-c.p. lamps will be installed.

**Nelson.**—Applications for the supply of electricity for motive power to mills are being investigated. The rent charged for electricity meters has been reduced from 2*s.* to 1*s.* per quarter.

**Poplar.**—The Borough Council have decided to apply to the London County Council for permission to raise a loan of £59,000 for the purpose of extending their electric lighting installation.

**Langdon-Davies Motor.**—This company have standardised single-phase alternate-current circuits having a periodicity of 60, and have issued a small list giving prices from ½ b.h.p. to 6 b.h.p.

**Luton.**—The Electric Lighting and Power Committee are about to expend £870 for extensions of cable to enable them to carry out an agreement with the Vauxhall Iron Company for supplying energy.

**Barrow.**—Application is to be made for further borrowing powers to the extent of £35,000 in order to provide for extensions to plant. A reduction in the price of electricity to 4½d. per unit to dwelling-houses is proposed.

**Dudley.**—The Tramway and Lighting Committee's report for the past month shows that 131,075 units were generated at the power station. Of this amount the tramway company took 85,124 units, and 226 private consumers 29,880.

**German-Dutch Cable.**—A syndicate is being formed with the object of laying the projected German-Dutch cable to connect the Dutch East Indies and the Pelew Islands with Shanghai and the American cable to the Philippines.

**Worthing.**—Sanction has been obtained to a loan of £5,600 for the provision of a refuse destructor, and the surveyor is about to prepare the necessary detailed plans, sections, and specifications for the same with a view to inviting tenders for the work.

**Maidstone.**—The Urban District Council have agreed that the following charges be made to the Light Railways Committee for the supply of energy: for first 200,000 units, 2d. per unit; for second 200,000 units, 1¾d.; beyond this amount, 1½d.

**Bo'ness.**—At a special meeting of the Town Council last week it was decided to instruct the electrical engineer to get statistics from parties who have producer-gas plants in use, and lay that and other information before a future meeting of the Town Council.

**Mansfield Woodhouse and Sutton-in-Ashfield.**—The Bill containing the orders authorising the Urban District Councils of Mansfield Woodhouse and Sutton-in-Ashfield to supply electricity within their respective districts has passed the Examiners of the House of Commons.

**Eccles.**—We understand that the arc lamps for which borrowing powers are sought have already been erected, the committee fearing that an accident might occur for want of light. The loss on the electricity account has been reduced from £476 in 1902 to £257 last year.

**Macclesfield.**—The Town Council have resolved that the consideration of the question of erecting an electric lighting installation in the borough be deferred until the chairman has prepared for submission to the committee the details of the proposed scheme now outlined by him.

**Perth.**—The Electricity Committee of the Town Council on Tuesday agreed to recommend the Council to introduce a fan to improve the draught in the flue at the electric works, it being expected that a considerable saving would be effected in the quantity of coal used at the station.

**Sleaford.**—The last report of the Electric Lighting Committee shows that the expenditure on the capital account amounts to £9,043. The total expenditure was £487 and receipts £1,129, showing a gross profit of £642. On the net revenue account there was a balance of profit of £204.

**Stroud.**—The National Telephone Company have commenced laying underground wires. The Bill to confirm an order to enable the Gloucestershire Electric Power Company to supply electricity in the districts of Stroud, Nailsworth, and Dursley, has passed the examiners of the House of Commons.

**Cheltenham.**—We understand that the Town Council will ask the president of the Institution of Civil Engineers to nominate an expert to investigate the working of the lighting undertaking, and to report as to its management. Sanction to a loan of £4,132 for purposes of electric lighting has been received.

**Caerphilly.**—A Bill to confirm Caerphilly electric lighting provisional order made by the Board of Trade has passed the examiners in the House of Commons. The Barry Railway Company and the Rhymney and Aber Valleys Gas and Water Company will oppose the order when the committee stage is reached.

**Hastings.**—The Council are purchasing 20 10-ampere meters at £3. 5s., 20 25-ampere meters at £3. 10s. each, and 10 50-ampere meters at £3. 15s. each, from Messrs. Ferranti Limited, of Hollinwood, Lancashire, subject to the conditions providing for the maintenance of the meters in working order for a period of three years.

**Sunderland.**—The Electricity Committee after considering the Electric Lighting Bill, which will repeal the Act of 1888 and give private companies and other authorities outside municipal authorities power to apply for land inside the borough, etc., have decided to recommend the Council to oppose the Bill at the next meeting.

**Rhodes Electrical Mfg. Co.**—The directors have declared an interim dividend for the half-year ending May 31, 1904, at the rate of 6 per cent. per annum (or 7½d. per share) on the ordinary shares of the company. Cheques for the dividend will be posted on or before June 15 next to all shareholders registered on the company's books on 1st inst.

**Redditch.**—The works manager has received applications for the supply of a large amount of power from a firm in the town. It involves an increase at once of 175 h.p., to be increased gradually up to 300 h.p. Steam has been adopted for the generating plant, and an offer for the lease or transfer of the undertaking to a private client has been declined.

**Bradford.**—The profits of the Bradford Corporation electricity department show a balance on the right side, although the committee has been charged with £1,000 for town hall administration expenses, which did not appear in last year's accounts. The receipts in excess of payments for the year ending March 31, 1903, were just short of £400.

**Penge.**—A letter from the Beckenham District Council asking upon what terms the Council would sanction the extension of the Beckenham electric lighting cable from the parish boundary along the Beckenham road in order to supply the Crystal Palace Park-road, which is in the Beckenham district, is before the Works Committee of the Urban District Council.

**Lincoln.**—The last year of the electricity department has been satisfactory. If it had been a private concern, the undertaking could have paid a dividend of something like 7 per cent. Although the committee has received £793 more in sales, the increased expenditure was only about £200. The cost was 1·59d. per unit, compared with 1·69d. last year.

**Blackburn.**—The Electricity Committee have approved the recommendation of the engineer (Mr. Giles) that the charges for lighting and power be revised, and that meter rents be abolished. The new tariff provides for a uniform rate of 4d. per unit for lighting, or, at the option of consumers, at the existing rate of 6d. and 3d. per unit on the rebate system.

**Southern Nigeria.**—The land telegraph line connecting Lagos with Forcados, Southern Nigeria, is to be completed and opened for traffic in about a week. Old Calabar, the headquarters of the Southern Nigeria Government, has also just been connected by telegraph with England, the first message having been received in Liverpool from Old Calabar on Monday last.

**Rand Central Electric Works.**—A cablegram from Johannesburg, notifying the result of working for the month of May in the *Financial Times*: "Kilowatt-hours generated, 968,680; yielding a gross revenue of £8,500." (Office note.—For the corresponding period of last year the result was: kilowatt-hours generated, 670,635; yielding a gross revenue of £6,006.)

**Colchester.**—The committee have adopted a reduction in the charges of current for motor purposes, as follows: up to 100 units per quarter, 4d. per unit; 100 to 500 units per quarter, 2¾d.; over 500, 2½d. The following statistics are reported: output in units during April, 1904, 25,563; 1903, 20,082; 1902, 12,849; number of 8-c.p. lamps, 24,917, 22 527, 15,640.

**Dover.**—The Local Government Board having been informed that the Council are considering a scheme for free wiring, and if adopted proposes to apply for a loan for that purpose, have replied that they are willing to consider the question of sanctioning a loan to cover estimated prospective expenditure for three years if desired. The engineer is to submit estimate accordingly.

**Gorton.**—Notice has been given of intention to transfer the undertaking authorised by the Gorton Electric Supply Order, 1899, to the Corporation of Manchester. The Urban District Council will reserve the right to purchase at the end of 21 years, computed from March 31, 1905, or at the end of any subsequent period of five years, upon the terms of Section 2 of the Electric Lighting Act, 1888.

**Birkenhead.**—The Town Council have now decided to obtain powers to the loan of £20,000, referred to in our issue of May 13, for the cables, meters, and other service materials required in the next three years. The report of the borough treasurer upon the revenue accounts of the electricity supply undertaking for the year ending March 31, 1904, shows an available balance of £1,386.

**Middlesbrough.**—The electric lighting department is showing very satisfactory progress under Mr. H. M. Taylor, the electrical engineer. The revenue has increased by 100 per cent., while the cost has only increased by 50 per cent. The charge per unit is very low compared with other similar undertakings in the country. Last year's net profit was £534 as compared with a net deficit of £405 in the previous year.

**Wrexham.**—The electrical engineer has placed the following figures before the Electricity Supply Committee: connections and supply—used for tramways, April, 1904, 11,503; April, 1903, 11,050; used for light and other purposes, 22,635; April, 1903, 18,104; units generated, April, 1904, 34,138; April, 1903, 29,154; new consumers connected, April, 1904, 2; April, 1903, 5; total number of consumers, April, 1904, 135; 1903, 129.

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**Exmouth.**—The Electric Supply Corporation, Limited, propose to ask the Board of Trade to extend the time of the order. They have informed the Council that all arrangements had been made for the capital necessary for carrying out the Council's undertakings, and they had decided to purchase a site for the generating station. The designs for the station were being prepared, and, together with those for the mains, would be forwarded in due course.

**Leek.**—The electricity generating station was formally opened last night. The public are invited to inspect the works to-day and to-morrow. A small exhibition of fittings, radiators, motors, etc., is on view in full working order and driving various machines. All consumers whose premises are wired for electricity were supplied from 6 p.m. on the opening day until 12 midnight free. A searchlight display also took place between 9 and 10 p.m. from the Black's Head Hotel.

**Stourbridge.**—The Midland Electric Company have offered to accept from the Council a notice of six or twelve months to discontinue the supply, and further, should notice to discontinue the supply be given, the company would take over all motors and arc lamps on a basis of 10 per cent. per annum reduction on the net cost, and all motors at a reduction of 5 per cent. per annum on the cost. The Council at their last meeting agreed to take the electricity in bulk for the compulsory area stated in their provisional order.

**The Government and Telephones.**—The Postmaster-General on Monday said, in reply to a question, that negotiations with the National Telephone Company on the subject of the purchase of their system were not concluded, and while they were still in progress it could hardly be expected that he should make any declaration of the intentions of the Government as to terminating the company's license by notice. If any arrangement was come to, he had every intention to fulfil his promise to bring it before Parliament for approval.

**Belfast.**—Subject to confirmation by the Council, the following charges for electricity for lighting purposes will come into operation from and after July 1: a uniform rate of 4d. per Board of Trade unit for all classes of lighting, subject to the following scale of discounts if payment be made within one month after the end of the quarter: one to 1,000 units per quarter, 2½ per cent. discount; 1 000 to 1,500, 5 per cent., rising by an additional 2½ per cent. for each 500 until 5,000 units per quarter are reached, when the discount will be 25 per cent.

**Stock Exchange.**—The Stock Exchange Committee have ordered Edmundson's Electricity Corporation, Limited, further issue of 20,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 50,001 to 70,000, and a further issue of £31,467 4½ per cent. first mortgage debenture stock (redeemable), to be quoted in the official list. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Metropolitan Electric Tramways, Limited, £350,000 4½ per cent. debenture stock.

**Bootle.**—The Electric Power and Lighting Committee have decided that for power purposes electricity be supplied on special terms under a formal agreement. With regard to wiring houses, the town clerk has been asked to report upon a report recommending that the Corporation should offer to instal and fit complete six lights in not more than four positions in each, of not less than six adjacent houses, the work to be executed on application by the owners under contract, and paid for by the Corporation in the same manner as in the case of free wiring installations, or obtained out of the revenue reserve account.

**York.**—The City Council have adopted a report of the Asylum Visiting Committee recommending the Council to empower them to put down electric power and lighting plant at the asylum to meet their requirements. The accounts for the year ended March 31 show that total loans to the amount of £100,850 have been sanctioned, and all but £7,924 borrowed. The revenue for the year amounted to £9,112 of which £4 149 was transferred to the net revenue account, leaving £3,799 absorbed by interest and sinking fund, and £550 transferred to reserve fund. The accounts after these transfers show a deficit of 14s. 5d.

**Scotch Electric Lighting Orders.**—The Glasgow Corporation have petitioned against the Barrhead electric lighting provisional order, Lanark County Council against the Bothwell order, Glasgow Corporation and Renfrew County Council against the Eastwood and Cathcart order, Renfrew County Council against the Johnstone order, Dumbarton County Council and Glasgow Corporation against the Kilpatrick order, Renfrew County Council and Glasgow Corporation against the Renfrew order, and Airdrie, Coatbridge, and District Water Trustees, Glasgow Corporation, and Lanark County Council against the Shettleston order.

**Portsmouth Dockyard.**—The work in connection with the lighting of Portsmouth Dockyard by electricity has recently been begun. Some vacant land close to the present electrical shop is now being prepared for the erection of the main generating station, and official houses, as they become unoccupied, are being taken in hand and wired for electric light. The whole of the electrical part of the improvements will be under the supervision of Messrs. Preece and Cardew, consulting electrical engineers to the Admiralty, and that of the buildings under Major J. Davidson, R.E., superintending engineer of Portsmouth Dockyard.

**Chiswick Telephones.**—With regard to an application received from the Postmaster-General asking permission to erect telephone poles, it has been decided to request the department to put the lines underground. The question of tariffs was discussed at last week's Council meeting, and the 1d. zone system was objected to on the ground that while in Chiswick they could call up a resident at its extreme end for 1d., when they called someone up a few yards away, but just over the border into Hammersmith, they had to pay 2d. It was agreed to suggest to the Postmaster-General that the rate should be 2d, each for the first 90 calls and 1d. each afterwards.

**Municipal Electrical Undertakings.**—The Police and Sanitary Regulation Committee of the House of Commons (Sections A and B) had under consideration on Monday and Tuesday, in the Leyton Urban District Council Bill and the Swindon Corporation Bill, the application of what is known as the "Bermondsey" clause to the electrical undertakings of municipal authorities. The committee (Section A), of which Mr. Corrie Grant was the chairman, refused the clause. On a similar application being made to the committee (Section B) presided over by Mr. F. W. Wilson in connection with the Swindon Corporation Bill, the committee declined to put the clause on the Corporation.

**Exeter.**—The Electric Lighting Committee have reported to the Council that it is desirable, in the interests of the undertaking, to establish a central enquiry office and showroom in the city, and to appoint a business manager and canvasser, who should be provided with an office. In regard to the question of introducing turbines for the generating machinery for the tramway supply, the electrical engineer having reported that there would be no economy in the working of a steam-turbine of less size than 500 kw., the committee resolved that tenders be invited for a triple-expansion vertical enclosed engine of a similar type to those already installed in the electricity station.

**Sheffield.**—Alderman Styring, on the electric light minutes being brought forward on Wednesday, said the result of the last year's working was fairly satisfactory. The revenue showed an increase of about £10,000 on the preceding year. When the Corporation purchased the undertaking in 1898 the revenue was £19,038, and it was now three times that amount, last year being £57,100. The surplus for the year was £5,430, and, having regard to the increased interest and sinking fund, that was a better result than was anticipated at the commencement of the year. The total accumulated surplus now stood at £21,002 He hoped shortly to be able to announce the date for opening the new power-house.

**Tanfield.**—The surveyor is about to furnish data respecting the probable cost of providing a power station to supply the whole of the Tanfield area with electric light, giving an estimate of the cost of land, house, plant, erecting, fixing, etc., of a power station complete, to combine public and private lighting. Mr. McCartan's opinion is to be obtained to ascertain the legal position of the Council together with that of the Cleveland and Durham and the Northern Counties Electricity Supply Company relative to the supply and distribution of electric light. At the same time the Cleveland and Durham County Electric Power Company will be asked for a quotation for the supply of electricity in bulk.

**Torquay.**—The Mayor, chairman of the Electric Lighting Committee, stated at the Town Council meeting on Wednesday that the number of lamps supplied with current from the generating station had increased from 20,865 in 1903 to 22.176 at the present time, whilst the station had only power to supply 22 000. On it being suggested that the price should be reduced from 7d. to 6d. per unit, and also that small consumers should not be charged meter rent, the mayor said the taking off of 1d. from the 7d. per unit would result in a loss, but the suggestion that small consumers be not charged meter rent was a very good one, and he hoped the committee might be able at no distant date to remove the charge for meters altogether.

**Dundee.**—In connection with the new electric station proposed to be erected in Dundee for the purpose of supplying motive power to the mills and factories of the city, the *Dundee Advertiser* understands that the preliminary arrangements have now been completed, and that steps will be taken on an early date to bring the matter before the Town Council with the view of coming to an agreement with that body before applying to Parliament for a provisional order. The proposal is to erect a station in the vicinity of the harbour, and lay the cables through the streets to all parts of the town. It has been decided to retain the present flat rate. The electricity accounts show an increase of revenue amounting to £4,000, and, in consequence, a recommendation is to be made that the charge for current to the tramway department should be reduced.

**Dublin.**—Since sanction was obtained to the raising of a supplemental loan of £50.700 for the completion of the city electric lighting undertaking, and the intimation was received from the Board of Works that the Treasury could not advance the money, the city treasurer has been endeavouring to raise the loan from private sources. Although he received more than one offer of the amount at 4 per cent. interest, he felt this was not a rate which the committee should bind themselves to pay for a long term. The Council have now empowered him to arrange with the Bank of Ireland for a loan at 4 per cent. under conditions which will enable the Corporation, should the market improve, to pay off the amount borrowed and outstanding at the end of two or three years, by means of a loan raised for the balance of the period at a lesser interest.

**Bristol.**—The Town Council have adopted a report in which the Electrical Committee stated that, having regard to the continual growth of the undertaking, they deemed it advisable that the second instalment of the Avonbank station should be completed, and the foundations for the third instalment be put in hand at once, at an estimated cost of £89 000, made up as follows: machinery equipment, £74,000; construction of foundation (third instalment), £15,000. In addition, they desire to provide additional mains, meters, substations, transformers, etc., at an estimated cost of £21,500, and they recommend that they be authorised to apply to the Local Government Board for their sanction to the borrowing of these various sums, amounting in the aggregate to £160,000, and that if such sanction be obtained they be authorised to carry out the necessary works.

**Swindon.**—The Corporation electrical works, which have now been running 12 months, have proved considerably more successful even than was anticipated. On May 30, 1903, 40 consumers were connected and 2,727 8-c.p. lamps were put in. During the 12 months there has

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been an increase of 156 consumers, and 6,973 8 c.p. lamps put in, making a total of 196 consumers and 9,700 8-c.p. lamps put in. In addition to that there are 47 horse-power of motors in operation in connection with the works. There have also been 132 street lamps connected. As an instance of the progress made it may be mentioned that when the works were opened 12 months ago, it was estimated that it would take two years before 12,000 lamps were connected, but that number has been nearly reached in 12 months' working. The revenue, it was estimated, should be £1,000 for the first year, but after 10 months' working the revenue has reached to over £2 300.

**Crewe.**—The uniform or flat rate of charge for current for lighting purposes is to be reduced from 4½d. to 4d. per unit from the March 31 last. The electrical engineer's report of the year's working up to March 31 shows a sale of 402,308 units (170,398 to private consumers and 231 910 for public lighting). This means an increase of 49,080 units sold over the previous year, of which 38 373 were supplied to private consumers and 10,707 to public lighting. Thirty new consumers were connected, the total now reaching 235. The average price obtained from private consumers was 3·68d. per unit. Last year the price obtained was 3·90d. The works costs have been reduced from ·94d. to ·87d., and the total costs, excluding interest and sinking fund, was from 1·26d. to 1·23d. per unit sold. The total cost, including interest and sinking fund, was 2 71d. per unit sold, against 2·89d. last year, a reduction of ·18d. per unit. The surplus this year, after paying all charges, was £1,116. 1s.

**Blackheath and Greenwich District Electric Light Co.**—The Board of Trade have approved of the agreements for the purchase of the undertaking of the Crystal Palace District Electric Supply Company, Limited, and possession of this business is to be given to the company within the next few days. We have been supplied with the following particulars as to the progress of the company's business during the present year: June 1, 1904—number of consumers connected, 1,942 (67,451 8 c.p. (35-watt) lamps; awaiting connection, 115 (2,822), making a total of 2,057 consumers with 70,273 8-c.p. lamps. The number of lamps connected on June 1, 1904, was 18,094 more than at the same period of last year, being the largest increase in the history of the company. The result for the March quarter, as compared with last year, is approximately as follows: gross revenue—1904, £6,612 (1903, £5,000)—increase £1,612; expenditure, £2,519 (£2,168)—increase £351; net revenue, £4,093 (£2,832)—increase £1,261.

**Glasgow.**—The Corporation have agreed to bear the cost of the provisional protection of an improvement of telephone apparatus by the assistant general manager (Mr. Macphee) on condition that the Corporation will, free of all charge for royalty, have the use of it for their telephone system. A minute of the telephone department has also been approved containing a statement to the effect that the chairman referred to the termination of Mr. Bennett's service as general manager, and on behalf of the committee expressed their appreciation of the able manner in which he had discharged the duties of his office. At a meeting of the Lower Ward District Committee of Lanark County Council, on Tuesday, it was reported that steps had been taken with a view to having the telephone poles removed from the Shettleston and Tollcross roads. Mr. Douglas, M.P., had brought the matter under the notice of the Postmaster-General, who replied that he could not consent to the removal of the poles. It was agreed to bring the matter before the County Council in order that further action might be taken.

**Southwark.**—The position of Mr. Rutherford Blaikie, the borough electrical engineer of Southwark, was the subject of an important discussion at last Wednesday's meeting of the Southwark Borough Council. The subject came up in the form of a report from a sub-committee dealing with Mr. Blaikie's alleged mismanagement of the undertaking. This report, together with Mr. Blaikie's observations thereon, appeared *in extenso* in our last issue. Mr. Alderman T. Haynes (the mayor) presided, and there was a large crowd in the public gallery. Before resuming the discussion, the Mayor stated that he had received a letter from Mr. Blaikie requesting that it should be read at that meeting and circulated amongst the members of the Council, but he (the mayor) considered the contents to be of such a libellous character, that he had decided that it should not be read. After a long discussion the recommendation, "That the resident engineer be given three months' notice to terminate his appointment," was agreed to, the voting being 35 for and 11 against, and the committee's report was adopted.

**Bridgend.**—The electrical engineer has submitted a further report on the arc lamps, in which he says "that from the date Crompton's man left up to the present the lamps have behaved in a satisfactory manner, and I have no reason to doubt but that they will continue to do so. It is interesting at this stage of the arc lamp question to point out in what manner all the trouble with the arc lamps which the Council have experienced could have been avoided. There are two clauses which are sometimes inserted in arc lamp specifications for town lighting as follows: (1) 'That lamps should be of a type which had been previously used for street-lighting; (2) that the lamps should burn for a certain period (say, four weeks) without extinctions.' Had the first clause been inserted in the Bridgend lighting specification the lamps would never have been installed, as alternating-current lamps of the Bridgend type had not previously been used for street-lighting, and if any other type lamp had been supplied the second clause would ensure that the lamps would burn for a reasonable period without extinctions, which the Council's lamps never did until they were re-designed."

**Bredbury and Romiley.**—A sub-committee of the Tramways and Electric Lighting Committee recently waited upon the Stockport Corporation Electricity Committee with regard to supplying the Council with electricity in bulk for power and lighting purposes. It was suggested that the supply might be derived from the tramway trolley wires, but having regard to the fact that the supply would only be intermittent, it would not be suitable for shop-lighting, and very indifferent for street-lighting. The question of cost to the Corporation of supplying Bredbury with electricity was considered, when it was pointed out by the Corporation that it would be more economical to erect a small station. As regards a transfer of the order, the Corporation were not prepared to consider it unless within a reasonable time it could be shown that the undertaking would pay, and they would require a guarantee that a sufficient number of persons would take the electricity. Finally, the sub-committee resolved that as the Stockport electrical engineer was compiling information and figures as to this matter, the further consideration of it be adjourned until they are received, when the sub-committee will again discuss the matter.

**St. Helens.**—On Wednesday the chairman of the Electric Supply, etc., Committee (Alderman Beecham) said the net profit on the electricity undertaking for the year had been £2,599, as compared with £576 in the previous year. For the year ended March, 1903, the number of units sold for lighting purposes was 290 000, and last year it had risen to 342,000. For motor power 363.000 units had been sold, against 209,000 It would be noticed that the amount of current sold for motors was more than for lighting purposes. For traction 1,387,000 units had been sold, against 1,014,000, and the total units sold had been 2,093,883, against 1,514,745, or an increase of 38 per cent. Against this increase the cost of production had also been smaller, for the cost of management at the works had been less. The expenses of management had been £250 lower, and he thought the Council would agree with him that it reflected the greatest credit upon the engineer (Mr. E. M. Hollingsworth), who had held his present position only 15 months. We are informed that the works costs have been reduced from ·64d. to ·53d., and the total costs from ·96d. to ·781. Part of this information appeared in our last issue under the heading "Liverpool."

**Hull.**—The Chamber of Commerce suggest that the local manager of the National Telephone Company should approach the North-Eastern and Hull and Barnsley Railway Companies and ascertain if they would be allowed to place call boxes at the stations in the city, and also at the suburban stations on their system. The agreement referred to in our last issue to supply energy for lighting and power to the North-Eastern Railway Company and also to Messrs. Reckitt and Co., is based on the fact that the points at which current is required are roughly 21 in number, and that these points are in most instances in close proximity to the Corporation low-tension mains, so that a comparatively small outlay will be necessitated, amounting in all to £2,300, as already noted. The agreement is for three years, and the Corporation are prepared to supply not less than one million units per annum, at 1½d. per unit for a 27 per cent. load factor, with an increase or a decrease of $\frac{1}{10}$d. per unit for each 3 per cent. decrease or increase in load factor. It is expected that no further extensions of generating or transforming plant will be required during the ensuing winter to deal with the anticipated load for the company, but it will be necessary during the autumn to make provision for the obtaining of further plant for the winter of 1905.

**St. Annes.**—At the last meeting of the Urban District Council, Councillor Irving, speaking on the working of the electricity works during the past year, said the works had now been going for three years. The first year a small profit of about £12 was declared; next year that grew to £107; and this year they had received in revenue £5,992. That item was made up by private lighting, £2,180; £1,015 for street-lighting; £2,670 for traction; and £57 from other sources. Against that they had to put the works costs, which came to £2,622, and that gave them a gross profit of £3,300. But they had to get rid of the interest and sinking fund, £1,718, and that left them with a profit of £1,582. In previous years they wiped off a little more than 2½ per cent, but the committee thought it advisable not only to increase the depreciation, but also to work right off the depreciation to the extent of 4 per cent. for the two previous years, and if they did that it would leave them to carry forward with a profit for the depreciation account next year of £786. The consumption had been 483,992 units. They had been most economically worked, he thought, and they had had a very successful year. They had also been able to reduce the cost of public lighting from 4d. to 2½d.; they had got rid of meter rents, which, he thought, was very creditable in such a short period of three years. The chairman, in attributing the success of these works to the engineer, Mr. J. H. Clothier, spoke very highly of the services rendered by him.

**Tunbridge Wells.**—The annual statement of accounts for the year ending March 31 of the borough electricity undertaking shows that the loans up to date amount to £74,682. On the revenue account the cost of generation of electricity has been £4,983. Of this £3,699 is for coal and £227 for water, the latter item under the new charges being doubled in the ensuing year. The cost of distribution, including repairs to mains, was £480, and the cost of maintaining public lamps £465, and of repairs to buildings £99. Rents, rates, taxes, and insurance represent £381, of which the Corporation rates alone amount to £216. Management expenses consist of £932 for salaries, and proportion of salaries to the general district fund £364, and stock management expenses £65, making a grand total of £7,808. The receipts from sale of electricity are £12,491, of which £7 014 is from private consumers at 6d., and £2,537 from public lamps. Meter rents realised £405 and other minor items, less an allowance of £97. 10s. for bad debts, represent a total of £12 896. The gross profit is £5,087, and of this £4,375 is paid in dividends to stock-holders and redemption of stock and £339 mortgage interest, leaving £372. 11s. as the net profit of the year, which is added to the surplus on the statutory profit appropriation account of £3,116, bringing the reserve fund of the undertaking, with the balance for the year, up to a total of £3,488. On the capital outlay account £74,442 has been spent on permanent works, 5,366 discounts on stock issued, £315 is the cash balance on capital account, £192 on stores account, and £3,822 sundry debtors, while on cash revenue account there is £777 in hand.

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**Battersea.**—The Council, having been informed that the agreement with the County of London and Brush Provincial Electric Lighting Company, Limited, in connection with the Electric Lighting (London) Bill will be exchanged shortly, have authorised their solicitor to withdraw their petition against that Bill when the exchange has been effected. The Lighting Committee have appointed Mr. W. Rines as chairman for the ensuing three months. An agreement has been arrived at with the London and South-Western Railway Company relative to electric lighting under the railway bridges, Latchmere-road. The company will pay the sum of £18. 17s. for the installation of the electric light, and £11. 14s. per annum for maintenance. The electric mains (including arc light leads) are to be extended from a point in York-road to the boundary of the borough in that road, at an estimated cost of £264. 5s. 11d. Foundation and excavation, etc., work for the steam-turbine and dynamo and electric pumps will be carried out in connection with the extension plant now being provided at the central electric station by the works department, at a cost of £194.

**Finchley.**—The Electricity Committee's last report states that up to May 20 172 applications had been received for the supply of light, equal to 8,901 8-c.p. lamps, and the committee, having regard to the fact that the full capacity of the generating station, as provided in the original scheme for 10,000 8-c.p. lamps for private lighting, and 150 street lamps, converted, was being rapidly reached, and that provision would need to be made for the winter load, recommended that application be made for sanction to a loan not exceeding £15,000 for the purchase and erection of additional plant at the works, and that advertisements be issued for tenders for a steam generating set of 350 kw. This sum would be expended in supplying machinery and mains, and on meters and service connections. The extensions would cover several new estates, excluding the roads already sanctioned. At the last Urban District Council meeting the Chairman said that since the meeting of the committee 656 more 8 c.p. lamps had been applied for, bringing up the total to 9,500, and if they included the lamps at the higher elementary school, they would bring the total up to 10,000—the number which they estimated to be able to supply when they applied for their original loan. After discussion it was decided to apply for £17,000.

**Swansea.**—The electrical engineer's last report states that 581 equivalent 8-c.p. lamps were applied for last month, making 56,510 lamps. The load on the St. Helen's section had so increased that a new feeder cable from the generating cable seemed in need. The engineer asked whether, if found advisable, he should lay it at a cost of £1,100. Only a few yards of ground would require to be opened up. To lay two spare pipes to Sketty as the tramway cables are being laid would cost £446. 19s. 10d., and the engineer desired instructions. Messrs. Oliver and Co., contractors for the arc lighting of St. Helen's-road, would start that work soon, the tramways company having given every facility. The balance-sheet of the electric lighting undertaking up to March 31 last shows that the gross profit of the year, after making all the necessary charges and bringing into account all receipts due to the Corporation, amounted to £5,795. Out of this had to be paid interest for the year to the end of December, 1903, amounting to £3,121, leaving a net balance for the year of £2,673, which together with the balance brought forward from last year's account (£1,810) left a surplus of £4,483. After bringing the sinking fund to its requirements to March 31 last, a net balance of £744 remains, which is to be carried forward.

**London Gazette.**—Claims in connection with the Manchester Southern Tramways (Lancashire) Bill, 1903, and of the undertaking of the Manchester Southern Tramways (Cheshire) Bill, 1903, and of the Manchester Southern Tramways Act, 1903, have to be proved before the 17th inst. at the chambers of Mr. Justice Buckley, Royal Courts of Justice, Strand. June 23, 1904, at 11 a.m. at the said chambers is appointed for hearing and adjudicating upon the claims. A petition for the winding-up of the National Electric Traction Company, Limited, by the High Court of Justice was on June 1, 1904, presented by the Consolidated London Properties, Limited, 66, Victoria-street, S.W., and will be heard at the Royal Courts of Justice, Strand, on the 14th inst. Edwin Thomas Oubridge, 170, Sandhurst-road, Catford, Kent, has ceased to be a partner in the business of Frederick William Ratton May and Edwin George Kennicott Calder and Edwin Thomas Oubridge, trading as the Southern Electrical Accessories Company, 4, Newington-causeway, London. Creditors of the Dover Electricity Supply Company, Limited, are requested to send particulars to Messrs. Mowll and Mowll, Castle-street, Dover, by 24th inst. A petition for winding-up the Electro-Voelker Syndicate, Limited, will be heard at the County Court, Park-street, Croydon, at 11 a.m. on 28th inst.

**St. Marylebone.**—The Finance Committee reported last night as follows: "We have considered as to the provision to be made for capital expenditure in connection with purchase of land for and the erection of generating station, machinery, plant, etc., for the electric lighting undertaking, and have conferred with the chairman of the Electric Supply Committee, in conjunction with Mr. Arthur Wright (electric adviser to the Council), thereon. We recommend the Council to make an application to the London County Council for sanction to the borrowing by the Borough Council of a sum of £436 500 for the purchase of land and for the erection and construction of a station for generating electricity under the powers of the St. Marylebone Electric Lighting Acts, 1901 to 1904, including the buildings, machinery, engines, lay-byes, quays, wharves, works, and conveniences connected therewith or for the purpose thereof, and the provision, laying down, and construction of mains and works for connecting the generating station with the existing mains, and the alteration and extension of mains and works; also for the advance of a sum of £136,500 (being part of the above-mentioned £436,500 for which sanction is asked) during the financial year ending March 31, 1905. Although the London County Council's Money Bill has passed the committee of the House of Commons, and Clause 6 of that Bill authorises the County Council to lend and the Borough Council to borrow £1,415,000 for payment of the award, the costs of the Bill, the judgment of the Courts, etc., it is possible that the Bill may not receive the Royal assent before the County Council rise for their recess at the end of July. In that event, the loan will not be forthcoming before the middle of October. At our request, the chairman has enquired and considered as to the best means of raising the money temporarily at the end of June, and we will submit a recommendation to the Council on June 9."

**Bolton.**—The Council have adopted the following alterations in the charges for the supply of electric current: That each consumer for lighting purposes be provided with one meter free of rent. That on the maximum demand system 4d. per unit be charged for the first three hours of maximum demand, and 1d. per unit for all units consumed in excess of the above, and that a rental of from 9d. to 1s. 6d. per quarter be charged for each demand indicator. That for motive power the charge for the first 1,000 units in any one quarter be at a uniform rate of 2d. per unit, and for all units in excess of such 1,000 units in any one quarter the charge be 1d. per unit. All the above charges for current to be subject to a discount of 10 per cent. on payment of the account within 21 days of such account being rendered. That as regards the charging on the flat rate of 4d. per unit, no change to be made. Subject to the requisite consent being obtained from the Board of Trade, the charge for electric current for tramway purposes be as and from April 1 last, at a rate of 1·10d. per unit. Application to be made to the Board of Trade for permission to charge at a price lower than 1·25d. per unit for the current supplied for tramway purposes. The sum of £6,818, part of the credit balance appearing on profit and loss account, is to be carried forward in aid of rates. The output last year was 5,056,898 units. The revenue for sale of current was £37,285, an increase of £5,228 more than the previous year. The profit of the fittings department was £795, the rental of meters was £739, and the rental of hired motors was £490, giving a gross revenue of £39,309. The cost of generating the necessary current was £14,914, and taking that from the gross revenue, the gross profit was £24,395, an increase of £3,588. The increase in gross profit was not quite so much as the increase in revenue, but that was because the committee have lowered the price very considerably. The interest and depreciation took £16,915, leaving a net profit of £7,480. In addition to that, there is a balance of £1,324 from last year, making a surplus to the department of £8,804. Out of this profit it is proposed to carry £6,818 in relief of rates, leaving £1,968 to be carried forward as surplus profit. The cost of production stands now at ·707d. per unit. The capital expenditure up to March, 1903, was £207,482, and the expenditure during the last year was £34,319, and in that expenditure is included the cost of enlarging the boiler-house, mains, meters, and motors, etc. The gross capital is £241,801, £41,299 has been written off, making a net capital of £200,502. Thus for every £100 expended they had is now a debt of only £83. The number of consumers had increased by 265, the largest number connected in any one year. There are 160,994 8 c.p. lamps, of which 44,621 have been connected during the year. There are 272 motor consumers and 93 miles of mains. Since the department commenced, nine years ago, £18 026 has been paid in the relief of the rates. During the earlier years there were losses amounting to £1,939, making a net relief to the rates of £16,087. We regret that we have been misinformed concerning the statement made in our last issue as to friction with regard to the employés at the electricity station. On enquiry we find that the remarks referred to West Bromwich.

**Nottingham.**—The Electricity Committee in their last report state that the demands for electricity have steadily increased, and extensions have been carried out from time to time to meet the requirements of new consumers. The whole of the sanctioned capital having been expended, application has been made for sanction to a further sum of £100 000 to provide for extensions of the undertaking. The income was £71,854, and the expenditure amounted to £36,978, the balance carried to the net revenue account being £34 875. Up to March 31 last £29,320 had been expended in repayment of loans. The reserve fund, towards which £6,541. 13s. 7d. was devoted during the year, now stands at £22,022. 12s. 6d. The total horse-power installed at the three generating stations is as follows—viz.: Talbot-street station, 8,925 h.p.; St. Ann's power station, 4,200 h.p.; Eastcroft, 480 h.p.—total, 13 605 h.p. The distributing mains have been extended in 58 directions during the year, the total extensions being 5·01 miles. The mileage of distributing mains at the end of the year was 47·4. The number of applications received for a supply of electricity on March 31 was 2,557, as compared with 2,238 on March 31, 1903. The number of 8 c.p. lamps or their equivalent connected up on March 31 was 239,366, as compared with 208,306 at the end of March, 1903. The number of motors connected to the mains has increased from 392 in 1903 to 498 in 1904, and the total horse-power from 1,346 to 1,776. The number of units sold during the year for various purposes was as follows: for lighting purposes, 3 285 986; for power purposes, 1,047,223; for tramway traction, 3,768,601—total, 8,101,810. Forty-six per cent. of the lighting units were sold at the reduced rate of 1½d. per unit. The total number of units sold for all purposes during the year ending March 31, 1903, was 6,510,476. In view of the fact that the electricity undertaking has been in full working order for a period of nearly 10 years, and that since the commencement no outside expert opinion had been given as to the position of the undertaking, Dr. A. B. W. Kennedy, F.R.S., was asked to make a report, in which he said that the condition of the stations and plant was thoroughly satisfactory. The committee had been fortunate in that, although the output had increased very rapidly, the area within which they had to supply still remained of such dimensions that they could supply it from their two principal stations without the use of high-pressure currents transmitted from a distance, and therefore without any of the losses due to transformation, which are unavoidable under those circumstances. This was an advantage only possessed by a very few among

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the larger towns. In a great many cases it had been found absolutely necessary to resort to three-phase transmission in spite of the fact that certain losses thus became inevitable. He considered that the capital expenditure had been extremely well kept down in relation to the amount of plant purchased. At the present date there was in the stations 8,430 kw. of plant, and the total capital expenditure had been £400,918, or at the rate of £47·4 per kilowatt. The average expenditure upon electric lighting throughout the country, even in places much larger than Nottingham, had been much greater than this, and, in fact, he had only noticed one case where the expenditure had been less than in Nottingham in proportion to the amount of power installed. In spite of the continued reduction in the price of electricity per unit, the total income had continued to increase in the most satisfactory manner, the increased output much more than balanced the decreased charge per unit. In the first three full years' working (comparing the years ending March, 1896, and March, 1899) the gross income increased from £4,353 to £12,925, or nearly three times, and in the last-named year the gross expenditure, including capital charges, was £9,348, or 72·3 per cent. of the income. In the last three full years' working, up to March, 1904, the income increased from £32 070 to £71,492, or nearly 2¼ times, the total increase in eight years being 16 4 times. They had reduced the average price charged per unit in 1904, however, to 38 per cent. of that charged in 1906, although in spite of this the total expenditure was still under 83 per cent. of the gross income.

## PROVISIONAL PATENTS, 1904.

MAY 30.

**12213. Improvements in electrical timing devices for fire brigade competitions, military drills, race meetings, and the like.** Albert Edward Nichols and Alfred Charles Brown, 7, Queen's-square, Finsbury-avenue, Eldon-street, London.

**12214. Improvements in electrical cooking and heating apparatus.** The British Prometheus Company, Limited, and Harold Skipwith, 34, Castle-street, Liverpool.

**12217. Improvements in wireless signalling.** John Munro, St. John's-grove, Croydon.

**12245. Improvements in and relating to electric switches, circuit breakers, and the like.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**12246. Improvements in means for starting electric flame arc lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**12247. Improvements in and relating to electrodes and lamps for arc lighting.** Edgar Alfred Carolan, 83 Cannon-street, London. (The General Electric Company, United States.)

**12248. Improvements in means for starting electric flame arc lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**12267. Improvements in electrical resistances.** William James Davy, 40, Chancery-lane, London.

**12268. Installation and apparatus for automatically putting alternating-current transformers into or out of circuit.** Jules Auguste Emile Mariage, 40, Chancery-lane, London. (Complete specification.)

MAY 31.

**12298. An improved appliance for gripping and supporting the wires of overhead wire systems of electric traction.** John Henry Luby and William Harris, Lloyd's Bank-buildings, Bristol.

**12333. Improvements in and relating to high-tension electric switches.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12334. Improvements in and relating to the construction of dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12335. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12336. Improvements in and relating to alternating-current electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12337. Improvements in and relating to thermal cut-outs for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**12338. Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**12339. Improvements in brush-holders for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**12344. Improvements in electric arc lamps.** John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**12340. Improvements in and relating to electric cut-outs, switches, and the like.** The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, 83, Cannon-street, London.

**12345. Improvements in electric arc lamps.** John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**12346. Improvements in and relating to electric switches.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London.

**12365. Improvements relating to telphers.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Arthur Stebbings Cliff, Germany.) (Complete specification.)

**12372. Improvements in and relating to apparatus for transmitting and receiving telegraphic signals and the like.** James Tarbotton Armstrong and Axel Orling, 61, Chancery-lane, London. (Complete specification.)

**12373. A new or improved maximum demand indicator.** Nalder Bros. and Thompson, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Roger S. White, United States.)

**12375. Improvements in electric clocks or time indicators.** George Bennett Bowell, 40, Chancery-lane, London.

**12376. Improvements in electric fire-alarms and thermo-indicators.** Alfred Henry McNeil and the Pearson Fire-Alarm, Limited, 40, Chancery-lane, London.

JUNE 1.

**12379. Improved adjustable support for electric light fittings.** John George Irving, 12, Canal-street, Nottingham. (Complete specification.)

**12382. Improvements in electric insulators.** Henry Julius Trautmann, Findale, Aberdeen-road, Highbury, London.

**12423. Improvements in printing telegraphs.** Leo Kamm, 27, Powell-street, Goswell-road, London.

**12433. Improved process for the production of insulating materials.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12434. Improvements in and relating to electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**12439. Improvements in electric fire-alarm and the like signalling apparatus.** Frank Hubber and William George Higgs, 6, Beams-buildings, Chancery-lane, London. (Complete specification.)

**12449. An improved small motor for alternating current.** Felix Reiss and Rudolf Klemm, 6, Lord-street, Liverpool. (Complete specification.)

**12455. Improvements relating to electric motor-starting switches.** Frederic Collyer Newton, 18, Buckingham-street, Strand, London.

JUNE 2.

**12467. Improvements relating to electrically-driven fans and the like.** Veritys, Limited, and Charles Bell Walker, 11, Burlington-chambers, New-street, Birmingham.

**12469. Improvements in network distributing or feeder boxes for electric light purposes.** Joseph Roper Penning and Sydney Heathcote Penning, Holly Lodge, Sidcup.

**12487. Loose electrical weight plug.** Henry Carl Petit Jean and Harry Peirson, 4, John-street, Hanway-street, Oxford-street, London.

**12517. Improvement in induction coils.** Vernon Warburton Delves-Broughton and John Austin Colf, 80, Central-hill, Upper Norwood, London.

**12541. The employment of X-rays and cathode rays in chemical reactions produced by electric discharges.** Count Amaury de Montlaur, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 3, 1903, being date of application in France.) (Complete specification.)

**12543. Improvements in or relating to trolley for electrically-driven vehicles.** Thomas Dixon Whitehead, 18, Buckingham-street, Strand, London.

**12545. Improvements in and relating to alternating-current electric meters.** Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 2, 1903, being date of application in Germany.) (Complete specification.)

JUNE 3.

**12568. An improved electric meter.** Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

**12607. The combined electric lamp-holder and candle-nozzle.** Edward Charles Harold Tiffin, "Cawley," Reginald-road, Northwood, Middlesex.

**12615. Improvements in and relating to thermo-electro piles.** Israel Katz, 81, High Holborn, London. (Complete specification.)

**12623. Improvements in and relating to electric controllers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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**12633. Improvements in separating zinc by electrolysis.** William Lester St. John Alton and William Ramsay, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**12643. Improvements in continuous-current electric motors for use in electric traction.** Auguste Mégroz, 322, High Holborn, London. (Date applied for under Patents Act, 1901, June 4, 1903, being date of application in Switzerland.) (Complete specification.)

**12644. Improvements in or relating to electrical troughs, conduits, or the like.** John James Bate, 6, Lord-street, Liverpool.

JUNE 4.

**12679. Improvements in trolley heads for electric tramcars.** Horace James and Arthur West, 187, South View-road, Sheffield.

**12691. Improvements in apparatus for the simultaneous transmission of telephonic and telegraphic currents over the same line.** Carlo Turchi, 46, Lincoln's-inn-fields, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 23, 1904.*

1903.

**4681. Electric cables and the jointing of the same.** Hanson.

**4682. Telephonic exchange apparatus.** Hanson.

**12091. Means for enabling shades carried upon bayonet-jointed electric lamp-holders to be easily and quickly removed.** Harrington.

**12174. Trolleys for overhead electrical conductor systems.** Lake. (Cantono.)

**12218. Electric signalling systems for railways.** Parshall and Parry.

**12315. Electric motor-control systems.** Carolan. (General Electric Company.)

**12618. Appliances for collecting electricity from a slotted conduit for the working of electric tramcars.** Hewer.

**12706. Flexible metallic tubing for armouring insulated electrical conductors and apparatus for its manufacture.** Bowley.

**12745. Controlling or regulating resistance starting switch for electrically-driven hoists.** Morrison and Maclachlan.

**12839. Controllers for electric motors.** Carolan. (General Electric Company.)

**13278. Electric alarm and controlling apparatus.** Werner and Olsen.

**14476. Arc lamps.** Davies.

**15706. Process for reducing organic substances in electrolytic bath.** Imray. (Farbwerke vorm. Meister, Lucius, und Brüning.)

**15811. Dynamo-electric machines for regulating the charge and discharge of storage batteries used in combination with main generators.** Lancashire Dynamo and Motor Company, Limited, and McLeod.

**16159. Electric measuring.** Cooper.

**16511. Electric hoist controllers.** Scott.

**16740. Time-limit devices applicable to electric circuit controllers and the like.** Carolan. (General Electric Company.)

**16741. Electric arc lamps.** Carolan. (General Electric Company.)

**16742. Electric switches.** Carolan. (General Electric Company.)

**16744. Controlling electric switches and cut-outs.** Carolan. (General Electric Company.)

**19200. Lifeguard to be applied to electric tramcars.** Lambelle.

**21194. Method of transmitting printing telegraphic messages over long lines and the apparatus therefor.** Battaglia-Guerrieri.

**23664. Method of and means for starting and breaking electromotors.** Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

**23851. Electric cranes.** Stothert and Pitt, Limited, and Pitt.

**27921. Systems for the automatic control of electric motors.** Otis Elevator Company, Limited. (Otis Elevator Company.)

1904.

**833. Telephone systems.** Redmon, Hall, Conway, and Smith.

**2035. Safety device or cut-out for preventing the reversal of electric boosters or generators and like apparatus.** Royce and Claremont.

**3344. Electric transmission of power for autocars and automobiles.** Soc. de Champrobert et Cie. (Date applied for under International Convention, Feb. 11, 1903.)

**4472. Audiphones, telephones, and like instruments employed for the transmission of sound.** Pape and Higgins.

**6496. Electric lamp and socket.** Soden.

**6612. Drum supports for electric lamp and other wires.** Ackermann and Engisch. (Date applied for under International Convention, March 28, 1903.)

**6724. Electricity meters for alternating currents.** Aron.

**9523. Galvanic battery cells.** Duntley.

**9954. Safety device for electric lifts.** Sprowson.

**7733. Electric igniting device for explosion engines.** Vereinigte Maschinenfabrik Augsburg und Maschinenbau-Gesellschaft Nürnburg, A.-G. (Date applied for under International Convention, Oct. 19, 1903.)

**9981. Shade-carrier for electric glow lamps and the like.** Walther.

**10036. Electric cables.** Berlin.

**10082. Supports for the trumpets of phonographs and the like.** James. (Cie. Générale de Phonographes, Cinematographes, and Appareils de precision.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅜-½ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ¼-⅜ |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 5½-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3-3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 87-90 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 10-11 |
| —— 5 per cent. Pref. | 5 | .. | 5⅛-5⅜ |
| Crompton and Co. | 3 | .. | 1⅞-2⅛ |
| —— 5 per cent. Debentures | 100 | .. | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | .. | ¼-⅜ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 74-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 72-77 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | — | 1⅜ 1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | — | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | — | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | — | 9⅛ 9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | — | 93 98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | — | 11½ 12¼ |
| —— 4½ per cent. Preference | 5 | — | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | — | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | — | 19 20 |
| —— 4 per cent. Debentures | 100 | — | 100 103 |
| Parker, Thos., Limited, Ordinary | 10 | — | 10 10¼ |
| Telegraph Construction and Maintenance | 12 | — | 36-39 |
| —— 5 per cent. Bonds | 100 | — | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,201-101,200 | 1 | — | ⅜-½ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | — | 120-125 |
| Bournemouth and Poole, Ordinary | 10 | — | 11¼-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | — | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | — | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | — | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | — | 100-103 |
| Brompton and Kensington, Ordinary | 5 | — | 10¼-11 |
| —— 7 per cent. Preference | 5 | — | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | — | 7-7⅛ |
| —— Nos. 20,001-30,000 | 5 | — | 7-7⅛ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | — | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | — | 105-108 xd |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | — | 7⅛-8 |
| —— 4½ per cent. Cum. Pref. | 5 | — | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | — | 4⅜-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | — | 104-106 |
| Chelsea Electricity Supply | 5 | — | 6-6¼ |
| —— 4½ per cent. Debentures | 100 | — | 107-110 |
| City of London, Ordinary | 10 | — | 10⅜-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | — | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | — | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | — | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | — | 7⅛ 8⅛ |
| —— 6 per cent. Cum. Pref. | 10 | — | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | — | 106 109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | — | 5⅜ 5⅝ |
| —— 6 per cent. Cum. Pref. | 5 | — | 5⅜-5⅝ |
| —— 4½ per cent. First Mort. Deb. | 100 | — | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | — | 1¾-2¼ |
| —— 5 per cent. Debenture Stock, Red | 100 | .. | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | — | 5¼-6 |
| —— 4½ per cent. First Deb Stock, Red. | 100 | — | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7⅛-8⅛ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | — | 11¼-12¼ |
| —— per cent. Debenture Stock Red | 100 | — | 102-105 |
| Kensington and Knightsbridge and Notting Hill | 100 | — | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | — | 9⅜-10¼ |
| London Electric, Ordinary | 8 | — | 14-14¼ |
| —— 6 per cent. Pref. | 5 | — | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | — | 19½ 20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | | 98-101 |
| Oxford Electric, Ordinary, 1-96 and -14,310 | 5 | .. | 5-5⅛ |
| —— 4 per cent. Debenture Stock | 100 | .. | 98 101 |
| Royal Electrical Company of Montrea. 4½ per cent. First Shares Mortgage Debentures | 100 | — | 100 103 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | — | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 | — | 85-90 |
| South London, Ordinary | | — | 3¾ 4¼ |
| St. James's and Pall Mall, Ordinary, 101-30,080 | 5 | — | 14-15 |
| —— 7 per cent. Pref. | 5 | — | 8-9 |
| —— 3½ per cent. Deb. | 100 | — | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | — | 4⅜-4⅝ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | — | 4⅜-4⅝ |
| Westminster, Ordinary | 5 | — | 12¼-13⅛ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | — | 6¼-6⅝ |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Electric Railways.—** | £ | | £ |
| Central London, Ordinary | 100 | – | 92-96 |
| —— 4 per cent. Pref. | 100 | – | 101-104 |
| —— ,, ,, deferred | 100 | – | 83 86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 | – | 112 115 |
| City and South London, Consolidated Ordinary | 100 | – | 50 52 |
| —— 4 per cent. Debenture Stock | 100 | – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 123-126 |
| —— ,, ,, ,, '96 | 100 | – | 120-123 |
| —— ,, ,, ,, '01 | 100 | – | 118-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10 10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | – | 99 101 |
| Waterloo and City, Ordinary | 100 | – | 89-92 |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 1-260,007 | 5 | – | 5 5¼ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 | – | 131-136 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ xd |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 98-103 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 100-103 |
| —— Ord Pref. | 100 | .. | 97-100 xd |
| —— Non-Cum. 5 per cent. Pref. | 10 | .. | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 102-104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 | .. | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9⅜-10¼ |
| —— 6 per cent. Cum. Pf., 30,001-60,000 | 10 | – | 10¼-11 |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 115-118 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | – | 2⅜-2⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 106-109 |
| —— Prov. Certs., all paid | 100 | – | 100-103 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | – | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 99-102 |

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| | £ | | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 | – | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18 19 |
| —— 6 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 | .. | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 | .. | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8-8¼ xd |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 11-11⅛ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 102-104 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 | – | ⅛-¼ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 | – | ⅛-1 |
| New General Traction, Ordinary | 5 | – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.). | 100 | – | 88-93 |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | – | 12-12½ |
| —— 5 per cent. Cum. Pref. | 10 | – | 9⅜-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 | – | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 | – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 xd |
| South Lancashire Electric Traction and Power Company— | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,132 5 per cent. Preference | 1 | – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | – | 104-106 |
| —— Deferred Stock | 100 | – | 84-87 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 98 100 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 103-105 |
| Oriental Telephone and Electric Company | 1 | – | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 4 | 1,531 | 1,295 | + 239 | — *h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | May 28 | 204 | 281 | + 13 | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 4 | 40 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 5 | 1,118 | 1,270 | - 152 | - 115 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 4 | 5,582 | 6,210 | - 628 | + 6,682 | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 3 | 988 | 1,308 | - 320 | + 432 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 2 | 1,667 | 1,721 | - 54 | + 1,786 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·62 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 4 | 775 | 2,012 | -1,237 | - 367 | 16½ | 16½ | Dec. 31 | 30,925 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 5 | 2,223 | 2,470 | - 247 | - 15 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 1 | 1,026 | 1,403 | - 342 | + 459 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 4 | 4,596 | 5,515 | - 919 | + 6,8 0 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 5 | 890 | 1,244 | - 354 | - 125*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 3 | 5,172 | 8,008 | -2,836 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 4 | 1,093 | 970 | + 123 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 5 | 344 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 4 | 2,166 | 2,734 | - 568 | + 580 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 6 | 236 | 252 | - 16 | + 264 | — | — | ,, 31 | — | 2,216,583 | 320,128*h* | — | — | — | — |
| Central London Railway | ,, 4 | 6,726 | 7,227 | - 501 | - 2,644 | 6 | 6 | ,, 31 | 367,225 | 45,306,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 5 | 2,859 | 2,579 | + 280 | - 2,125*h* | 6⅔ | 6⅔ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 2 | 539 | 693 | - 153 | - 573 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 3 | 239 | 283 | - 41 | - 164 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 4 | 200 | 271 | - 71 | - 232 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 5 | 161 | 181 | - 20 | + 1924 | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 3 | 4,349 | 4,723 | - 374 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 3 | 1,202 | 1,333 | - 31 | | | | | | | | | | | |
| Dundee City Tramways | ,, 1 | 851 | 870 | - 19 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 4 | 739 | 996 | - 257 | + 655 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 4 | 16,040 | 15,374 | + 656 | — *h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Gloucester Corporation | ,, 1 | 224 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 1 | 3,593 | 3,935 | - 343 | + 499 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | May 24 | 1,719 | 1,262 | + 457 | — | 34 | 34 | March 31 | 56,631*h* | 9,758,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·36 |
| Hull Corporation, E. S. | June 4 | 2,165 | 2,094 | + 71 | + 1,850 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,998 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 4 | 473 | 771 | - 298 | - | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 2 | 134 | 334 | - 200 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 1 | 221 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 4 | 5,850 | 7,688 | -1,838 | + 2,860 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Leicester Corporation | ,, 4 | 1,106 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | May 28 | 11,342 | 10,861 | + 481 | + 4,953 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | June 5 | 1,597 | 2,005 | - 408 | - 26*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | May 7 | 10,728 | 8,483 | +2,245 | +22,034 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | June 4 | 163 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 4 | 12 815 | 16,023 | - 3,176 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 4 | 134 | 95 | + 39 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 4 | 3,704 | 3,836 | - 132 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | May 28 | 650 | 380 | + 270 | + 1,309 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | June 4 | 1,904 | 2,483 | - 579 | + 1,402 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | May 30 | 195 | 165 | + 30 | + 82 | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | June 2 | 423 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 6 | 4,118 | 5,608 | -1 490 | 3,965 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 4 | 164 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 5 | 4,662 | 5,648 | - 986 | + 1,047 | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | May 19 | 913 | 938 | + 15 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | June 1 | 309 | 487 | - 178 | + 169 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 3 | 823 | 543 | + 280 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 5 | 1,339 | 1,810 | - 471 | + 251 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C | ,, 4 | 786 | 972 | - 186 | + 185 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,585,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |
| West Ham Corporation | ,, 2 | 1,055 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 1 | 688 | 492 | + 96 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## NOTES.

**Submarine Mining Volunteers.**—Detachments of the Tyne Volunteer Division Submarine Miners (R.E.) are undergoing a week's training at stations in the South. The men will be trained in electric lighting, engine-driving, and the laying of mines.

**West African Telegraphy.**—Telegraphic communication has been opened between this country and Old Calabar, the headquarters of the Southern Nigeria Government, and a cablegram received last week from Lagos announced that the line connecting that place with Forcados, Southern Nigeria, will be ready for traffic in a day or two.

**Glover's Almanack.**—The almanack which Messrs. W. T. Glover and Co. have issued during the past two or three years has been interesting to all electrical engineers. The interest lies in the excellent selection made of the sayings of various electrical engineers. It will be seen from our advertisement columns that next year's issue is to be even more amusing, in view of the fact that everyone is invited to assist in its publication.

**The Institution Conversazione.**—As a result of the new by-laws, there will be two hosts and hostesses at the Institution conversazione this year—*i.e.*, the President and Miss Gray, and Mr. Alexander Siemens, as the President-Elect, with Mrs. Siemens. The date fixed is Tuesday, June 28, and the conversazione will be held, as usual, in the Natural History Museum at South Kensington between the hours of 9 and 11.30 p.m.

**The Wireless Telegraphy Newspaper.** — The ocean daily newspaper was successfully produced by means of the Marconi wireless telegraphy system throughout the voyage of the "Campania," which arrived at New York on Saturday. The vessel kept in touch with Poldhu for 2,300 miles, and communication was established with Cape Breton at a distance of 2,000 miles, connection with both sides of the Atlantic being maintained for three days in mid ocean. Communication was also established with other liners.

**The Meteorological Office.** — The committee appointed to investigate the working of this institution have submitted several important recommendations, among them being one that it should be reconstituted under the Board of Agriculture. It is also suggested that wireless telegraphy should be experimented with, by co-operation with the Admiralty or the steamship companies, as a means of providing advance news of weather in the Atlantic, the committee believing that this would be invaluable in strengthening the forecast service.

**Electricity in Mines.**—In the course of his presidential address at the fortieth general meeting of the Institution of Mining Engineers last week, Mr. James C. Cadman alluded to the report of the Departmental Committee on the Use of Electricity in Mines as illustrating the importance to which electricity had attained as a motive power in mines. He expressed gratification at the action of the Commissioners in not recommending any restrictions calculated to hinder the development of this source of power, which promised to become an essential factor in economic mining operations. In fact, electrical power would, he predicted, exercise a revolutionary effect, owing to its adaptability and efficiency.

**The Institution Journal.**—We have received the volume of the *Journal* dated May, which contains papers on "Transatlantic Engineering Schools and Engineering," by Dr. R. M. Walmsley; "The Rated Speeds of Electric Motors as affecting the Types to be Employed," by Mr. H. M. Hobart; "The Railway Electrification Problem and its Probable Cost for England and Wales," by Mr. F. F. Bennett; "Experiments on Eddy Currents," by Dr. W. M. Thornton (Newcastle Section); "Three-Phase Working, with Special Reference to the Dublin System," by Mr. W. Brew (Dublin Section); "The Steam-Turbine," by Mr. W. Chilton (Manchester Section); and "The Education of an Electrical Engineer," by Prof. F. G. Bailey (Glasgow Section), with the respective discussions. The number also contains the speeches delivered on the occasion of Mr. McMillan's death.

**Bulgarian Lighting and Traction.**—The *Board of Trade Journal* for June 9 announces that the Municipality of Philippopolis have issued a notice inviting tenders for a 50-year concession of the electric lighting of that town, and for the construction and working of an electric tramway to Stanimaka. The concessionaire must provide the energy for both services on the terms contained in the specification, which may be obtained from M. le Maire, Philippopolis, on payment of 20fr. (about 16s. 8d.), or may be seen at the commercial intelligence branch of the Board of Trade. A deposit of £6,000, and documentary evidence that the tendering firm has successfully executed a similar enterprise, must accompany all offers, which will be opened on Aug. 3. These stipulations appear abnormally onerous, as the fact of a responsible firm going to the trouble and expense of submitting a tender should provide an adequate guarantee of its *bona fides*.

**Exhibition of Lightning Arresters.**—The Old Students' Association of the Electrotechnic Institute of Grenoble have organised an exhibition of lightning arresters, which will be held at Grenoble during the meeting of the French Association for the Advancement of Science. This exhibition will last from Aug. 4 to 11 this year, and the exhibits will cover every type of apparatus designed for the protection of electric wires from lightning. They will be classed according to the type of system which they are designed to protect. Exhibits should be sent before July 20 to the association at the Rue General Marchand, Grenoble. The large number of water-power stations using high-tension distribution in the Grenoble district makes this exhibition of great local interest. The exhibition is designed simply as a means of making known what has been done in this direction, and there will be no prizes or awards made. There will be no charge for entrance to the exhibition to members attending the congress.

**The Newcastle Tramway Question.**—The committee of the House of Commons have decided the vexed question of through running on the Tyneside Tramway Company's cars over the Corporation lines against the weight of municipal evidence. Tramway managers from all the large towns, including Leeds, Glasgow, and Dublin (the last named representing the United Tramways Company of that town), gave evidence that through running powers would seriously affect the organisation of the Corporation tramways, but the committee have decided that the company shall have the right to run over the Corporation line connecting their system with the centre of the town, though they have restricted the running rights to this route, which seems to us reasonable and fair. There is no doubt that the convenience of the public influenced the committee in their decision, and we trust that mutual arrangements between the two tramway undertakings will prevent the convenience on the one route interfering with the general service in Newcastle. The Bill contains no provision regulating the arrangement of fares or details of running, these matters being left to the parties themselves and the Board of Trade.

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**Wireless Telegraphy in War.**—The manager of some works on the Baltic has received a message reporting progress in the repairs to one of the Russian ironclads from his company's branch establishment at Port Arthur, which is said to have been sent by wireless telegraphy *vid* Chefoo. Although there is no evidence at present that the Russian authorities in the East have received messages by such means, an interesting point of international law may arise out of the question of wireless communication. Some of the authorities who are examining the question are inclined to hold that if a blockaded port is in wireless communication with the shore station on neutral territory, this does not necessarily constitute a breach of neutrality on the part of the country in whose territory the receiving station is situated, any more than would communication over an unsevered cable, the contention being that the enemy have a remedy by stationing a vessel between the dispatching and receiving station fitted up with the necessary apparatus for interfering with wireless messages. We notice, by the way, that the Argentine Government has rejected Mr. Marconi's proposal to establish a wireless telegraphy station in that country.

**The Gilbert Tercentenary.**—The Institution of Electrical Engineers visited Colchester on Saturday, the occasion being the formal reception and unveiling of an historical picture presented by the Institution to the town of Colchester in commemoration of the tercentenary of Dr. William Gilbert, the "father of electrical science," who was born in that town, became physician to Elizabeth and James I., and was president of the College of Physicians. The party included Mr. R. Kaye Gray (president), Prof. Ayrton, Dr. Silvanus Thompson, Dr. Larmor, Prof. J. D. Everett, Prof. Perry, Prof. Ferguson, Mr. Probert, Dr. Allchin, Mr. W. N. Shaw, and others. After visiting the birthplace and tomb of Gilbert, the party inspected the electric light and power works of the Colchester Town Council, and were subsequently entertained by the Mayor and Corporation to luncheon at the town hall. After a drive to Constable's Country a return was made to the town hall, where the picture (a painting by A. Ackland Hunt of Gilbert demonstrating experiments in magnetism before Queen Elizabeth) was unveiled by the mayoress. Speeches were delivered by Mr. R. Kaye Gray, Prof. Silvanus Thompson, and others, eulogising Gilbert's work as a pioneer in scientific research.

**Automobile Club.**—We have received a copy of the rules to govern the trials for small cars which are being organised by this club for Aug. 29 to Sept. 3. The chief features in these rules are that the trials shall be restricted to cars of which the cost does not exceed £200, and that a radical alteration has been introduced in the method of making the awards. The entries will be divided into four classes—*i.e.*, for cars not exceeding in cost £125, £150, £175, and £200 respectively. Entries will only be accepted from manufacturers or their nominees. The trials will probably take place from a centre in the Midlands, and will consist of 12 non-stop runs of approximately 50 miles each, the prizes being awarded for the maximum number of such runs, besides which prizes will be given entirely at the discretion of the judges. The same system of observation of the cars as hitherto will be adopted, every car being accompanied throughout the runs by an official, who will note everything that is done to the cars. Washing and a reasonable amount of adjustment are to be allowed after every run, so that the conditions will approximate to those of ordinary touring, the great object being to produce a car which will run on the roads without breakdown if it receives reasonable attention. Entries (accompanied by fees of £10, £12, £14, and £16 respectively) will be received up to July 23, or up to Aug. 13 on payment of an increased entrance fee.

**High-Speed Railways.**—It is reported that Messrs. Siemens and Halske and the Allgemeine Elektricitäts Gesellschaft have prepared detailed schemes for the construction of a high-speed electric railway from Berlin to Hamburg, a distance of 180 miles. The former offer to construct the line for £3,500,000 single track, or £5,200,000 double track, guaranteeing a speed of 100 miles an hour. The Allgemeine Company is willing to guarantee a speed of 125 miles an hour, charging the same fares, though the cost of construction would probably be higher. On the basis of Messrs. Siemens and Halske's figures it is estimated that with £1 first-class fares and 15s. second, 520,000 passengers annually would make the single line and 850,000 the double line profitable. As the Kaiser is ambitious that Germany should be the pioneer in this class of traction, it is considered rather probable that one of these schemes will be adopted. In this connection we notice that Prof. von Borries, of the Technical University, Charlottenburg, delivering a lecture on the subject of high-speed electric railways before the German Society of Engineers, expressed his conviction that steam locomotion had reached the limit of its capabilities, and prophesied its supersession by electric. He considers, however, that a speed of 95 miles an hour must suffice for the present, any higher rate entailing too great an expenditure of energy.

**A Curiosity in Advertisements.**—The following quaint and interesting advertisement is reproduced in the *Electrical Review* of New York from the Massachusetts *Gazette* of March 7, 1765. Our contemporary states that several antiquaries have investigated the subject, but so far without eliciting any additional information: "A COURSE OF EXPERIMENTS ON THE newly discovered *Electrical Fire*, to be accompanied with methodical LECTURES on the Nature and Properties of that wonderful Element will be exhibited by DAVID MASON, at his House opposite Mr. *Thomas Jackson*; Distiller, near Sudbury-Street. — To consist of two Lectures, at one Pistareen each Lecture.— The first Lectures to be on Monday and Thursday, and the Second on Tuesday and Friday Evenings every week, Weather permitting. OF ELECTRICITY in general That the Electric Fire is a real Element,—That our Bodies at all Times contain enough of it to set an House on Fire,—That this Fire will live in Water,—A Representation of the seven Planets, shewing a probable Cause of their keeping their due Distances from each other, and the Sun in the Centre,—The Salute repulsed by the Ladies Fire, or Fire darting from a Lady's Lips, so that she may defy any Person to salute her,—A Battery of Eleven Guns discharged by the Electric Spark, after it has passed through eight Feet of Water,—Several Experiments shewing that the Electric Fire and Lightning are the same, and that Points will draw off the Fire so as to prevent the Stroke,—With a number of other entertaining Experiments, too many to be inserted in an Advertisement. TICKETS to be had either at his House above or at his Shop in Queen-Street."

**Obitnary.** — The *Scientific American* announces the death, at the age of 80, of Mr. William Wallace, one of America's most distinguished electrical inventors. An Englishman by birth, Mr. Wallace emigrated to the States with his father, established himself at Ansonia, Conn., and founded the firm of Wallace and Sons, widely known as one of the leading makers of copper and brass alloys. His electrical work was done partly in collaboration with Prof. Moses G. Farmer. A compound telegraph wire, which consisted of a steel core upon which a copper covering was electrolytically deposited, giving a wire of remarkable con-

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ductivity, strength, and lightness, and the Farmer-Wallace dynamo machine were the result of their combined efforts. The dynamo was used to illuminate the Centennial Exhibition of 1876, the occasion being regarded as the earliest instance of electric lighting on a large scale in the States. Mr. Wallace subsequently introduced a plate arc lamp to be used in connection with his dynamo, the object being to place a number of arc lights in series circuit. In this manner originated the series method of arc lighting, which is now so generally employed. Mr. Wallace was greatly interested in the scientific questions of the day, and threw not a little light upon unsolved electrical problems.

**Wake Up, America!**—The editorial remarks which appear in the issue of June 4 of the *Electrical World* of New York on a high-voltage three-wire system, reminds us of discussions which used to take place in our columns five or six years ago. It seems hardly possible that the electrical industry in America should not have profited more by experience in this country. The editorial remarks are based on a paper read by Mr. Barnes before the convention recently held at Providence, in which the author described a 500-volt three-wire lighting system. On this subject the editor of the *Electrical World* remarks: "The use of high voltage—that is, 200 to 250 volt lamps—has come to be somewhat common, particularly in isolated plants, but the development of the idea into a complete three-wire system is much out of the ordinary, and such a system, carrying, as in this case, more than 80,000 connected incandescent lamps besides motors and arcs, occupies a unique position among central stations." We fail to see that the position is unique when more than half of the lighting in the United Kingdom is carried out on just such a system. Our contemporary proceeds: "The most serious consideration in the case of a high-voltage three-wire system is the possibility of securing efficient and durable incandescent lamps, in the lack of which service must suffer and economy must fall." This, again, reminds us of the debates in the English Press five or six years ago, which debates have been settled by practical experience in favour of the higher voltage. It seems to us that both the central-station engineers and the incandescent lampmakers in the States must have been exceedingly indifferent to possible means of improvement for some time.

**International Electrical Congress.**—We give herewith the programme of Sections B and C of the St. Louis Congress to be held this autumn. The programme for Section A we have already published. It will be seen that English engineers are well represented in Section B and fairly well in Section C. In Section B, which deals with the general application of electrical engineering, Prof. C. P. Steinmetz is chairman and Prof. Samuel Sheldon is secretary. The papers for this section, with their authors, are as follows: "Direct-Current Commutation," by Prof. E. Arnold; "Compensated Alternators," by Dr. O. S. Bragstad; "Standardisation of Dynamo-Electric Machinery and Apparatus," by Colonel R. E. Crompton; "Calcul des Alternateurs," by M. Andre Blondel; "Uber die Naturliche Radioactivität der Atmosphare und des Erdbodens," by Profs. Drs. Elster and Geitel; "The Distribution of Voltage and Current in Closed Conducting Networks," by Prof. Dr. Clarence P. Feldmann; "Self-Regulating and Compounded Synchronous Machines," by M. A. Heyland; to be announced, by W. M. Mordey; "Rectifiers," by A. Nodon; "Electricity in Ancient Egypt," by Sir W. H. Preece; "Magnetic Leakage in Alternate-Current Machinery," by Prof. C. A. Adams; "Electric Motors in Shop Service," by Mr. C. Day; "Carrying Capacity of Cables and Conductors," by Mr. J. W. Esterline; "Sparking Distances Corresponding to Different Voltages," by Mr. H. W. Fisher; "The Design of Insulators," by Prof. H. J. Ryan; "The Regulation of Alternators," by Mr. D. B. Rushmore; "The Influence of Wave Shape upon Alternating-Current Meter Indications," by Prof. E. B. Rosa; "The Equipment of a Commercial Testing Laboratory," by Dr. Clayton H. Sharp; "Very High Voltage Transformers," Prof. H. B. Smith. Section C, which deals with electro-chemistry, will be presided over by Prof. H. S. Carhart, and Mr. Carl Hering is the secretary. The papers and authors are as follows: "Methods of Determining the Degree of Dissociation," by Prof. Dr. S. Arrhenius; "Electrometallurgy of Nickel," by Geh. Reg. Prof. Dr. W. Borchers; "Electrolytic Methods for the Rapid Production of Copper Sheets and Tubes," by Sherard O. Cowper-Coles; subject to be announced, by Dr. F. Dolezalek; Electrical Extraction of Nitrogen from the Air," by J. Sigfried Edstron; "Alumino-Thermics," by Dr. H. Goldschmidt; "Electrolytische Zerstörungen in der Erde," by Prof. Dr. F. Haber; "Electro-metallurgy of Iron and Steel," by Dr. P. C. L. Heroult; "Chlorine Smelting," by Mr. J. Swinburne; "The Chemistry of Electroplating," by Prof. W. D. Bancroft; "The Lead Voltameter," by Mr. A. G. Betts and Dr. Edward Kern; "The Preparation of Materials for Standard Cells," by Prof. H. S. Carhart and Dr. C. A. Hulett; "Alkaline Batteries," by Thos. A. Edison; "The Silver Voltameter," by Dr. K. E. Guthe; "The Units Employed in Electro-chemistry," by Mr. Carl Hering; "Notes on Electrolytic Copper Refining," by Mr. J. T. Morrow; "The Energy Absorbed in Electrolysis," by Prof. J. W. Richards; "The Relation of the Theory of Compressible Atoms to Electro-chemistry," by Prof. T. W. Richards.

**Italian Railways.**—In a contribution to the *Elektrotechnische Zeitschrift*, Pietro Lanino discusses railway politics, with special reference to the prospects of electric traction in Italy. He says the experiments already made with electric traction in the peninsula on standard gauge tracks have met with encouraging success. The principal railway systems of the Italian continent are leased to two companies, whose concessions expire in July, 1905. It was due chiefly to the enterprise of these companies that the experiments in question were undertaken, their purpose being to decide the relative merits of electric and steam traction for the conditions obtaining locally, with a view, of course, to an eventual extension of the leases held in the event of the superiority of electric haulage being proved. The question of State ownership is meanwhile engaging the serious attention of the Government, and the prevailing feeling seems to favour this monopoly. The author further points out that, although a number of reforms have been introduced of late years on the Italian railways, the financial results still leave much to be desired. This state of things is largely due to the fact that the existing systems are encumbered with more than 3,000 miles of branch lines worked with limited services at a loss. Electric traction would very naturally be introduced in the first place on these lines, and with the water power available for generating purposes, it is probable that better services at reduced rates could then be established, in many instances to mutual advantage. The high-tension system of electrical distribution adopted on the Valtellina Railway is referred to as especially suitable for branch lines over which heavy goods traffic predominates. It is also pointed out that the connections between the large provincial towns and the neighbouring smaller townships are at present very inadequate. That there is an opening for electric traction to remedy this defect is proved by the success of the Varese Railway undertaking. Due to the elongated form of the peninsula, the question of increased speed is of vital importance to Italy, and it is interesting

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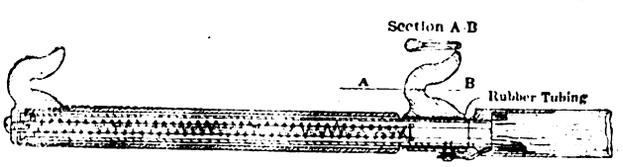
to learn in this connection that the parliamentary commission which has been considering the question of direct railway connection between Rome and Naples have decided in favour of electric traction on the projected line. But great difficulties have yet to be solved before this bold project can be realised. It is estimated that about 75 million sterling would be required for the construction of the track alone, and it is obvious that the scheme cannot be carried out unless a concession to work the line be granted to a private company. Apparently this would be opposed to Government policy, but despite their leaning towards the State ownership of the railways, it is recognised in political circles that the assistance of private companies cannot well be dispensed with at the present stage. It is the author's personal conviction that Italy offers a very good field for electric traction.

**Train-Dispatching by Telephone.**—In the *Street Railway Journal* of May 21 appears an interesting article on the train-dispatch system used on the Rochester and Eastern Rapid Railway. For this purpose telephones are used on a system which presents some novel features. The dispatching line consists of a pair of No. 12 copper wires carried on porcelain insulators on brackets below the high and low tension feed wires. The telephone brackets are placed 12in apart, and both brackets are on the same side of the pole. The line has seven transpositions to the mile. The high-tension transmission line above it is 15,000 volts. The brackets are placed low enough on the pole to permit the use of an emergency telephone connecting fishpole, which is carried in the car, and which is a special feature of this system, as described below. At switches and other convenient points along the line, jack boxes are fastened to the poles, and connected with waterproof wires to the telephone line, these jack boxes being connected in multiple or bridged across the line. The pole used to connect on to these telephone wires is shown in the accompanying figure. This pole is, of course, used for emergency purposes only. It can be connected with the line at any point. It is made of maple, and joined in two sections, so as to be easily stored away in the car when not in use. As shown in the figure,




the upper hook is mounted on a sleeve, which slides up and down over the end of the pole. This sleeve is held in position by a weak spiral spring. When the top hook is hooked over the wire, the weight of the pole is sufficient to pull the pole part way out of the sleeve and bring the bottom hook in contact with the lower wire. In the bottom of the pole is a spring jack, into which the telephone plug is inserted the same as in the jack box. If anything occurs that causes the car to be blocked, the motorman has orders to at once get into communication with the train dispatcher without waiting to attempt to repair the trouble or find out what is wrong, and while the car is stopped, one of the crew must keep within hearing distance of the telephone on the car, so that the train dispatcher can get the train crew at any moment. The telephones used on this railway for train dispatch are kept quite distinct from all the other telephones on the system, so as to ensure that the train dispatch shall not be interrupted by other service messages. The cars used are of a heavy type, being 52ft. in length, and having a vestibule at one end for the motorman. The telephone is placed in this compartment, and is equipped with a reel containing about 75ft. of waterproof cord ending in a plug. This is used when connection is required with the jack boxes at passing points. If the car is stopped elsewhere on the road, the emergency pole is made use of.

**A Magnetite Arc.**—Mr. C. B. Steinmetz describes in the *Electrical World* of New York a magnetite arc lamp, which we understand has been developed under his supervision by the General Electric Company of America. The electrodes are of magnetite, or a mixture of magnetite and other materials. The distinguishing feature of this arc as compared with a carbon arc is that the light is obtained from the arc itself, and not from the surface of the electrodes. Experiments with a large number of metals showed that those of the iron group yielded a brilliant arc flame of very high tension and white colour. They did not give a long life, however, as the metals are combustible. It was concluded, therefore, that a stable oxide of these metals must be used. Amongst the conducting oxides, magnetite fulfils best the requirements of a carrier of the arc flame, since it is well conducting, stable at all temperatures, very plentiful in nature, and gives a white arc of high efficiency. Pure magnetite, however, is not quite satisfactory, since its efficiency is not very high, hardly twice as high as that of the ordinary carbon arc; and the arc tends to flicker, and the rate of consumption of the electrode is rather high—as high as $\frac{1}{8}$in. per hour. This, while very much lower than the rate of consumption of flame carbons, of 1in. to 2in. per hour, would still give only 50 to 60 hours' life with the standard size of electrode adopted for the magnetite arc lamp, of 8in. length. Therefore, with the magnetite as carrier of the arc flame are incorporated other substances in small quantities as arc-steadying compounds—titanium compounds for increasing the efficiency, etc. In the manufacture of these magnetite arc electrodes, by partially reducing the material to metal, a greater density is produced and so a greater amount of material with the same size of electrode, which gives a longer life. Such partial reduction, however, has the disadvantage that when not carried far enough it leaves the electrode porous and of relatively short life, while when carried too far the light tends to unsteadiness, turns faint and blue whenever the arc strikes metal, and in this case sciutillating sparks are thrown off, which may crack the outer lamp globe. A much better method of producing electrodes was found by not reducing the material, but adding a restrainer—that is, a substance which, added to the electrode material in small quantities, reduces the rate of consumption. Hereby, without any loss of efficiency, rates of consumption of 20 to 30 hours per inch are produced, which give a life of 150 to 200 hours for the 8in. electrode. With very little sacrifice of efficiency, a life of 500 to 600 hours is produced, and such an electrode has about the same life as an incandescent lamp—that is, the arc lamp requires trimming about as often as an incandescent lamp requires renewal. This latter feature, however, while obviously valuable in cases where trimming is difficult, as with lamps in inaccessible places, or during protracted strikes, etc., for general illumination is hardly needed, since it would in street-lighting give a life of two months—and a street lamp should be looked after oftener than this. A simple and satisfactory form is an electrode in which the material is compressed as impalpable powder in a thin iron tube, which is then sealed over by the arc. The length of arc used varies from $\frac{3}{4}$in. to $1\frac{1}{8}$in., and this length is maintained constant.

**The Protection of Telephone Wires.**—In the *Electrical World* of New York for May 21 there appears a most complete article by Mr. Robt. E. Chetwood, jun., on

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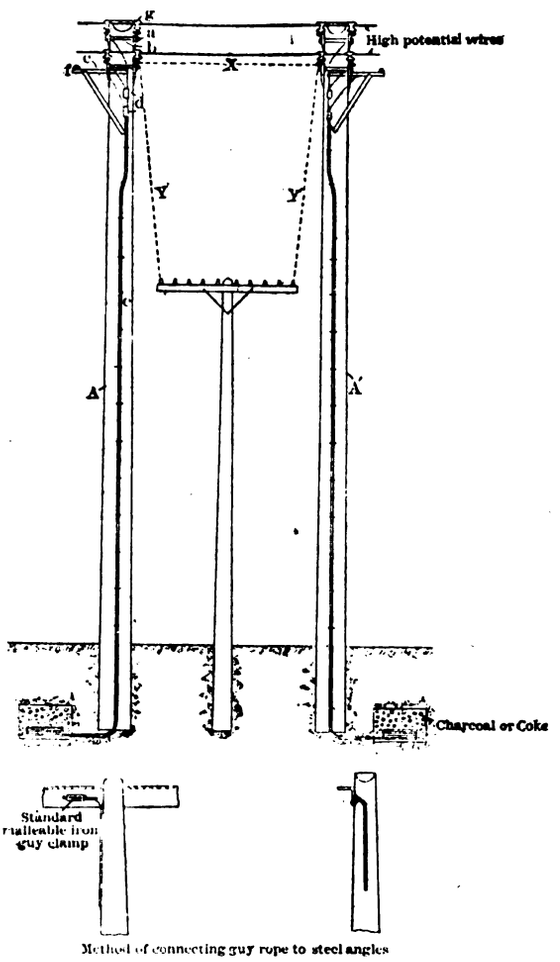
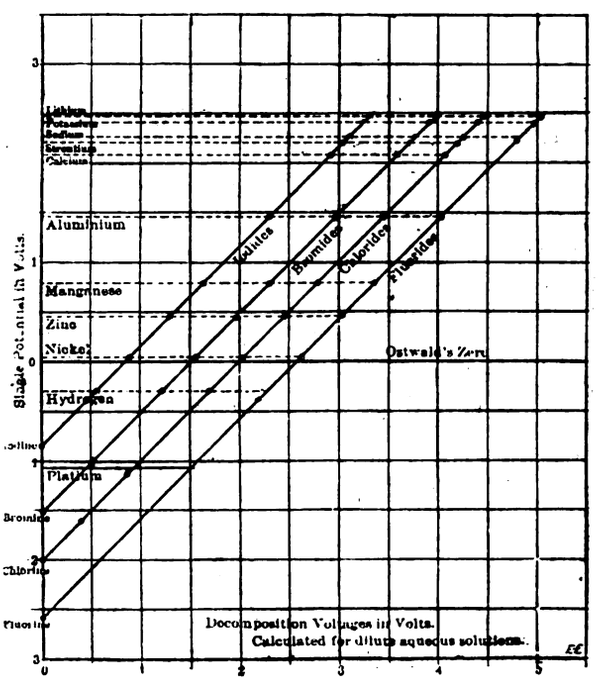
the protection of telephone or telegraph lines when in hazardous proximity to high-tension lines. In this article the author describes numerous means of protection, which tend to reduce the possibility of accidental contact between the high-tension wires and the telephone or telegraph service to a minimum. The construction he prefers is a short cross-over span, with the high-pressure wires above, on double insulators, but not dead-ended. The insulators have steel pins, which are grounded. If this plan is impracticable, the telephone wires go over on a short span. Where short spans cannot be used guard-wire spans are introduced. The interesting feature of the high-tension guard wires is that when grounded they must be capable of carrying three times the normal high-tension line current. The real difficulty in many cases is to make an effective ground. The method described is probably the most satisfactory known under the conditions of practical line



Method of connecting guy rope to steel angles

construction. It consists in employing a galvanised iron rope and burying a coil of half a dozen turns, not less than 18in. in diameter, at the depth of permanently moist earth, in three bushels of fine coke. The general features of the cross-over construction described seem to be well worthy of imitation. We reproduce herewith a drawing of the suggested construction, which seems an absolutely safe one. It should be noted that the poles, A and A', should be of such height and so placed that X is less than either Y or Y'. The distances Y and Y' should be the distances from the lowest crossarm on the upper line when that line is equipped to its full capacity. The other symbols have the following meanings: *a*, galvanised steel crossarm; *b*, 1in. galvanised iron pipe; *c*, standard malleable iron guy clamp; *d*, standard guy clamp; *e*, standard guy rope; *f*, grounded guard of galvanised steel angles; *g*, high-potential insulator with steel pin; *h*, standard insulator with steel pin.

**Single Potentials of the Halogen Elements.**—At the Washington meeting of the American Electro-Chemical Society on April 7 to 9, a paper on this subject, of which we take the following account from *Electrochemical Industry* of New York, was contributed by Mr. W. R. Mott, who pointed out that "there are many points in the ionisation theory not in harmony with some facts observed in the study of single potentials." He thinks that "the impossible solution tensions assigned to metals tend to blind one to the fact that the actual chemical reaction taking place, and its free and bound energy, are the essential points." Dr. Patten and the author have calculated the single potential of chlorine for dilute aqueous solution as −2·00 volts. By similar methods the author has calculated the single potentials of the other halogen elements: iodine, −0·89 volts; bromine, −1·53 volts; fluorine, −2·53 volts, all being referred to Ostwald's zero. The author then proceeded to discuss decomposition voltages, and presented the accompanying diagram with the decomposition voltages as abscissæ and the single potentials of the metals as ordinates. The decomposition voltages are calculated from the thermochemical data simply by Thomson's rule. This diagram represents the well-known additive law. Equal increments mark the displacement of one metal by another metal, or




of one halogen element by another halogen element. This results in two sets of parallel lines. This diagram can be used in the calculation of any one of the factors—the total decomposition voltage, the single potential of the anion, and the single potential of the cation—when the other two factors are known—but it must be remembered that the formation of normal salts in dilute aqueous solution is postulated. The author then discussed the various experimental determinations of the single potentials of the various anions, the values of which were given above. In conclusion, he stated that the additive law holds much better for dilute aqueous solutions than for solid salts. Solid salts may, in different forms, possess very different amounts of energy; for example, amorphous silver iodide has a heat of formation of 6·6 large calories, while the crystalline variety has a heat of formation of 16·2 large calories. This introduces a difference of 0·33 volts in their corresponding decomposition voltages. The difference between the decomposition voltage of the solid salt and of the dissolved salt represents the heat of solution or the energy of the reaction resulting from the affinity of the salt for the solvent. Other solvents than water have very different heats of solution. Solubility is largely determined by the mutual affinity of the solvent and solute as represented by the heat of solution.

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## A HOPKINSON TEST FOR MULTIPHASE INDUCTION MOTORS.

BY R. W. WEEKES, M.I.E.E.

The following tests on three-phase induction motors were carried out by the author on the suggestion of Dr. W. E. Sumpner, and with his co-operation, at the works of the General Electric Company at Witton. The motors tested were manufactured by that company for a distribution of power plant supplied to the Lake View Consols Mine in Australia.

The method of testing is, he believes, new in this country, and it has for its object the more accurate determination of the properties of the motors, while, at the same time, it economises power and enables two large motors to be tested together at full load if there is sufficient electrical energy available to supply the sum of the losses in the two machines under trial. For the purpose of the test two motors of approximately the same output are required. These two motors are bolted to the bedplate in the test-room and connected together by a belt. The pulleys are so selected that the machine which acts as a motor drives the second machine as a generator at slightly over synchronous speed. Under these conditions, the second machine acting as a generator supplies the bulk of the power to the motor. It then remains to measure the watts supplied from the power station at the works, and the watts circulating between the two machines under trial. With these figures, which are equivalent to those usually taken on a Hopkinson test with direct-current machinery, the efficiency of the machine can be much more accurately determined than by the usual method. In carrying out the trials of the motors for the above mine, the method was used on three separate occasions. In the first, two 10-h.p. motors were tested together, then one of the 10-h.p. motors was replaced by a motor of 7½ h.p. On the final occasion a motor of 30 h.p. was tested, driving a motor of 25 h.p. as a generator. In selecting the sizes of

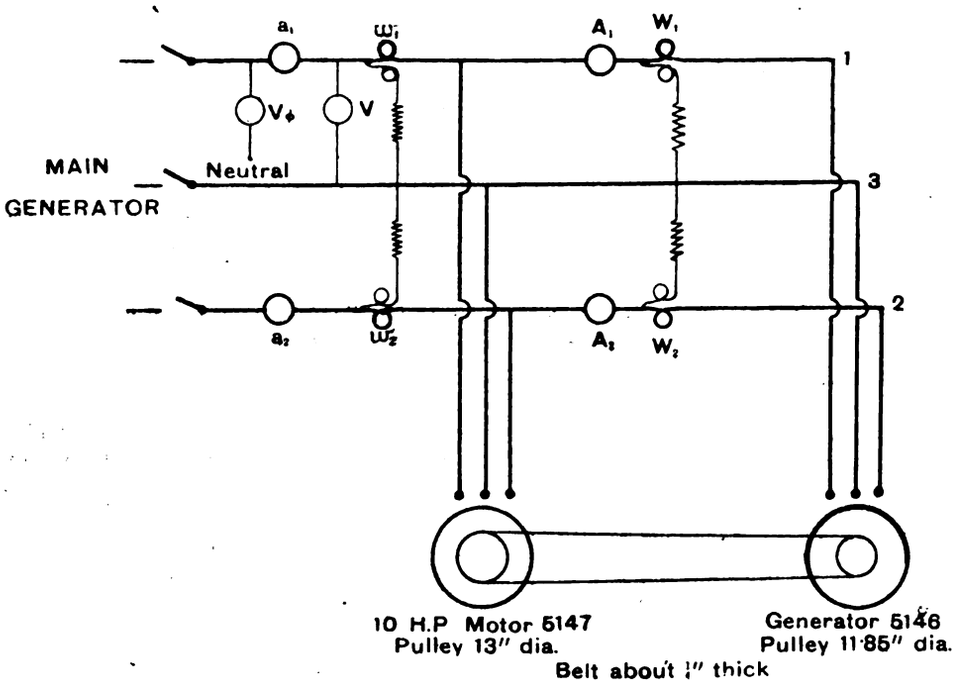


FIG. 1.—Diagram of Stator Connections for the Hopkinson Test of Three-Phase Motors.

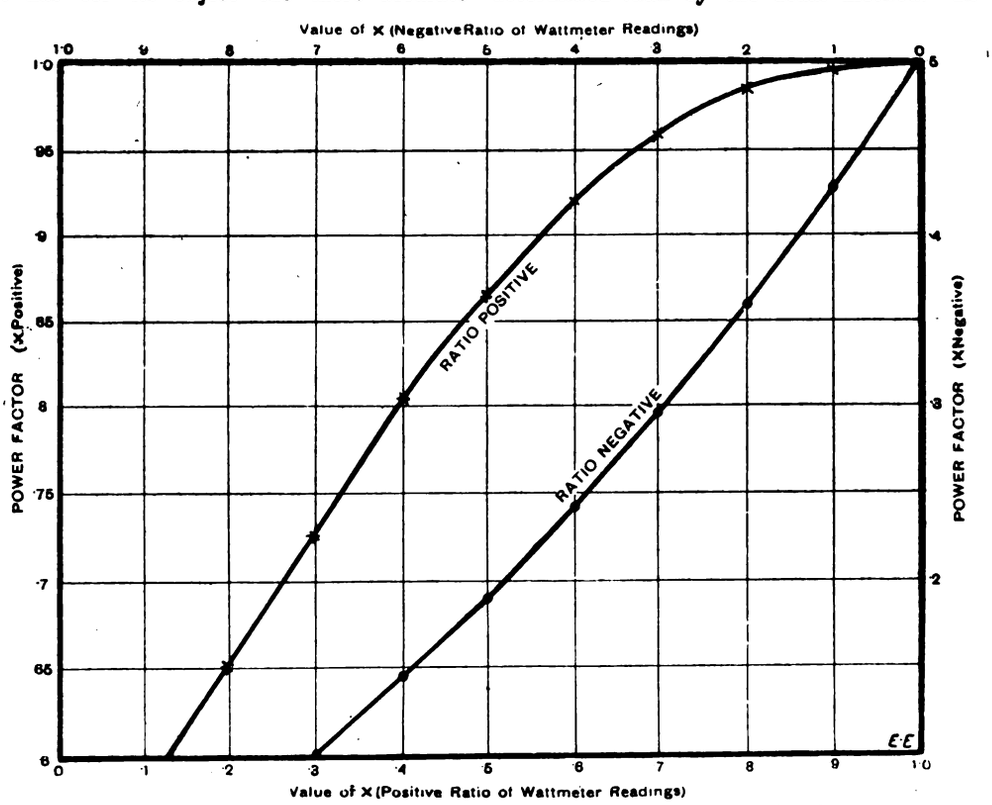


FIG. 2.—Curves for ascertaining Power Factors from Power Readings of Two Wattmeters on a Three-Phase System.

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TABLE I.—TEST OF TWO 10-H.P. THREE-PHASE MOTORS, TAKEN APRIL 16, 1904.
No. 5,147 as a motor driving No. 5,146 as a generator.

| No. of reading. | Time. p.m. | $a_1$. | $a_2$. | $w_1$. neg. | $w_2$. | $A_1$. | $A_2$. | $W_1$. | $W_2$. | V. | V$\phi$. | ⌒ | Rotor period, seconds. G. | Rotor period, seconds. M. | Stator temperature, F°. G. | Stator temperature, F°. M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.23 | 28·0 | 25·6 | 1·24 | 3·58 | 24·0 | 26·4 | 4·88 | 2·64 | 210 | 131 | 41·6 | ·75 | ·50 | — | — |
| 2 | 4.39 | 27·2 | 25·2 | 1·20 | 3·77 | 25·0 | 26·0 | 4·88 | 2·73 | 205 | 129 | 41·2 | ·75 | ·50 | — | — |
| 3 | 5.0 | 26·0 | 25·0 | 1·12 | 3·51 | 24·1 | 25·0 | 4·45 | 2·51 | 203 | 126 | 41·0 | ·75 | ·50 | — | — |
| 4 | 5.15 | 26·3 | 25·0 | 1·12 | 3·41 | 24·0 | 24·2 | 4 31 | 2·51 | 205 | 127 | 40·0 | ·75 | ·50 | 90·5 | 98 |
| 5 | 5.40 | 28·7 | 28·0 | 1·48 | 4·48 | 26·0 | 26·5 | 5·51 | 2·90 | 225 | 140 | 41·5 | ·78 | ·49 | 93·5 | 103 |
| 6 | 6.15 | 27·5 | 28·5 | 1·32 | 4·35 | 25·0 | 25·5 | 5·30 | 2·86 | 220 | 136 | 41·5 | ·75 | ·50 | 98 | 110 |
| 7 | 6.50 | 27·0 | 27·5 | 1·20 | 4·23 | 25·0 | 25·0 | 5·30 | 2·84 | 220 | 136 | 41·0 | ·75 | ·50 | 100 | 113 |
| 8 | 7.25 | 28·0 | 27·8 | 1·32 | 4·35 | 24·0 | 25·0 | 5·30 | 2·82 | 220 | 137 | 41·0 | ·79 | ·49 | 100·2 | 114 |
| 9 | 7.55 | 27·0 | 27·5 | 1·40 | 4·03 | 24·0 | 25·0 | 5·10 | 2·75 | 218 | 134 | 40·6 | — | — | 100·5 | 114·5 |
| 10 | 8.10 | 21·3 | 22·0 | 1·16 | 2·93 | 0 | 0 | 0 | 0 | 218 | — | 40·6 | 3·8 | ·30 | — | — |
| 11 | — | 20·6 | 21·0 | 1·88 | 2·56 | 0 | 0 | 0 | 0 | 218 | — | 40·6 | — | — | — | — |
| 12 | 8.20 | 20·0 | 21·0 | 1·48 | 2·66 | 0 | 0 | 0 | 0 | 218 | — | 40·6 | 8·0 | — | — | — |

NOTES.—Reading No. 10 was taken with belt on, stators excited, rotor of motor open-circuited.
,, No. 11 was taken with both rotors open-circuited, stators excited, machines standing.
,, No. 12 was taken with belt off, both motors running light. Temperature of air, 64deg. F.

TABLE II.—RESULTS DEDUCED FROM OBSERVATIONS IN TABLE I. AS TO EFFICIENCY AND POWER FACTORS OF TWO 10-H.P. THREE-PHASE MOTORS.

| Number of reading. | Loss from mains Kw. $w_1+w_2$. | Separated losses – ·5 kw. for belts. Motor. Kw. | Separated losses – ·5 kw. for belts. Gen. Kw. | Gen. output $W_1+W_2$ | Motor efficiency. Input. Kw. | Motor efficiency. Output Kw. | Motor efficiency. $\eta$ | B.H.P. 10 h.p. | Generator efficiency Input Kw. | Generator efficiency Output Kw. | Generator efficiency $\eta$ | Slip %. M. | Slip %. G. | Power factor of motor. $W_1+w_1$. | Power factor of motor. $W_2+w_2$. | Power factor of motor. Ratio. | Power factor of motor. Cos $\phi$. | Power factor generator. $W_1/W_2$. | Power factor generator. Cos $\phi$. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2·34 | 1·10 | ·74 | 7·52 | 9·86 | 8·76 | 88·9 | 1·17 | 8·26 | 7·52 | 91·1 | 4·81 | 3·21 | 3·64 | 6·22 | ·583 | ·912 | ·540 | ·89 |
| 2 | 2·57 | 1·24 | ·83 | 7·61 | 10·18 | 8·94 | 88·0 | 1·20 | 8·44 | 7·61 | 90·3 | 4·86 | 3·25 | 3·68 | 6·50 | ·566 | ·903 | ·560 | ·90 |
| 3 | 2·39 | 1·13 | ·76 | 6·96 | 9·35 | 8·22 | 88·1 | 1·10 | 7·72 | 6·96 | 90·1 | 4·88 | 3·27 | 3·33 | 6·02 | ·550 | ·895 | ·565 | ·90 |
| 4 | 2·29 | 1·07 | ·72 | 6·82 | 9·11 | 8·04 | 88 3 | 1·08 | 7·54 | 6·82 | 90 5 | 5·00 | 3·33 | 3·19 | 5·92 | ·537 | ·887 | ·584 | ·91 |
| 5 | 3·00 | 1·54 | ·96 | 8·41 | 11·41 | 9·87 | 86·5 | 1·32 | 9·37 | 8·41 | 90·0 | 4·97 | 3·10 | 4·03 | 7·38 | ·545 | ·893 | ·527 | ·88 |
| 6 | 3·03 | 1 52 | 1·01 | 8·16 | 11·19 | 9·67 | 86·5 | 1·30 | 9·17 | 8·16 | 89 | 4·83 | 3·21 | 3·98 | 7 21 | ·550 | ·895 | ·540 | ·88 |
| 7 | 3·03 | 1·57 | ·97 | 8·14 | 11·17 | 9·60 | 86·1 | 1·29 | 9·10 | 8·14 | 89·5 | 4·88 | 3·27 | 4·10 | 7·07 | ·580 | ·910 | ·536 | ·88 |
| 8 | 3·03 | 1·57 | ·97 | 8·12 | 11·15 | 9·58 | 86 | 1·29 | 9·08 | 8·12 | 89·5 | 4·99 | 3·08 | 3·98 | 7·17 | ·557 | 897 | ·533 | ·88 |
| 9 | 2·63 | — | — | 7·85 | — | — | — | — | — | — | — | — | — | 3·7 | 6·78 | ·547 | ·294 | ·539 | ·89 |
| 10 | 1·77 | — | — | 0 | — | — | — | — | — | — | — | 8·2 | ·65 | — | — | — | — | — | — |
| 11 | ·68 | — | — | 0 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 12 | 1·18 | — | — | 0 | — | — | — | — | — | — | — | ·31 | ·31 | — | — | — | — | — | — |

the pulleys, the difference in diameters should be, as near as possible, such as to provide for the sum of the slips in the two machines under test at full load, and also the slip of the belt. It is on this ratio of the pulley that the output from the generator depends, if the rotor windings are short-circuited, as an asynchronous generator gives an output proportional to its speed above synchronism.

In Fig. 1 is given the diagram of connections used when testing the two 10-h.p. motors. These connections only refer to the stator circuits. These motors were provided with slip-rings on the rotors, and these were connected in the ordinary way to starting resistances. The procedure of starting up was thus exceedingly simple. After the stator connections (shown in the diagram) had been made and the main switch closed, the rotor resistance for the motor circuit was inserted and gradually reduced and short-circuited as the motor ran up to approximately synchronous speed. The starting resistance for the generator rotor circuit was then switched in, and gradually reduced until the rotor circuits were short-circuited, when all was ready for the test. The power supplied to the two machines and also that circulating between them was measured by the two-wattmeter method, which has the advantage of giving at the same time as the power measurement a ratio from which the power factor can be determined. The curves for getting the power factor from this ratio of the wattmeter readings are given in Fig. 2.

Coming now to the actual tests, the figures observed for the two 10-h.p. motors are given in Table I. Commencing from the left-hand side of this table, $a_1$ and $a_2$ are the currents in two of the mains from the power station. $w_1$ and $w_2$ are the watts supplied, and it should be noted that $w_1$ was negative. $A_1$ and $A_2$ are the readings of the ammeters in two of the conductors between the motors. The wattmeters, $W_1$ and $W_2$, give the circulating power; $V_1$ gives the average voltage between any two wires of the three-phase system; and V is the voltage between one wire and the neutral point of the star. The frequency specified was 40 complete cycles per second, and it will be seen that this was approximately maintained. The next columns give the period of the current in the rotor circuits of the generator and motor respectively. This was observed by means of a low-reading voltmeter shunted across the slip-ring. The swing of the needle of this voltmeter could be easily counted owing to the exceedingly low frequency of the rotor currents. This method of ascertaining the slip of both motor and generator is much more accurate than any determination of actual speed can possibly be, as the slip is measured direct, instead of taking the difference of two nearly equal speeds. The last two columns give the stator temperatures, which were taken in order to see when the motors had heated up and reached a steady temperature. It will be seen that after nine readings at rather more than full load three final readings were taken without any power circulating between the two machines. These readings will be referred to later.

In Table II. are given the results deduced from the readings taken as to the efficiency, power factor, and slip of each machine. In order that these figures may be appreciated, the following remarks as to each column are necessary. The energy taken from the mains to make up for the losses in each machine, and also that in the belt, is given in the second column ($w_1+w_2$). In order that an accurate determination of the efficiency may be obtained for each machine, it is necessary to divide up this total loss into its three components. To ascertain the actual loss in belt slip, and also in the belt itself, we can make use of readings Nos. 10 and 12. It will be seen that the two motors running light with the belt off took from the mains 1·18 kw. With the belt on under the same conditions otherwise, they took 1 77 kw. This shows that the extra power required to bend the belt, and due to extra bearing friction caused by the belt tension, is 0 59 kw. There is, however, under these conditions no load being transmitted by the belt, and hence the belt should not be slipping. The extra bearing friction should be included under the motor losses, as the motors are designed for

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TABLE III.—HOPKINSON TEST OF TWO THREE-PHASE MOTORS.

30-h.p. machine as motor, 25-h.p. machine as a generator.

| No. of reading. | Time. | $a_1$. | $w_1$. neg. | $w_2$. | $A_1$. | $A_2$. | $W_1$. | $W_2$. | V. | V$\phi$. | ⌒ | Rotor period second. G. | Rotor period second. M. | Stator temperature deg. F. G. | Stator temperature deg. F. M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12.10 | 109·5 | 4 95 | 19·1 | 95 | 94 | 10·6 | 20·7 | 220 | 140 | 41 2 | ·65 | ·50 | — | — |
| 2 | 12.20 | 105 | 4·4 | 18 0 | 93·5 | 91 | 9 8 | 19 6 | 213 | 134 | 41·8 | ·65 | ·52 | — | — |
| 3 | 12.45 | 104 5 | 5·28 | 18·45 | 88 | 87 | 9·7 | 19·45 | 225 | 142 | 40·5 | ·76 | ·53 | 118 | 133 |
| 4 | 1.45 | 94·5 | 5·06 | 16·32 | 76 | 74·5 | 8·25 | 17·20 | 224 | 142 | 41·75 | ·87 | ·56 | 131 | 145 |
| 5 | 2.15 | 91 | 4 82 | 15 20 | 73 | 71 | 8·3 | 15·3 | 224 | 142 | 40·8 | ·85 | ·59 | 130 | 143 |
| 6 | 2.18 | 84 | 3·30 | 12·70 | 69 | 67·9 | 7 0 | 13·45 | 193 | 123 | 40·8 | ·78 | ·46 | — | — |
| 7 | 2.22 | 78 | 4·82 | 12·90 | 60 | 56 | 5·4 | 12·95 | 225 | 142 | 40·8 | 1·16 | ·36 | — | 142 |
| 8 | 2.52 | 95·5 | 5·50 | 16·4 | 74 | 72·5 | 7·9 | 16·4 | 224 | 142 | 41·5 | ·95 | ·60 | 128·5 | 147·5 |
| 9 | 3.10 | 88 | 4·75 | 15·2 | 71 | 69·5 | 7·4 | 15·8 | 229 | 144 | 41·8 | ·93 | ·56 | 129 | 146·6 |
| 10 | 3.20 | 67 | 4·84 | 10·6 | 39 | 37 | 1·5 | 8·4 | 225 | 143 | 41·8 | 2·06 | ·31 | — | — |
| 11 | 3.30 | 89 | 3·75 | 13 8 | 70 | 73 | 7·7 | 14·05 | 197 | 123 | 41 0 | ·75 | ·50 | 127 | 144 |
| 12 | 3.33 | 59 | 4·84 | 8·68 | 26 | 25 | — | — | 220 | 140 | 41·0 | ·30 | 4·0 | — | — |
| 13 | 3.35 | 56 | 5·29 | 7·61 | 24 | 25 | — | — | 220 | 138 | 41·0 | — | — | — | — |
| 14 | 3.40 | 56·5 | 4·72 | 7·82 | 24 | 23 | — | — | 220 | 136 | 41·0 | 30·0 | 5·4 | — | — |

NOTES.—Reading No. 5 was taken at a low voltage.
,, No. 6 was taken with the first step of the motor rotor resistance in circuit.
,, No. 10 was taken with the two steps of the motor rotor resistance in circuit.
,, No. 11 was taken under varying conditions, and is not reliable.
,, No. 12 was taken with belt on and the motor driving the generator with its rotor circuit open.
,, No. 13 was taken with both rotors open-circuited and the machines standing.
,, No. 14 was taken with the belt off, both motors running light.

TABLE IV.—RESULTS DEDUCED FROM TABLE II. AS TO THE EFFICIENCY, POWER FACTOR, AND SLIP OF 25-H.P. AND 30-H.P. MOTORS.

| Number of reading. | Power supplied. $w_1+w_2$. | Separated losses = ·60 kw. for belts. Motor. Kw. | Separated losses = ·60 kw. for belts. Gen. Kw. | Gen. output $W_1+W_2$ | Motor efficiency. Input Kw. | Motor efficiency. Output Kw. | Motor efficiency. $\eta$ | B.H.P. / 30 h.p. | Generator efficiency Input. Kw. | Generator efficiency Output Kw. | Generator efficiency $\eta$ | Slip %. M. | Slip %. G. | Power factor of motor. $W_1+w_1$ | Power factor of motor. $W_2+w_2$ | Power factor of motor. Ratio. | Power factor of motor. Cos $\phi$. | Power factor of generator. $W_1/W_2$ | Power factor of generator. Cos $\phi$. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 14·15 | 7·66 | 5·9 | 31·3 | 45·45 | 37·79 | 83·3 | 1·68 | 37·20 | 31 3 | 84·4 | 4·85 | 3·73 | 15·75 | 29·7 | ·53 | ·884 | ·513 | ·874 |
| 2 | 13·6 | 7·21 | 5·79 | 29·4 | 43·00 | 35·79 | 83·3 | 1·60 | 35·19 | 29·4 | 83·7 | 4·60 | 3·69 | 15·20 | 27 8 | ·527 | ·883 | ·504 | ·868 |
| 3 | 13·17 | 7·08 | 5·49 | 29·15 | 42·32 | 35·24 | 83·5 | 1·58 | 34·64 | 29·15 | 84·1 | 4·19 | 3·25 | 14·17 | 28·15 | ·506 | ·867 | ·498 | ·864 |
| 4 | 11·26 | 6·49 | 4·18 | 25·45 | 36·71 | 30·22 | 82·5 | 1·35 | 29·63 | 25·45 | 86·0 | 4·28 | 2·76 | 12·14 | 24·57 | ·505 | ·867 | ·480 | ·855 |
| 5 | 10·38 | 5·78 | 4·00 | 23·60 | 33·98 | 28·20 | 83·1 | 1·26 | 27 60 | 23·60 | 85·5 | 4·16 | 2·88 | 10·48 | 23·23 | ·472 | ·850 | ·543 | ·891 |
| 6 | 9·40 | 5·55 | 3·25 | 20·45 | 29·85 | 24·30 | 81·5 | 1·08 | 23·70 | 20·45 | 86·4 | 5·33 | 3·12 | 10·15 | 19·70 | ·514 | ·875 | ·520 | ·880 |
| 7 | 8 08 | 5·71 | 1·77 | 18·35 | 26·43 | 20·72 | 78·5 | ·92 | 20·12 | 18·35 | 91·0 | 6·80 | 2·11 | 8·13 | 18·30 | ·445 | ·835 | ·416 | 818 |
| 8 | 10·90 | 6·30 | 4·00 | 24·30 | 35·20 | 28·90 | 82·2 | 1·29 | 28·30 | 24·30 | 86·0 | 4·02 | 2·54 | 10·9 | 24·30 | 448 | ·837 | ·482 | ·856 |
| 9 | 10·45 | 6·14 | 3·73 | 23·20 | 33·65 | 27·51 | 81·8 | 1·23 | 26·93 | 23·20 | 86·5 | 4·26 | 2·57 | 11·05 | 22·60 | ·489 | ·860 | ·467 | ·847 |
| 10 | 5·76 | 4·50 | ·66 | 9·9 | 15·66 | 11·16 | 71·5 | ·50 | 10·56 | 9·9 | 93·5 | 7·75 | 1·16 | 3·56 | 12·10 | ·294 | ·726 | ·179 | ·638 |
| 11 | 10·05 | 5·67 | 3·78 | 21·75 | 31·80 | 26·13 | 68·5 | 1·17 | 25·53 | 21·75 | 85·0 | 4·87 | 3 25 | 10·3 | 21·50 | ·479 | ·855 | ·549 | ·895 |
| 12 | 3·84 | — | — | — | 3·84 | — | — | — | — | — | — | ·61 | 8·1 | — | — | — | — | — | — |
| 13 | 2·32 | — | — | — | 2·32 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 14 | 3·10 | — | — | — | 3·10 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

belt driving. A reasonable assumption would therefore be that after allowing for belt slip when the load comes on, 0·5 kw. is the power wasted in the belt and belt slip. These 500 watts can be deducted from the sum of $(w_1+w_2)$, and the result is the power wasted in the two machines. To divide this between them may be accurately done on the assumption that the power wasted is in proportion to the slip of the rotor in each case. By these means, columns Nos. 3 and 4 have been arrived at. Take, for instance, reading No. 6. The total loss for the two machines is

$$3·03 - 0·50 \text{ kw.} = 2·53 \text{ kw.}$$

The motor slip is 4·83 per cent., and that of the generator 3·21 per cent. Therefore, the motor loss is

$$\frac{2·53 \times 4·83}{4·83 + 3·21} = 1·52 \text{ kw.},$$

and that of the generator

$$\frac{2·53 \times 3·21}{4·83 + 3·21} = 1·01 \text{ kw.}$$

The fifth column, which gives the output of the generator—*i.e.*, the power circulating between the two machines—is the sum of the two wattmeter readings, $W_1$ and $W_2$.

We now come to the calculation of the motor efficiency. The power supplied to the motor is evidently the sum of all the wattmeter reading, but can be more conveniently obtained by adding up column 2 and column 5. The output supplied by the motor as brake horse-power is transmitted by the belt to the generator. We have, however, determined the loss in the motor, and hence it only remains to deduct this loss from the input to get the output. Again, reverting to observation 6, we get

$$\text{Motor output} = 11·19 - 1·52 = 9·67 \text{ kw.}$$

$$\text{The efficiency} = \frac{9·6}{11·19} = 86·5 \text{ per cent.}$$

In this test, as in all tests on the Hopkinson method, the load on the two machines is not equal, and the motor is overloaded. This overload, as is shown on the next column, varies from 8 to 32 per cent. for different observations. The lower load in readings 3 and 4 was chiefly due to the supply voltage being low. The efficiency, as that column shows, rises to over 88 per cent. at the rated full load of the motor.

The generator efficiency can be calculated in the same way. The output is directly measured, and the input can be calculated by adding on the ascertained losses. The columns which give the slip of the rotors of both the motor and generator need little comment. It should be remembered, however, that the slip of the motor is high because the motor is overloaded. The actual slip of the motor at full load may be determined on the assumption that it is proportional to the load. Thus, from observation 6, we get that the slip when the motor was delivering 10 h.p. would be

$$\frac{4·83 \times 1·00}{1·30} = 3·71 \text{ per cent.}$$

The last columns deal with the power factors of the motor and generator, which are deduced from the ratio of the readings on the two-wattmeter method of the supplied

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and circulating power respectively. These power factors were checked by a comparison between the kilovolt-amperes and the wattmeter readings with satisfactory results, which showed that the whole of the instruments employed were in reasonable agreement with each other, and hence accurate. An interesting point not shown in the table is that the power factor of the power supplied from the mains is low.

Thus in reading 6 the ratio of $\frac{w_1}{W_2}$ is

$$\frac{-1{\cdot}32}{4{\cdot}35} = -{\cdot}304.$$

From the negative curve of Fig. 2 we get for this ratio a power factor of 0·286. This power factor is low, and it is evident that practically all the wattless current is taken from the supply mains.

It should also be noted that the power factor of the generator is, from the nature of the induction type of machine, the same as when it is used as a motor. With a given load the power factor of the generator is practically fixed, and this accounts for the low power factor of the main current. The main generator supplies the difference of the power currents with the sum of the wattless currents required by the two machines.

With respect to the belt slip, the figures obtained should give sufficient information to enable this to be calculated. Unfortunately, however, in the test in question the last three readings were not repeated, as they might have been, to verify the slip under no-load conditions. Also the diameters of the pulleys were not measured with the accuracy which might have been employed. The diameters, as taken by means of a steel rule, were 13in. for the motor pulleys and 11·85in. for the generator pulley, and the belt was about 0·3in. thick.

The calculation can then be made in the following way:

If $p$ is the percentage increase in speed of the generator over the motor caused by the pulley diameters;
$D_m$ = the diameter of the motor pulley;
$D_g$ = the diameter of the generator pulley;
$t$ = the thickness of the belt;
$m$ = the slip of the motor as a percentage;
$g$ = the slip of the generator as a percentage;
$b$ = the belt slip as a percentage.

Then the following equations hold:

$$1 + p = \frac{D_m + t}{D_g + t};$$

$$p = \frac{D_m - D_g}{D_g + t}.$$

In the case of the two 10-h.p. motors, $D_m$ was 13in., $D_g$ was 11·85in., and $t$ about 0·3in.

$$\therefore p = \frac{13 - 11{\cdot}85}{11{\cdot}85 + 0{\cdot}3} = \frac{1{\cdot}15}{12{\cdot}15} = 9{\cdot}43 \text{ per cent.}$$

Again, from speed considerations

$$(1 - m)(1 + p)(1 - b) = 1 + g.$$

Since $m$, $p$, $b$, and $g$ are all small quantities, we have with sufficient accuracy

$$b = p - (g + m).$$

In this case with reading No. 6 in the table $m = 4{\cdot}83$, $g = 3{\cdot}21$, and $p$ as determined above $= 9{\cdot}43$.

Using the approximate formula, we get the belt slip as equal to $9{\cdot}43 - (4{\cdot}83 + 3{\cdot}21)$

$$= 1{\cdot}39 \text{ per cent.}$$

The power given to the belts is 9·67 kw., so that the loss in belt slip is 134 watts. This is less than was assumed for the total belt loss, but, as mentioned above, the pulley diameters may not be quite correct, and a small difference in them would affect the result considerably.

In Tables III. and IV. are given the figures taken for two motors, one of 30 h.p. and the other of 25 h.p. In this case the 30-h.p. motor was used as the motor and the 25-h.p. machine was used as the generator. The only pulleys available at the time were approximately 16in. and 14½in. in diameter respectively. The difference between them was rather too much, and in consequence, when first started, the motor was overloaded between 60 and 70 per cent. This was reduced by slackening the belt and allowing rather more slip. This reduced the speed of the generator, and brought the load down in consequence. It will be noticed that reading No. 6 was taken with the first step of the rotor resistance in the motor rotor circuit. Even then an efficiency as high as 81 per cent. was obtained. Reading No. 10 was taken with two steps of this resistance in circuit, and then the efficiency fell to 71·5 per cent. The other figures of this test will be useful to anyone wishing to experiment with this method of testing motors.

The best way of adjusting the load in this test is to use a rotor starter with resistance coils of sufficient capacity that they can be left in circuit during the test. By adjusting this resistance the slips can be adjusted to any desired value. The small loss in the rotor starter can be easily measured if need be. In the case of the 25-h.p. and 30-h.p. motors, the slips were lower than was expected, and the difference between the pulleys rather too much. The normal starting resistances used for the rotors in this test were not of sufficient section to allow of their being left in circuit.

In conclusion, the advantages of testing three-phase induction motors in this way are many, and in most test-rooms pulleys will be found in stock which will be suitable for the purpose. In carrying out the tests at the General Electric Company's works there was no difficulty in this respect. The advantages may be summed up under three headings. First, the method is more accurate, as it allows of the losses in the two machines being read directly off low-reading wattmeters. It avoids the use of mechanical brakes. Secondly, it economises the power required when testing, as, for instance, on the last trial only 9·4 kw. were taken from the mains when the 30-h.p. motor was working at full load. With this expenditure of power two motors were tested together, which would have required approximately 45 kw. to test if run against brakes. Thirdly, the system allows of two machines being tested at the same time, and economises the time of the test-room staff, and, what is more important from the author's point of view, the time of the consulting engineer who has to pass the motors for export.

Before leaving the subject it may be remarked that the motors, which were made by the General Electric Company, were of considerably higher efficiency than had been guaranteed under the contract.

## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E., A.M.I.C.E., ETC.

*(Continued from page 745.)*

*History of Marconi's Success (concluded).*

1902.

*January.*—Mr. Marconi sailed for America on s.s. "Philadelphia," which vessel was fitted with his system of wireless telegraph apparatus, and during the voyage he succeeded in receiving legible messages up to 1,551½ miles and Morse signals up to 2,099 miles from Poldhu station, Mullion, Cornwall.

*March 17.*—Agreement entered into with the Government of the Dominion of Canada, whereby the Canadian Government agreed to subsidise the Marconi companies for the establishment of a station in Canada for wireless telegraphic communication between Canada and the United Kingdom, provision also being made for the erection and working of wireless telegraph stations in other parts of the Dominion of Canada. A station for transmission and receipt of Transatlantic messages at this time in course of erection at Glace Bay, Cape Breton.

*April 28, 29, and 30.*—Demonstration arranged and attended by the chief officials of the Dutch Government, communication being established and maintained between the Dutch warship "Evertson" and Scheveningen Agreement concluded with the Belgian Government for the installation of the Marconi system on nine of the Ostend-Dover Royal Mail boats and at two coast stations.

*May 28.*—Torpedo destroyer "Recruit" struck in Brissons in fog. Cruiser "Hyacinth," destroyer "Vigilant,"

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and two tugs dispatched to render assistance. "Hyacinth" sent message by wireless telegraphy to Devonport advising the floating of the "Recruit."

*July 14-16.*—Mr. Marconi received messages from Poldhu on Italian battleship "Carlo Alberto" at Cape Skagen, a distance of 800 miles, and at Kronstadt, a distance of 1,600 miles.

*July 24.*—Practical demonstration of Marconi system of wireless telegraphy on steamer "Koh-i-Noor" and at North Foreland station. Communication established with Southend-on-Sea, Frinton-on-Sea, Chelmsford, North Foreland, and Nieuport, in presence of Right Hon. J. R. J. Seddon, Earl Onslow, Lord Charles Beresford, the Belgian Minister, and other representative gentlemen.

*August 30.*—Mr. Marconi received messages from Poldhu on Italian battleship "Carlo Alberto" at Ferrol.

*September 10.*—Messages received from Mr. Marconi, stating that he had received messages on Italian battleship "Carlo Alberto" at Gibraltar, at Spezia, and throughout Mediterranean voyage.

*December 21.*—Messages transmitted by wireless telegraphy from Cape Breton, Nova Scotia, to Poldhu, Cornwall.

1903.

*January 19.*—Message sent from President Roosevelt to the King, *vid* Cape Cod and Poldhu (over 2,800 miles). Message clearly received at Poldhu and forwarded to Windsor.

*March 18.*—Remarkable experiments on tuning carried out by Dr. Fleming and Mr. Marconi between Poldhu and the Lizard (six miles); also Poole (200 miles). Two different sets of messages, one from the large station at Poldhu and the other from the small ship station at the same place being received *simultaneously* and on the same aerial at the Lizard, the former being checked by the Poole station.

*Ships and Stations Fitted.*—The following are some details giving the number of ships equipped by the Marconi Company up to date: British Admiralty, between 70 and 80; Italian Navy, between 40 and 50; Cunard Company, 11; Norddeutscher Lloyd, four; Allan Line, three; Atlantic Transport Company, three; American Line, four; Compagnie Transatlantique, six; Belgian Mail Packet, nine; Red Star Line, four; Hamburg-American Line, three; Isle of Man Steam Packet Company, one; Navigazione Generale Italiana, five ships already fitted and contract signed under which Marconi's have a right to equip (if required) the whole of this company's fleet, numbering about 120 vessels; yachts, one ("Samaritan," Royal Yacht Squadron). Their recent contract with the Admiralty covers the use of the apparatus of this company on all ships of war which the naval authorities may decide to equip. They have also 13 land stations in the United Kingdom, one in Belgium, two in Germany, four in America, two in the Congo Free State, six in Hawaii, two in Canada—29 in all. Three stations in Alaska, one in Havana, and one in Florida are being equipped, whilst seven shore stations have been erected in Italy, and seven more are to be in operation shortly; also six are on order for Newfoundland. The company by its contract with Lloyd's of September, 1901, has the right to equip any of the 120 or so stations belonging to Lloyd's which it may be thought necessary to equip. A number of these stations have already been fitted, and are at work as wireless stations for communication with passing ships. There are also, of course, the three high-power stations at Poldhu (England), Glace Bay (Canada), and Cape Cod (U.S.A.), already referred to. That a ship, if properly equipped, need never lose touch with land (at least on a voyage from England to America) is shown by the journal published on board the "Lucania" on her voyage to America, Oct. 12, etc., 1903, and other similar journals which have since been published. On Oct. 14 messages were received from both sides of the Atlantic, the "Lucania" being then in mid-ocean. It is said to be the intention of the Cunard Company to fit their principal ships in a similar way with high-power apparatus, so that a daily journal containing news of current events on land may be produced on board.

*(To be continued.)*

## THE RELUCTANCE OF THE AIR-GAP IN THE INDUCTION MOTOR.

BY N. PENSABENE, A.I.M. (BELGIUM).

There is no other machine for which the predetermination of the air-gap permeability has such great importance as the induction motor, since the full-load power factor of this machine depends (in conjunction with other conditions) upon the right proportion between the exciting current and the full-load current. According to the leakage factor calculated for a given type of machine, the designer, in order to obtain the maximum power factor at full load, must arrange the elements of the machine in such a way as to have a determined magnetising current. If $\sigma$ is the leakage factor, the maximum power factor will be given at full load when $i' = i_1 \sqrt{\sigma}$, where $i_1$ is the full-load current and $i'$ the exciting current. In this case it is well known that the maximum power factor is

$$\cos \phi_{max.} = \frac{1}{1+2\sigma},$$

Now, the light current is given by

$$i' = k \frac{e \cdot p \cdot d_1}{{n_1}^2 \sim \cdot A_a} 10^8,*$$

where $e$ = voltage per phase; $p$ = total number of poles; $n_1$ = number of conductors per phase; $\sim$ = frequency; $d_1$ is the air-gap corrected in order to take into account

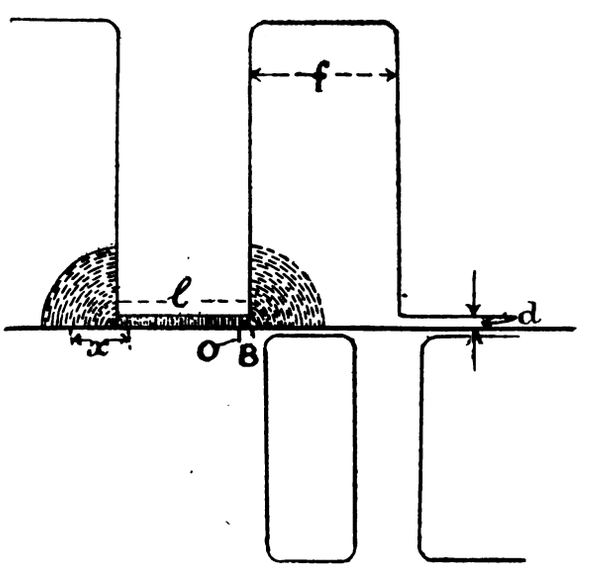


FIG. 1.

the iron reluctance; and $A_a$ is the fictive surface of the gap by which the flux would pass under a given magnetic pressure, travelling across the air-gap depth. Having fixed the iron dimensions of the machine, it is necessary to know $A_a$ to fix $n_1$ in order to obtain the light current, $i'$. Many writers estimate $A_a$ by simply multiplying the mean cross section of the exposed iron at the air-gap by a spreading coefficient. Now, this spreading coefficient depends upon many elements, and it is of some use to know how it varies as a function of the width of slots, the air-gap length, and the number of slots per pole.

We will study now the case of open slots in the stator and totally enclosed slots in the rotor. The teeth induction never being very high, we may consider the teeth surfaces as equipotential, and suppose that the flux passes from the stator to the rotor, and *vice versâ*: (1) by crossing the air-gap length; (2) by passing from the teeth stator sides, following circles which have their centres in O (Fig. 1), so that O B = $d$, air-gap length.† We shall see that this hypothesis will lead to conclusions which agree very closely with experimental results.

* See the article published by the writer in the *Electrical Engineer*, Feb. 12.

† There are also some lines passing by the flank sides of the teeth, but we need not consider them, as they are of the order of the flank dispersion; and their influence can be taken into account by taking for the iron length of the machine the net iron length plus the insulation between sheets.

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If L is the length of the machine between flanges less the air-ducts, the permeance for one tooth is given by—

$$P = \frac{L\,l}{d} + 2L \int_{d}^{d+\frac{f}{2}} \frac{dn}{x \arccos \frac{d}{n}}$$

To simplify we can write with little inaccuracy,

$$P = \frac{L\,l}{d} + 2L \int_{d}^{d+\frac{l}{2}} \frac{dn}{\frac{x\pi}{2} - d}$$

So we get

$$P = \frac{L\,l}{d} + 2L \int_{d}^{d+\frac{f}{2}} \frac{dn}{\frac{x\pi}{2} - d} = \frac{L\,l}{d} + \frac{4\,L}{\pi} \int_{d}^{d+\frac{f}{2}} \frac{d(\pi x - 2d)}{\pi x - 2d}$$

$$\text{or } P = \frac{L\,l}{d} + \frac{4\,L}{\pi} \left[\log (\pi n - 2d)\right]_{d}^{d+\frac{f}{2}}$$

$$= \frac{L\,l}{d} + \frac{4\,L}{\pi} \log \left[\frac{\frac{\pi f}{2} + \pi d - 2d}{\pi d - 2d}\right]$$

and finally $P = \frac{L\,l}{d} + \frac{4\,L}{\pi} \log \left(\frac{1{\cdot}38\,f}{d} + 1\right)$,

and if S is the number of slots per pole,

$$A_a = P\,d\,S = L\,l\,S + 1{\cdot}27\,L\,.\,S\,.\,d \log \left(\frac{1{\cdot}38\,f}{d} + 1\right),$$

which we can write $A_a = L\,.\,S\,(l + \epsilon\,d)$,

where $\epsilon = 1{\cdot}27 \log \left(\frac{1{\cdot}38\,f}{d} + 1\right)$.

The curves (Fig. 2) give the different values of $\epsilon$ according to the ratio $\frac{f}{d}$.

Before giving the experimental corroboration of the above formula, the following examples will show how the spreading coefficient may vary between large limits. Suppose two cases in which the pole-pitch and the exposed iron surface at the air-gap are the same:

(1) $S = 9$; $l = 1$; $f = 1{\cdot}22$; $d = {\cdot}05$; $\frac{f}{d} = 20$; $\epsilon\,d = {\cdot}22$;

spreading coefficient $= 1 + \frac{\epsilon\,d}{l} = 1{\cdot}22$.

(2) $S = 15$; $l = {\cdot}6$; $f = {\cdot}74$; $d = 0{\cdot}15$; $\frac{f}{d} = 4$; $\epsilon\,d = {\cdot}43$;

spreading coefficient $= 1 + \frac{\epsilon\,d}{l} = 1{\cdot}72$.

We see that the spreading coefficient in the second case is 1·41 larger than in the first case.

The correctness of the above curves will be proved by the following tests with machines having different air-gaps and width of slots. The correction of the air-gap length has been found experimentally by plotting the curves in Fig. 3, which are the open-circuit characteristics. If there were not magnetic resistance in the iron path, these curves would be straight lines; this not being the case, we will correct the air-gap by simply writing (Fig. 3)

$$d_1 = d\,\frac{AC}{BC}.$$

Knowing $d_1$, we calculate $A_a$ by the curves, and with formula (1) we find the light current $i'$, which will be confronted with the one found experimentally. The following machines have drum-wound stators then the coefficient in (1) will be ·44.

$$i' = {\cdot}44\,\frac{e\,.\,p\,.\,d_1}{n_1^2\,.\sim.\,A_a}\,10^8.$$

(The E.M.F. of the alternator used in these tests is not a sinusoidal one but containing the third, fifth, and eleventh harmonics. Its equation can be written

$E = E_1 \sin \phi + E_3 \sin (3\phi + \pi) + E_5 \sin 5\phi + E_{11} \sin 11\phi$.

The only pronounced harmonic is $E_3$, which has no influence in our case, so we can suppose correct the coefficient ·44.)

I. The curve 1 in Fig. 3 is the characteristic of a machine having the following data:

$S = 9$; $f = 1{\cdot}4$; $l = 1{\cdot}2$; $L = 25{\cdot}4$; $\sim = 50$; $n_1 = 288$, $e = 635$ V; $d = {\cdot}12$; $d_1 = \frac{AC}{BC}\,d = {\cdot}140$; $p = 12$. We have then

$$\frac{f}{d} = 11{\cdot}7; \quad A_a = 9 \times 25{\cdot}4\,(1{\cdot}2 + {\cdot}12 \times 3{\cdot}6) = 374.$$

and $$i' = \frac{{\cdot}44 \times 635 \times 12 \times {\cdot}14}{288^2 \times 50 \times 374} = 30 \text{ A.}$$

The test gives $i' = 30{\cdot}5$ A.

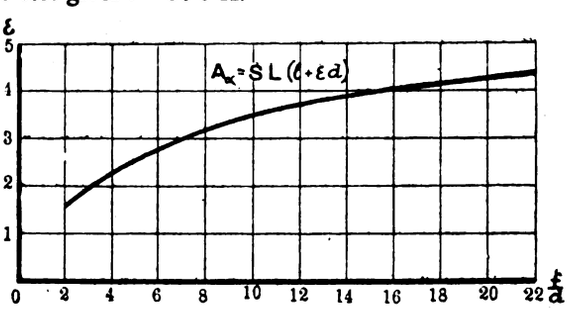


FIG. 2.

II.—Curve 2 in Fig. 3 is the curve of a machine having $S = 9$; $f = 1{\cdot}3$; $l = {\cdot}9$; $L = 21\,6$; $n_1 = 90$; $\sim = 50$; $p = 6$; $e = 127$ V; $d = {\cdot}065$; $d_1 = \frac{AC}{BC}\,d = {\cdot}072$; $\frac{f}{d} = 20$; $A_a = 9 \times 21{\cdot}6\,({\cdot}9 + {\cdot}275) = 230$.

Then $$i' = \frac{{\cdot}44 \times 127 \times 6 \times {\cdot}072}{90^2 \times 50 \times 230} = 25{\cdot}8.$$

The test gives 26·5.

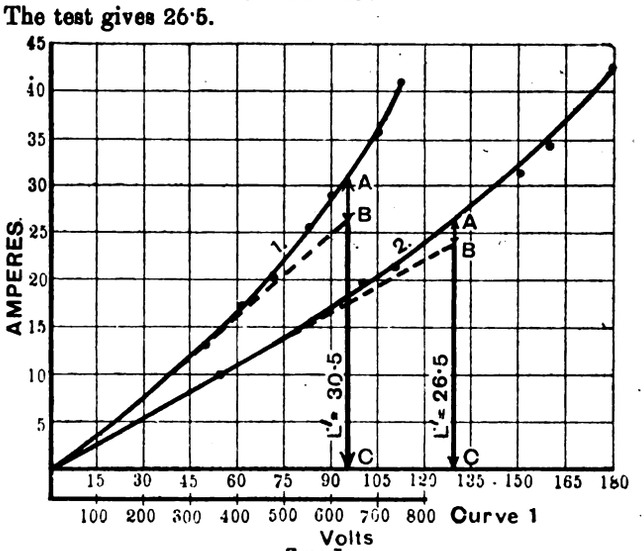


FIG. 3.

III.—This machine is of the same design as the II, but the air-gap is ·95. We take for this machine the same ratio, $\frac{AC}{BC}$, as for II., so

$$d_1 = {\cdot}95 \times \frac{AC}{BC} = {\cdot}104 \qquad \frac{f}{d} = 13\,8$$

$$A_a = 21{\cdot}6 \times 9\,({\cdot}9 + {\cdot}365) = 246,$$

and we have

$$i' = \frac{{\cdot}44 \times 127 \times 6 \times {\cdot}104}{90^2 \times 50 \times 246}\,10^8 = 35 \text{ A.}$$

The test gives $i' = 34$.

IV.—In this machine the iron reluctance is very small, having a low induction in the teeth. The air-gap measured is ·085 and we take $d_1 = {\cdot}09$. We have: $S = 9$; $l = {\cdot}66$; $f = 1{\cdot}02$; $d = {\cdot}085$; $d_1 = {\cdot}09$; $n_1 = 936$; $\frac{f}{d} = 12$; $L = 11{\cdot}8$; $\sim = 50$; $A_a = 9 \times 11{\cdot}8\,({\cdot}66 + 3{\cdot}6 \times {\cdot}085) = 103$.

$$i' = \frac{{\cdot}44 \times 635 \times 6 \times {\cdot}09}{936^2 \times 50 \times 103}\,10^8 = 3{\cdot}4 \text{ A.}$$

The test gives $i' = 3{\cdot}8$ A.

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In another article we will consider the more common case of machines having semi-enclosed slots in stator and rotor.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

697. How would you arrange and what materials would be most suitable in making-up a set of ambulance requisites for a central station?—H. B.

698. A certain mill is equipped with a 60-h.p. waterwheel of the "undershot" type. The mill is subjected to periodical shortages of water. It is proposed to provide a 50-h.p. induction motor of the single-phase type, the motor and waterwheel to be run in parallel on the shafting, it being assumed that the motor will automatically take up any excess of load as the waterwheel slows due to lack of water. During the winter months the shafting is occasionally but lightly loaded, and there being an excess of water at this period, is it possible for the waterwheel to drive the rotor of the motor above synchronous speed, and thus cause it to act as an "asynchronous generator," and return current to the line, causing variations in line pressure, etc.? If so, please describe methods of prevention.—FIFTIQUIDA.

### ANSWERS.

*Question No.* 690.—What are the relative advantages and disadvantages of lap and wave wound armatures for continuous-current machines?

*Answer to No.* 690 (*awarded* 10*s.*).—The main advantages of the two-circuit (or wave) winding may briefly be stated thus: (1) two-circuit windings, for multipolar machines, require fewer face conductors (and therefore commutator segments) in order to generate a given voltage with a given flux per pole than multiple-circuit windings; (2) the electrical balance in the armature with two-circuit windings is still preserved, even if the armature should become eccentric with regard to the bore of the field. With multiple-circuit windings, on the other hand, this eccentricity would be accompanied by unequal E.M.F.'s induced in the different circuits, thereby tending to cause sparking. These two points, together with the increasing demand for continuous-current motors of small and moderate sizes and high voltage, have probably been the cause of the very wide application of two-circuit windings. This style of winding has, however, limitations imposed by the size of the machine, and has not been found to give entire satisfaction in machines of over 100 kw. output. Generally, it may be said that, where heavy currents are to be collected, two-circuit windings are inadmissible. This point will be considered later. In Figs. 1 and 2 are given diagrams of a two-circuit and a multiple-circuit winding for a six-pole machine. The two-circuit winding is derived from the formula $c = n\,y \pm 2\,m$, where $c$ = number of face conductors, $n$ = number of poles, $y$ = average pitch, and $m$ = number of windings on armature.

In Fig. 1 there are 56 face conductors, hence $56 = 6 \times y \pm 2 \times 1$; thus $y = 9$, or 9·66. The first value (9) can only be accepted in this case. In multiple-circuit windings the number of conductors should be a multiple of the number of poles. Thus $y = \frac{c}{n}$, where $c$, $n$, $y$ have the same meaning as above. The *average* pitch, therefore, must be even, the front and back pitches differing by 2. In Fig. 2 $c = 60$, $n = 6$, therefore $y = 10$, giving the front pitch as 9 and the back pitch as 11.

It should be noted that the turns in series between the brushes in a two-circuit winding are one-half of the total turns on the armature, independent of the number of poles, since there are but two paths through the winding, whereas in a multiple-circuit winding the turns in series between the brushes are $\frac{1}{n}$th of the total turns on the armature, $n$ being the number of poles. It will thus be observed that motors and generators operating at a high voltage can be built

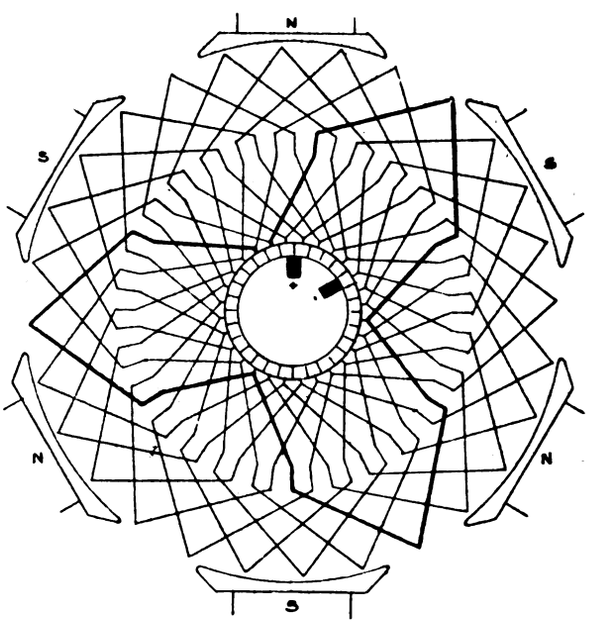


FIG. 1.

without undue proportions by adopting the two-circuit winding. Consider the case of a six-pole, 50-kw. machine for 500 volts running at 575 revolutions per minute, the flux entering armature per pole being 3·5 megalines. The turns in series between the brushes, therefore, will be 124.

$$E = \frac{4\,T.N.M}{10^8}$$

where E = internal voltage generated; T = number of turns in series between brushes; N = number of magnetic cycles per second; and M = magnetic flux entering armature per pole.

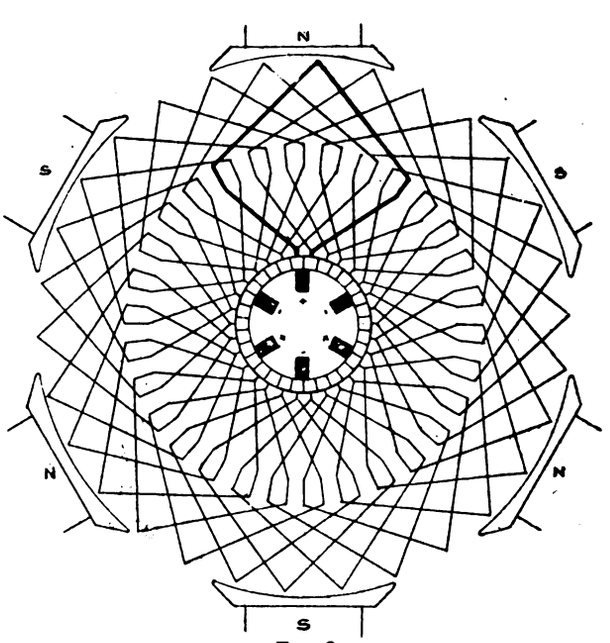


FIG. 2.

Employing a two-circuit winding, the total number of face conductors will be 496, thus making the armature dimensions as: external diameter, 21·5in.; internal diameter of core, 13in.; effective length of core, 7·2in.; density in armature core, 77·7 kilolines per square inch (see Table II.). With a multiple-circuit winding the total number of face conductors would be

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1,488, which would be entirely impracticable in the size of machine which we are considering—viz., 50 kw. The compromise in this case would be to increase the magnetic proportions of the machine, working at as high a magnetic density as permissible. This, however, does not lead to standardisation of the sizes of machines, nor does it utilise the material to the best advantage. In order to standardise the size of machines as much as possible, all dimensions of the frame, yoke, magnet core, armature spider, shaft, etc., should be independent of the voltage. The armature punchings, too, should preferably be the same, and this calls for one style of winding for all voltages; hence it is in this direction that the two-circuit winding has received its greatest development. This style of winding limits the number of slots and the number of groups of conductors (or half-coils) that are possible to place in a slot in order to obtain a symmetrical winding. Table I. illustrates this point, giving the number of conductors, or sides of coils, possible per slot for machines with from four to twelve poles.

TABLE I.

| Number of poles. | Possible number of conductors or groups of conductors per slot for symmetrical windings. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 1 | 2 | — | 6 | — | 10 | — | 14 | — |
| 6 | 1 | 2 | 4 | — | 8 | 10 | — | 14 | 16 |
| 8 | 1 | 2 | — | 6 | — | 10 | — | 14 | — |
| 10 | 1 | 2 | 4 | 6 | 8 | — | 12 | 14 | 16 |
| 12 | 1 | 2 | — | — | — | 10 | — | 14 | — |

TABLE II.—Arrangement of Comparative Designs for Armatures of 50-kw. Generators.

| *Specification.* | A. | B. | C. | D. |
|---|---|---|---|---|
| Number of poles | 6 | 6 | 6 | 6 |
| Kilowatts | 50 | 50 | 50 | 50 |
| Volts | 125 | 125 | 500 | 500 |
| Amperes | 400 | 400 | 100 | 100 |
| Speed (r.p.m.) | 575 | 575 | 575 | 575 |
| Periodicity in cycles per second | 28·8 | 28·8 | 28·8 | 28·8 |
| Megalines entering armature per pole | 3·02 | 2·04 | 3·5 | 4·0 |
| *Armature.* | | | | |
| Diameter over all (in.) | 21·5 | 21·5 | 21·5 | 21·5 |
| Length over conductors (in.) | 19·75 | 19·75 | 20·5 | 22 |
| Diameter at bottom of slots (in.) | 19·375 | 19·125 | 19·25 | 19 |
| Internal diameter of core (in.) | 13 | 14⅞ | 13 | 11·75 |
| Length of core over all (in.) | 8·75 | 8·75 | 8·75 | 8·75 |
| Number of intermediate ventilating ducts | 2 | 2 | 2 | 2 |
| Width of intermediate ventilating ducts (in.) | ·375 | ·375 | ·375 | ·375 |
| Effective length, magnetic iron (in.) | 7·2 | 7·2 | 7·2 | 7·2 |
| Depth of slot (in.) | 1 1/16 | 1 3/16 | 1⅛ | 1¼ |
| Width of slot (in.) | ·375 | ·375 | ·313 | ·216 |
| Number of slots | 108 | 107 | 124 | 162 |
| Width of tooth at periphery (in.) | ·25 | ·255 | ·232 | ·2 |
| Radial depth of air-gap | — | — | — | — |
| *Armature Slots and Conductors.* | | | | |
| Height of bare conductor (in.) | ·375 | ·42 | ·375 | ·1 |
| Width of bare conductor (in.) | ·1 | ·25 | ·07 | ·088 |
| Height of insulated conductor (in.) | ·403 | ·48 | ·403 | ·12 |
| Width of insulated conductor (in.) | ·128 | ·31 | ·098 | ·108 |
| Cross-section, bare conductor (sq. in.) | ·0375 | ·105 | ·0263 | ·0088 |
| Amperes per conductor | 66·6 | 200 | 50 | 16·7 |
| Amperes per sq. in. | 1,800 | 1,900 | 1,900 | 1,900 |
| Conductors per slot | 4 | 2 | 4 | 8 |
| Total copper cross-section per slot (sq. in.) | ·15 | ·21 | ·105 | ·704 |
| Width × depth of slot (sq. in.) | ·398 | ·445 | ·352 | ·27 |
| "Space factor" of slot | ·377 | ·472 | ·299 | ·26 |
| *Commutator.* | | | | |
| Diameter (in.) | 16·5 | 14·6 | 16·5 | 16·5 |
| Number of segments | 216 | 107 | 248 | 324 |
| Thickness of segment at periphery (in.) | ·21 | ·4 | ·18 | ·13 |
| Thickness of insulation between segments (in.) | ·03 | ·03 | ·03 | ·03 |
| "Active length" (in.) | 7·375 | 8 | 3 | 3 |
| *Brushes.* | | | | |
| Material | Carbon | Carbon | Carbon | Carbon |
| Number of sets | 6 | 6 | 6 | 6 |
| Brushes per set | 5 | 5 | 2 | 2 |
| Thickness of brush (in.) | ⅞ | ⅞ | ⅜ | ⅜ |
| Width of brush (in.) | 1·25 | 1·25 | 1·25 | 1·25 |
| Contact surface per brush (sq. in.) | 1·1 | 1·1 | ·47 | ·47 |

TECHNICAL DATA.

| *Armature.* | | | | |
|---|---|---|---|---|
| No-load voltage | 125 | 125 | 500 | 500 |
| Number of face conductors | 432 | 214 | 496 | 1,296 |
| Number of slots | 108 | 107 | 124 | 162 |
| Number of conductors per slot | 4 | 2 | 4 | 8 |
| Style of winding | Multiple circuit single | Two circuit single | Two circuit single | Multiple circuit single |
| Number of circuits through armature | 6 | 2 | 2 | 6 |
| Mean length, one armature turn (in.) | 41 | 41 | 44 | 48 |
| Total armature turns | 216 | 107 | 248 | 648 |
| Turns in series between brushes | 36 | 53·5 | 124 | 108 |
| Length between brushes (in.) | 1,475 | 2,195 | 5,456 | 5,180 |
| Cross-section, one armature conductor (sq. in.) | 0·375 | ·105 | ·0263 | ·0088 |
| Resistance of winding from + to − brushes at 60deg. C. (ohm) | 0·052 | ·00822 | ·0816 | ·0772 |
| C R drop in armature at 60deg.-C. (volts) | 2·08 | 3·3 | 8·16 | 7·72 |
| C R drop in brush contacts, etc. (volts) | 1·46 | 1·46 | 1·5 | 1·5 |
| Density in armature core (kilo-lines per sq. in.) | 66 | 66·6 | 77·7 | 77 |
| *Commutation.* | | | | |
| Number of segments in commutator | 216 | 107 | 248 | 324 |
| Number of segments per pole | 36 | 17·85 | 41·4 | 54 |
| Average volts between commutator segments | 3·47 | 7 | 12·1 | 9·26 |
| Armature turns per pole | 36 | 17·85 | 41·4 | 108 |
| Armature turns per segment. | 1 | 1 | 1 | 2 |
| Armature ampere-turns per pole | 2,400 | 3,570 | 2,070 | 1,800 |
| Segments lead of brushes | 3 | 2 | 3·5 | 4 |
| Percentage lead of brushes | 8·35 | 8·92 | 8·45 | 7·4 |
| Percentage demagnetising ampere-turns | 16·7 | 17·84 | 16·9 | 14·8 |
| Percentage distorting ampere-turns | 83·3 | 82·16 | 83·1 | 85·2 |
| Demagnetising ampere-turns per pole | 400 | 638 | 350 | 266 |
| Distorting ampere-turns per pole | 2,000 | 2,932 | 1.720 | 1,534 |
| Periphery of commutator (in.) | 51·8 | 45·8 | 51·8 | 51·8 |
| Peripheral speed (P) (ins. per sec.) | 496 | 440 | 496 | 496 |
| Length of arc of contact of brush (T) (in.) | ·875 | ·875 | ·375 | ·375 |
| Frequency of commutation (⁓ per sec.) $\left(n = \frac{P}{2T}\right)$ | 284 | 250 | 662 | 662 |
| Width of segment plus insulation (in.) | ·24 | ·43 | ·21 | ·16 |
| Maximum number of coils short-circuited under a brush | 4 | 3 | 2 | 3 |
| Turns per coil ($w$) | 1 | 1 | 1 | 2 |
| Maximum number of simultaneously commutated conductors per group ($r$) | 8 | 6 | 4 | 12 |
| "Free length" per turn ($f$) (in.) | 26·6 | 26·0 | 29·6 | 33·6 |
| "Embedded length" per turn ($e$) (in.) | 14·4 | 14·4 | 14·4 | 14·4 |
| Lines per ampere-turn per inch of free length ($u$) | 2 | 2 | 2 | 2 |
| Lines per ampere-turn per inch of embedded length ($v$) | 10 | 10 | 10 | 10 |
| Lines per ampere-turn for free length ($u \times f$) | 53·2 | 53·2 | 59·2 | 67·2 |
| Lines per ampere-turn for embedded length ($v \times e$) | 144 | 144 | 144 | 144 |
| Lines per ampere for free length $\left(\frac{r}{2} \times u \times f\right) = p$ | 213 | 160 | 118 | 404 |
| Lines per ampere for embedded length ($r \times v \times e$) $= q$ | 1,150 | 864 | 576 | 1,670 |
| Total lines linked with short-circuited coil per ampere ($p + q$) | 1,363 | 1,024 | 694 | 2,074 |
| Inductance per segment (L) $= \frac{w \times (p+q)}{10^8}$ (henry) | ·00001363 | ·00001024 | ·00000694 | ·0000415 |
| Reactance per segment ($2 \pi n$ L) (ohm) | ·024 | ·0214 | ·0288 | ·173 |
| Number of sets of brushes employed for wave winding | — | 6 | 6 | — |
| Minimum series reactance of short-circuited conductors (for wave winding) | — | ·0214 | ·0288 | — |
| Reactance voltage (volts) | 1·6 | 4·28 | 1·44 | 2·89 |

Thus, a four-pole machine with 99 coils can have these placed in 33 slots. Manufacturers sometimes, for the

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sake of employing the same punchings, group four conductors (or groups of conductors) per slot in a four-pole field, and employ a "dummy" coil—*i.e.*, a coil not connected to the winding or commutator. This, however, gives rise to a lack of symmetry, and should only be used where the sparking constants are very conservative. With two-circuit windings only two sets of brushes are needed, as far as collection of the current is

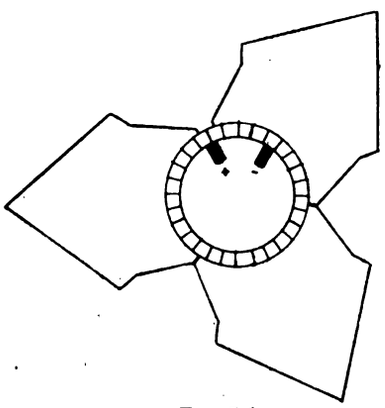

FIG. 3.

concerned; but in order to prevent the commutator being too expensive, and also to keep the reactance voltage to conservative values, it is customary to use as many sets of brushes as there are poles. In Fig. 3 is shown diagrammatically the conductors of the winding of Fig. 1 temporarily undergoing short-circuit at the positive brush. In this circuit there are six conductors, or the equivalent of three turns, in series, and if at full load there is a reactance

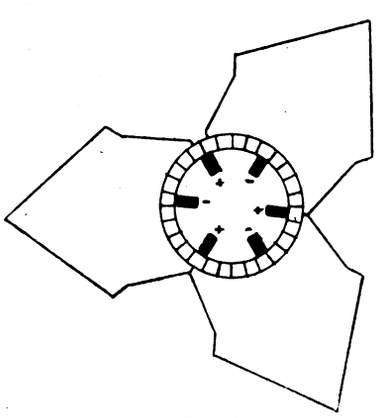

FIG. 4.

voltage of one volt per turn, the reactance voltage of the short-circuited coil amounts to three volts. But if, as in Fig. 4, all three sets of positive brushes are employed, each pair of conductors is short-circuited by another path consisting of two positive brushes and the interconnecting cable. In each of these independent circuits the reactance voltage is one volt, and the commutation should be much better than the previous arrangement. The diagram of

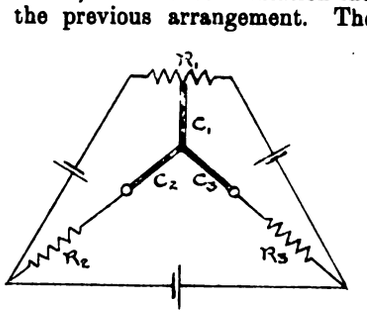


FIG. 5.

Fig. 4 illustrates an analagous system of circuits, in which $R_1$ represents the contact resistance of one brush bridging two adjacent segments, $R_2$ the contact resistance from a segment to a second brush, and $R_3$ the value for the third brush. $C_1$, $C_2$, $C_3$ represent the resistances of the interconnecting cables, and the reactance voltage in the three turns is represented by a cell. Thus it will be seen that the brush contact resistance and brush resistance have a very great effect upon the sub-division of current between the different sets of brushes of the same sign. This unequal sub-division of the current gives rise to sparking, which in certain cases has been of a destructive nature to the commutator.

When there are as many brush sets as there are poles, the flux density at each pole-face must be the same; otherwise the position of the different sets of brushes must be shifted with respect to each other to correspond to the different densities, the same that would be required with a multiple-circuit winding. Hence any change of the armature with respect to the poles will, in the case of two-circuit windings, be accompanied by an unequal sub-division of the current between the different brush sets of the same sign, and, therefore, the armature must be maintained in one position with respect to the poles, and with exactness, since there is no counteraction in the armature to prevent the unequal sub-division, as in the case of multiple-circuit windings. In the case of multiple-circuit windings, however, the drop in any circuit, and likewise the armature reaction on the field in which the current is generated, tend to prevent an excessive flow of current from the corresponding sets of brushes. The equalising rings fitted to multiple-circuit windings allow these currents to circulate without affecting the sub-division at the brush sets.

On account of these features it is now considered advisable by manufacturers to employ multiple circuit for all large machines. Each style of winding is, however, specially suited to its specific purpose, and with this object in view Table II. has been drawn up. In this table are given, in tabulated form, comparative designs for the armatures of 50-kw. generators for 125 and 500 volts. Each voltage has two designs given, one with a multiple circuit and the other with a two-circuit winding. The size of the frame, magnet system, etc., is to be considered the same for all voltages, the ampere-turns on the spools being varied to allow for the slightly increased density at the higher voltage. From this table it will be seen that designs A and C only require the armature punchings altered for 125 and 500 volts, all other parts—spider, end flanges, etc.—would be standard. By the arrangement of carrying through these comparative designs, it will be seen that the multiple-circuit winding is especially suited for the 125-volt machine and unsuitable for 500 volts, whereas the case for the two-circuit winding is *vice versa*.—MONOPHASE.

*Answer to No.* 690 (*awarded* 5*s.*).—From mechanical considerations wave windings would always be preferred, for they reduce the number of conductors and increase their section as compared with a wave winding for the same output. This is easily seen to be the case from the fact that with a wave winding each conductor carries half the total current, and the total conductors are equal to twice the effective conductors in series between the positive and negative brushes; whilst with a lap winding each conductor carries $\frac{\text{total current}}{\text{number of poles}}$, and the total number of conductors is equal to the number of conductors in series between the positive and negative brushes multiplied by the number of poles. Electrically also the wave winding has advantages. It removes all danger of internal balancing currents due to differences of pole strength, for there are only two circuits in parallel, and each of these has an equal number of conductors under each of the poles of the machine, so that any inequality of pole strength affects both circuits alike, and leaves the balance unaffected. With the lap winding, on the other hand, any difference of pole strength causes differences of current in the various circuits in parallel, and thus leads to sparking at one or more sets of brushes, and occasionally to violent surging of current from the high volt circuits into the lower-volt ones and back again. Even when equalising connections are fitted to the lap winding between points of equal potential, as is commonly done on the larger multipolar machines, though the bad effect on the brushes is more or less avoided, yet the wasteful internal currents are not prevented.

As regards reactance voltage and tendency to spark, both types of winding are much alike. Thus a lap winding with 400 conductors and 100 commutator plates on a four-pole machine might be safely replaced by a wave winding with about 200 conductor and about 100 commutator

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plates, for though in the wave winding the current per conductor will be doubled, and there will be two sections in series forming the short-circuit under the brush (Fig. 1) instead of only one, as in the lap winding (Fig. 2), yet the reactance voltage will be no greater, since it also depends on the square of the number of turns per section, and these turns are halved in the case of the wave winding. When, for the purpose of economising in the size of commutator, as many sets of brushes as poles are used with a wave winding, instead of only two sets (which is all that is really necessary), the short-circuit under the brush is modified, and the tendency to spark is reduced, though this reduction is found to be only slight in practice. Another difficulty

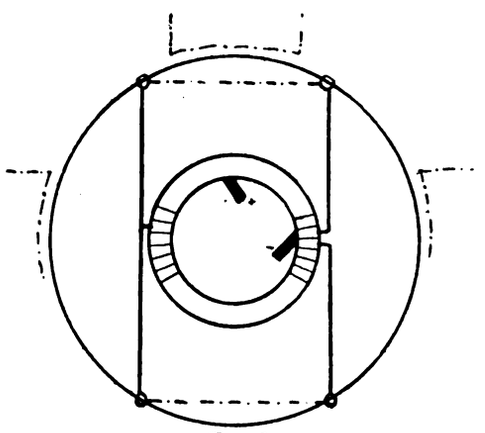

FIG. 1.

arises, however, when more than two sets of brushes are used. All the sets of brushes of similar sign are at practically the same potential (being connected to the same point on the armature winding, within a conductor or so), and the division of the current amongst the different sets of brushes depends practically on their respective contact resistances to the commutator. A very slight increase in pressure on one set may, therefore, cause much more than its share of the current to pass through that set, and so lead to considerable local heating and glowing of the carbons. This difficulty is, however, also present to a certain extent with lap windings when these are fitted with equalising connections.

The only valid objection to wave windings occurs at the larger outputs. The point is soon reached where the

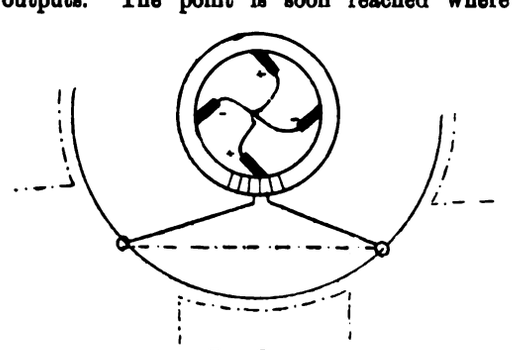

FIG. 2.

number of conductors becomes too small to permit the number of commutator plates necessary for low reactance and sparkless running to be obtained, and beyond this point lap windings have to be adopted. It is on this account that practically all the larger modern generators at ordinary voltages have to have plain lap windings, though undoubtedly wave windings are preferred whenever their use does not reduce the possible commutator plates below the minimum required for sparkless running.—Q.

*Answer to No.* 690 (*awarded* 5*s.*).—The characteristic points of "lap" and "wave" windings are shown in Figs. 1 and 2 diagrammatically. Fig. 1 represents the lap winding, and it will be noted that there are four distinct circuits; whilst in Fig. 2, which represents the wave winding, there are only two circuits in parallel. In this way the wave winding can be used with only two sets of brushes in place of four with the other windings. This is convenient on motors working in inaccessible positions, as the brushes on the under side of the commutator can be left off. Of course, in cases where the amperes per square inch exceed 45 amperes, two sets of brushes are not enough; and also some designers find that the commutation is more satisfactory with the full number of brushes.

Wave windings are generally used on motors up to, say, 70 h.p. capacity, as they are found to be more satisfactory from a commutation point of view, due to the absence of any tendency to "buck," whereas with unequalised lap windings this latter sometimes gives trouble. Of course, on larger machines lap windings are always equalised, but there is usually not room for the rings on small armatures, and also the extra expense should be avoided. On larger motors and generators, of about 200 kw. capacity and upwards, wave windings are very seldom used, equalised

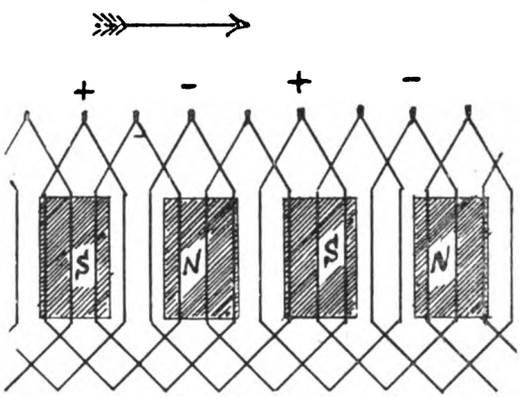


FIG. 1.

lap windings being the standard practice, the reason being that with the former type of winding it is seldom possible to use enough commutator segments to keep the average volts between adjacent segments within a safe limit. This latter should not exceed 10 to 12 volts for satisfactory commutation. Another point which is against wave windings on large machines is that the amperes per conductor are usually very high, as there are only two circuits. This latter should not exceed 200 amperes.

To demonstrate the above remarks, the writer proposes to discuss the armature winding of a 250-kw. generator recently designed which operated very satisfactorily on test.

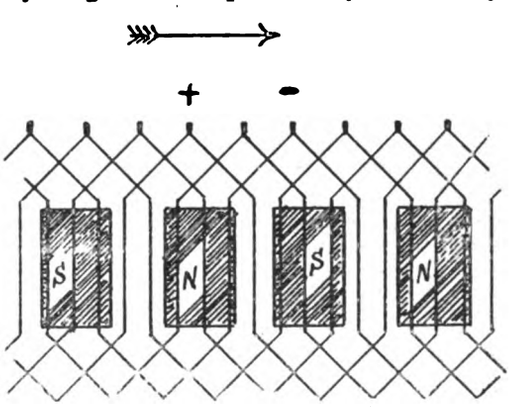


FIG. 2.

This generator was of the multipolar type (six-pole), rated at 600 volts, 250 kw. (417 amperes), 514 revolutions per minute. The armature was lap-wound, and equalised: number of slots in the core = 132; conductors per slot = 6; number of commutator segments = 396. From these figures it is found that the average volts between adjacent segments = 9·1 volts, and the amperes per conductor = 70. Now assume that a wave-wound armature was used in place of the above. To allow for the same flux through the armature, 262 total conductors are required—that is, with 132 slots two conductors per slot with one dead coil. The maximum number of commutator segments possible is 131; therefore, with this winding the volts between adjacent segments = 27·6 volts (a figure over 100 per cent. beyond the working limit), and also the amperes per conductor = 208, which is also outside the limit.

On the other hand, take the case of a small four-pole motor, rated at 500 volts, 10 h.p., 750 revolutions per minute, with a wave-wound armature, and working at a

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flux of, say, 1·75 megalines, approximately 1,100 total conductors are required. On small motors of this type there will be no difficulty as regards the volts between adjacent segments or the amperes per conductor, but the advantage of the wave winding lies in the fact that only 1,100 conductors approximately are required in the above case, whereas 2,200 conductors approximately are required on a lap winding to give the same flux. An obvious gain in cost of labour is thereby obtained with the wave winding.

In conclusion, wave windings should always be used on small machines and lap windings on large ones. With machines of about 100 kw. capacity experience and calculations can decide which winding to use. It is said by some designers that wave windings do not give such good commutation even on small motors as lap windings, but this is usually due to incorrect design in the other parts of the motors.—P.

*Answer to No.* 690 (*awarded* 5*s.*).—The question whether an armature should be wave or lap wound for any particular case depends largely on the current it is to give. A given winding with wave connections will give double the voltage of the same winding with lap, or, in other words, a lap winding for a given voltage must have twice as many turns as a wave. With a wire-wound armature this means a great saving in cost for a wave winding—firstly, in giving a better space factor in the slots, because the cotton covering on the wire takes up a less proportion of the space, and, secondly, because the armature is cheaper to wind. It also gives a better-running machine, because if four sets of brushes are used (on a four-polar), the coil short-circuited has half the number of turns carrying double the current. As the sparking E.M.F. is proportional to current × turns$^2$, the wave winding would appear to have an advantage of 2 : 1 over the lap. This is not exactly the case, because it is almost impossible to get the two sets of positive or negative brushes to share the current equally. Other advantages are the impossibility of unequally loading the two halves of the armature winding in case of its becoming eccentric owing to wear of bearings, and the ability to use only two sets of brushes.

These points are of considerable importance in the case of traction motors. When, however, we come to deal with large currents, the saving in space with a wave winding largely disappears, and with a bar armature with one-turn coils the lap winding has the advantage as regards sparking, owing to the uneven distribution of current in the brushes with wave winding as mentioned above. Also, with these large currents it is necessary to make the most of the commutator surface, and to make each set of brushes collect its share. With careful centering and the use of equalising rings there is no difficulty in ensuring this with a lap winding. In machines with more than four poles it would sometimes be a saving to use a duplex wave winding instead of a lap. Such machines however, are, frequently found to give trouble at the brushes, even when well designed as regards armature reaction and reactance voltage, owing apparently to interchange of current between the two windings. As a rough guide, a machine may with advantage be wound wave if the current is below 300 amperes, and lap if above that figure. The limit will, of course, vary a good deal according to the speed and design of the machine.—W.

*Question No.* 691.—What is the best simple test for ascertaining the number of degrees of hardness of boiler feed water in order to check the working of the water-softening plant. I want a simple method which can be readily carried out in the engine-room without the use of elaborate laboratory apparatus.

*Answer to No.* 691 (*awarded* 7*s.* 6*d.*).—It would, perhaps, have been better if the questioner had at least given some idea as to the type or make of water-softening plant in use, and whether the treatment is controlled automatically or by hand. The most reliable and, at the same time, a fairly simple method of ascertaining the hardness, in degrees, of water, is by means of the soap test. The apparatus required is of a simple description, and is quite suitable for engine-room use. The method of making the above-mentioned test is given in the following instructions, which are issued by the makers, for controlling the chemical treatment of the Archbutt-Deeley water-softening process.

*Instructions for Controlling the Chemical Treatment.*

1. *When the hardness does not exceed 4deg.* — (*a*) If the alkalinity does not exceed the hardness by more than 1deg. the water is fit for most purposes. (*b*) If the alkalinity exceeds the hardness more than 1deg., too much alkali has been used. (*c*) For boilers, unless liable to prime, if the alkalinity is less than 1deg. in excess of the hardness, rather more alkali should be added. For boilers liable to prime the alkalinity should not exceed the hardness.

2. *When the hardness exceeds 4deg* —(*a*) If the alkalinity is more than 4deg. more lime should be added. (*b*) If the alkalinity is less than the hardness, more alkali is required.

3. *Whatever the hardness* —(*a*) If no colour be obtained with nitrate of silver, more lime is required. (*b*) If a brown colour is obtained with nitrate of silver, too much lime has been added.

NOTE.—The colour obtained should be pale yellow.

The tests referred to are made as follows:

1. *Nitrate of Silver Test.*—Put about eight drops of a 5 per cent. solution of silver nitrate into a clean white porcelain basin, and add some of the water under test with a dipper. Do not make the test in direct sunlight. Rinse out the basin immediately after test. Brown stains on the bottom of the basin may be removed with a solution of cyanide of potassium.

2. *Alkalinity Test.*—Measure exactly, with a pipette, 70 cubic centimetres of the clear filtered water into a clean white porcelain basin. Add a sufficient number of drops of methyl orange solution to colour the water a distinct yellow, then add, at first slowly, and finally drop by drop, from a burette, decinormal sulphuric acid, stirring with a glass rod, until the yellow colour changes to a rose tint. The difference of a drop will cause the change. The volume of acid used in cubic centimetres multiplied by 5 is the alkalinity of the water in degrees. This test must be very carefully made in a good light.

3. *Soap Test for Hardness.*—The standard soap solution used for this test must be purchased "of such strength that exactly 14·25 cubic centimetres are required to produce a permanent lather with 50 cubic centimetres of standard hard water of 14deg. hardness." It is supplied by Messrs. F. Sutton and Co., manufacturing and analytical chemists, of Norwich. Measure exactly 50 cubic centimetres of the water under test into a clean 8oz. stoppered bottle, and add the soap solution from a burette, at first one cubic centimetre at a time, and then ·5 cubic centimetre at a time, and finally drop by drop, shaking well after each addition until a soft lather is obtained, which, if the bottle is laid at rest upon its side, remains continuous over the whole surface for five minutes. Observe the number of cubic centimetres of soap solution used, and read off the hardness from the usual tables.

The whole of the above-mentioned tests can be carried out in 15 minutes. A hardness test should be taken of the untreated water before each treatment, and it is a good plan to make two soap tests on the treated water, one as a check against the other (separate samples being used). The writer had experience of this treatment on a very variable canal water (the hardness often varying from 5deg. to 30deg. within 24 hours), which had a very muddy appearance, and on advice tried the use of aluminoferric as a means of clearing the water. The effect was certainly striking, the water being rendered quite clear. The aluminoferric was used in the proportions of 1½lb. to 6,000 gallons of water, and added in the form of a solution whilst the water was being agitated, after running the chemical reagents in. The apparatus for carrying out all the tests referred to above can be obtained in divided lock-up cabinet (measuring about 28in. by 14in. by 14in.), containing complete set, for £2. 10s.—NIGHT SHIFT.

*Answer to No.* 691 (*awarded* 7*s.* 6*d.*).—If only a simple test is required in order to ascertain that the feed water is properly softened, there is a very elegant and easy test introduced by Mr. Porter (of Porter-Clarke process fame). I have used it for many years on a practical scale with very great success in our boiler-house. All that is required is a glass vessel, such as a drinking tumbler, to hold a sample of the water, and a piece of phenolphthalein paper to lay on the top of the water. If the feed water has not been

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sufficiently softened nothing more can be seen, but if the water is properly softened, then faint streaks of pink appear to fall from the paper floating on the surface. These appear in about a minute. If the water has received too much caustic lime, and is therefore over-treated, the pink colour becomes very pronounced almost immediately. Phenolphthalein paper may be bought ready made at the operative chemist's, or it may be made, with a little patience, by dissolving phenolphthalein and sugar in spirits of wine, and then dipping blotting or filter paper into it and hanging the paper up to dry. The paper would require dipping and drying twice or three times very carefully, and it would have to be done in a room with plenty of ventilation and no fire, to avoid risk and to ensure success. A thick glass "trial jar," about 6in. high and 1in. diameter, and provided with a foot, may be bought at the chemist's for about 5d., and would be better than an ordinary tumbler. Phenolphthalein costs 2s. an ounce. Best refined white sugar should be used. This test is about all that is actually required in practice, but if it is also desired to know the number of degrees of hardness, then more must be done. Firstly, a definite meaning must be assigned to "a degree," and it is usual to mean one grain of carbonate of lime in a gallon of water. Now it happens that distilled water will dissolve, under the conditions of the question, about one grain of quicklime in 1,000 grains of water. Therefore, take a small quantity of clean quicklime (say ½oz.), put it into a clear glass wine bottle, fill the bottle up to the top of the shoulder with clean distilled water—*i.e.*, water that has dropped from a leaking steam-pipe—put a good cork into the bottle, and shake it well up several times at intervals during the day. This will give a saturated solution of quicklime. Allow it to stand all night, and a clear liquid will be found in the bottle in the morning. Now procure a graduated measure glass of 1,000 grains capacity with a spout for pouring and fill it up to the 1,000 mark with the clear solution of lime water. Obviously the solution will contain very nearly one grain of quicklime, because this is as much as the water can dissolve, and therefore every fluid grain measured will contain ·001 grain of quicklime. Now procure a small glass flask with a neck and holding about 4oz. Into this pour 700 grains of the feed water to be tested and put a piece of the phenolphthalein paper (¼in. square) on to the top of the water, allow it to stand for a minute or two, and then swash it round in order to mix thoroughly. Into this flask pour a few grains of the solution of quicklime, swash round as before, and if no colour appears, add a few more measures of the quicklime solution. Go on in this way very patiently until a faint pink colour appears, and then allow it a few minutes to see whether it will disappear. If so, then add a few more grain measures of the quicklime solution until the faint pink is just permanent. The flask, and also the measure glass, must be kept covered over as much as possible to prevent the entrance of carbonic acid gas from the air, as that would interfere with the experiment. Suppose, now, that we have used 15 fluid grains of the quicklime solution in the measure glass, then there would be the equivalent of three grains of carbonate of lime still left in each gallon of the partly softened feed water. The above quantities are chosen so that five fluid grains of the quicklime solution shall represent one grain of carbonate of lime in the gallon of feed water. Seven hundred grains are the ·01 of a gallon, which is 70,000 grains, and 10 fluid grains containing ·001 of quicklime each amount to ·01 grain of quicklime. If 700 grains contain ·01 grain, 70,000 grains will contain one grain, or, in other words, if ·01 gallon contains ·01 grain, then one gallon will contain 100 times as much (or ·01 × 100 = 1 grain). It must be remembered that each molecule of carbonate of lime in the feed water is kept in solution by a molecule of carbonic acid gas also dissolved in the water, and that the quicklime really seizes this molecule of gas and so renders the water incapable of dissolving the carbonate of lime any longer, therefore every molecule of quicklime added in the above measuring process sets free and renders insoluble a corresponding molecule of carbonate of lime which weighs almost exactly twice as much as the molecule of quicklime. This makes the whole matter perfectly clear and logical, but for ordinary practical purposes we must remember that commercial quicklime is not pure, and therefore more would have to be used in the water softener than the test would indicate, especially if it had been in store some time and become well slaked.—F, G. A.

*Answer to No.* 691 (*awarded* 5*s.*).—The best and simplest method for ascertaining the number of degrees of hardness of boiler feed water is as follows: Procure a flask or bottle (8oz. to 10oz. capacity), a 25 cubic centimetre burette (a glass tube, held upright in a stand, and marked off in cubic centimetres, with an indiarubber pinch-cock attached to one end for regulating the flow of a few drops at a time), a measure glass graduated to 70 cubic centimetres, and a small quantity of Wanklyn's standard soap solution. Measure off 70 cubic centimetres of the feed water into the flask, or, if preferred, a flask can be purchased already marked off at 70 cubic centimetres, thus doing away with the measure glass. Then fill up the burette with soap solution and add one cubic centimetre of same to the feed water. Shake the flask well after addition and notice whether a lather is formed; if not, continue to add the soap solution, one cubic centimetre at a time, shaking the flask well after each addition, until a lather appears and remains after shaking and standing for, say, five minutes. The number of cubic centimetres of the soap solution used to cause a lather to appear corresponds to the number of degrees of hardness of the feed water. Wanklyn's standard soap solution can be purchased ready for use, say, half a litre at a time, costing about 3s. The soap solution will not keep good for ever, as after a few months it sometimes suffers changes and loses in strength; it is therefore not wise to purchase too large a quantity at a time. Another simple method for rough testing is to use "Soloid" soap, obtained from Messrs. Burroughs, Wellcome, and Co., in small tablets, each tablet corresponding to five milligrammes of calcium carbonate, equalling 5deg of hardness. One tablet is added to 70 cubic centimetres of the feed water, and shaken up until dissolved. If a lather is formed, then the water is under 5deg. of hardness; if no lather appears, another tablet is added, shaken up until dissolved, and so on until a lather appears and stands after shaking, calculating 5deg. of hardness for each tablet used. For this test the only apparatus required is a flask or bottle marked off to 70 cubic centimetres and the tabloids.—E. BAMBRIDGE.

## FORTHCOMING EVENTS.

SATURDAY, JUNE 18.

**Crompton and Co., Limited.**—Inspection of Arc Works, Chelmsford, followed by annual athletic meeting. Train leaves Liverpool-street at 10.55 a.m.

SATURDAY, JUNE 25.

**Junior Institution of Engineers.**—At 3 p.m., visit to the Chelsea generating station of the Underground Electric Railways Company of London, Lot's-road, Chelsea. (The visit to Dover to inspect the Admiralty Harbour works announced for July 2 has been postponed to July 9.)

**Incorporated Municipal Electrical Association.**—Ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2.

## APPOINTMENTS VACANT.

**Charge Engineer,** Woolwich Electricity Works. Salary, £109. 4s. per annum. Applications by June 20.

**Refuse Destructor Foreman**, Folkestone. Wages £2 per week, with house, fuel, and light. Applications by June 23.

**Foreman,** Stockport, for car-shed and repairing shop. Salary, £120 per annum. Applications by 12 noon on June 20.

**Switchboard Attendant,** Swindon Corporation. Wages £1. 7s. 6d. per week, increasing £6. 10s. per annum for the first two years. Applications by July 5. See advertisement.

**Clerks,** Swindon. Salary, £91 and £78 per annum, increasing by £6. 10s. per annum. Applications by June 29. See advertisement.

**Telephos, Limited.**—This company has been registered with a capital of £10,000, the objects being to adopt a certain agreement (the parties to which are not named), to acquire the property named therein, and to carry on the business of suppliers of electricity, electrical and mechanical engineers, etc.

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THE

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### TO CORRESPONDENTS.

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*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## THE MINISTER OF COMMERCE AND INDUSTRY.

The report of the committee appointed in July last year to consider the position and duties of the Board of Trade and the Local Government Board, has been published this week. Under the terms of the reference the committee had to report as to whether any, and, if so, what, alterations should be made in the constitution and status of these offices. They had also to consider whether in the interests of administrative efficiency any rearrangement of duties between these and other Government departments is desirable. The committee, which was ably presided over by the Earl of Jersey, consulted Mr. Gerald Balfour and Mr. Long, the presidents of the two departments in question. They also obtained views of gentlemen who had previously held these offices. Besides this, representations from the Associated Chambers of Commerce, the Association of Municipal Corporations, and from the British Medical Association were received and considered. With respect to the Board of Trade, the report points out that this was established in 1786 for "the consideration of all matters relating to trade and foreign plantations." As constituted there were over twenty members of the Board, but this constitution is now obsolete, as the Board of Trade never meets. The responsibility for the conduct of its business rests upon the president, who is ably assisted by the permanent staff. The report points out that the work of the Board of Trade has greatly increased in importance of recent years. New duties and responsibilities have been imposed upon it by the Legislature in connection with "shipping, railways, labour disputes, and other matters." We feel that the committee might have honoured electrical engineering with its lighting and tramway interests with special mention, and not have included the same in the general category of "other matters." There is no doubt that electrical progress has entailed much extra work on the Board of Trade, and there is generally satisfaction with the way in which the duties have been performed. The industry, as represented by its leading men, has always been consulted before new regulations are framed and issued, and in several cases internal disputes of a general character between electrical undertakers and their consumers have been definitely settled by the issue of such regulations. Considered broadly, however, the committee are correct when they point out that "it is not the province of the Board of Trade to create or to control commerce. That must be left to private enterprise and to individual effort and initiative. There are, however, numerous ways in which the Board of Trade can assist the mercantile community, by helping to remove obstructions and by holding the balance evenly between conflicting interests or between employers and employés where statutory powers are entrusted to it. In these and in other ways the Board of Trade can render material assistance to the mercantile community, and the committee consider it a matter of importance that the relations between the commercial classes and the Board of Trade should be friendly and cordial. It is true that in all great questions of international commerce the Foreign Office, rather than the Board of Trade, necessarily plays a predominant part, and that in matters relating to commercial treaties with foreign nations the former department has direct conduct of the negotiations. Moreover, in matters of trade which affect revenue, the Treasury must have a controlling voice." The conclusion arrived at with respect to the Board of Trade is that its president shall have his salary raised from two thousand pounds to five thousand pounds a year, and that the parliamentary secretary and the permanent secretaries shall also have their salaries increased. In addition

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to this gratifying increase in remuneration, the head of the Board of Trade is to be called in future "The Minister of Commerce and Industry." The Local Government Board's case is different, as the responsibility is actually taken by a Board consisting of certain members of the Cabinet. Here, again, increases of salary are recommended. The reorganisations recommended between the two departments are comparatively few; thus the Board of Trade is to have direct responsibility over consuls and the editing of consular reports. The Commissioners of Customs are also, if the committee's report be adopted, to transfer to the Board of Trade certain duties in connection with the registration of shipping. The Home Office will take over from the Board of Trade the work in connection with alien immigration. The changes recommended to be made tend to make the Board of Trade more valuable to the commerce and industry of the country. It is also of note that this department is to continue under the control of a single individual. This is a reflection of the opinion expressed by the committee that the creation and controlling of commerce must be left to individual effort and initiative.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### CORRESPONDENCE INSTRUCTION.

SIR,—In your issue of June 3 you give part of a paper, entitled "The Tuition of Electrical Engineering," read by James Pigg before the Newcastle Section of the Institution of Electrical Engineers, in which there appears to be a rather serious error. I refer to the extract on Ohm's law as explained by some tuition-through-the-post papers. In this they first describe the law, and afterwards go on to explain the difference between current strength and watts, and the following is extracted from it: "Suppose, then, the numerical values of E is 12, R is 2, and C is 6, then $\frac{E}{R} = C = \frac{12}{2} = 6$, and $\frac{E}{C} = R = \frac{12}{6} = 2$, and C R = E $= 6 \times 2 = 12$. By these three equations nothing has been found but the missing factor in each case. To find, then, the watts of work or power, be careful to notice that if the volts are 12 and the ohms 2, then 10 of the volts remains to do work for $12 - 2 = 10$, and as the amperes formed were six in number, then a current having a pressure of 12 volts, and a volume of six amperes, and a resistance of two ohms, has a current power of 60 watts, for (12 – 2) $6 = 60$, or *subtract the ohms from the volts, then* $12 - 2 = 10$, *and* $10 \times 6 = 60$."

I quite agree that $12 - 2 = 10$ and $10 \times 6 = 60$; but why subtract 2 from 12? I always thought watts was simply volts multiplied by amperes, or

$$W = C E, \text{ and not } W = (E - R) C.$$

Can anybody explain this latter, or have I been labouring all these years under a wrong impression? To take an example of an ordinary 16-c.p. 200-volt lamp. This takes about ·33 of an ampere; hence by Ohm's law

$$R = \frac{E}{C} = \frac{200}{\cdot 33} = 606 \text{ ohms.}$$

Now apply this to the above formula of his, and we get

$$W = (E - R)\ C = (200 - 606)\ \cdot 33 = 134.$$

This shows us that the lamp is absorbing a minus power—*i.e.*, the lamp is actually giving out power at the rate of 134 watts—and hence eight incandescent lamps would give out 1 h.p. Wouldn't this be lovely? Perpetual motion wouldn't be in it! I have visions of whole factories being driven by the power given out from all the light, and steam-engines would be quite at a discount, as all that would be required would be to wire a place as at present, and with enough lamps connected to the 'bus bars it would be possible to drive motors, and so drive the whole mill at the only cost of lamp renewals.

Turning to mechanical power, this is expressed in foot-pounds of energy. There is no term subtracted from the feet to allow for the resistance, as in the absurdity $W = (E - R)\ C$. Perhaps I have read it wrong, and, if so am quite open to reason. Can any of your readers explain wherein I am wrong, or do their views coincide with mine

Yours, etc., E. R. ALEXANDER.

[N.B.—Mr. Alexander has evidently not noticed the query in the title of Mr. Pigg's paper.—ED. *E. E.*]

### COMPETITIVE BOILER TESTS.

SIR,—In your issue of May 13, on p. 735, you give prominence to some results of competitive tests of Babcock and Wilcox and Stirling boilers, and as the latter boiler was built by us, we ask you to kindly publish the following supplementary information. The evaporation per pound of oil from and at 212deg. F. varied from 14·22lb. in the Babcock and Wilcox boiler during the fourth test to 15·31lb. for the Stirling boiler during the first test. The minimum and maximum efficiencies of the Stirling boiler ranged from 71·5 per cent. during the last test to 79·16 per cent. during the first test. The Babcock and Wilcox boiler was practically a new one, having been in service something less than four months, whereas the Stirling boiler had been in regular use for over 15 months. During the tests the openings between the front headers of the Babcock and Wilcox boiler were closed with asbestos, as was also the space between each of the front nipples. Between the rear circulating tubes baffle bricks were placed, leaving an opening above this baffle of 33in. The third test on the Babcock and Wilcox boiler was vitiated, due to leakage from two tubes which cracked, and the test had to be repeated after these fractured tubes were taken out and renewed, together with an additional tube as a matter of precaution. Before the third test was repeated the bottom row of tubes was washed out and the internal surfaces of the headers cleaned. Prior to making the last, or capacity, test, the two bottom rows of tubes and the circulating tubes were again cleaned. As four days and one night were devoted to cleaning and repairs *during the tests*, and an average of six men employed day and night, the cleaning was doubtless efficiently performed. Great credit is certainly due to the Babcock and Wilcox engineer, who nursed this boiler so successfully that it went through the tests without further failure or cleaning.

The writer of the article, in his pleased surprise at the results, evidently regarded the above points as unworthy of notice, but looked at from the commercial point of view, we should have thought they would be of very considerable interest in arriving at a decision as to which was the best type of boiler—the Stirling, which, after nearly 16 months of hard service, went through the tests without unusual cleaning and no repairs, or the Babcock and Wilcox boiler, which had to be carefully nursed and coaxed after being in use less than four months. Space forbids our touching on other interesting points in the committee's report on these tests, a copy of which we shall, however, be pleased to send to any of your readers.—Yours, etc.,

THE STIRLING COMPANY,
(E. G. Constantine, manager, British branch.)

## INSTITUTION OF ELECTRICAL ENGINEERS.

The report of the work of the Students' Section for the 1903-4 session (signed by Mr. H D. Symons, chairman, and Mr. A. G. Ellis, hon. secretary) states that 11 meetings have been held, exclusive of the annual general meeting. The average attendance was 36, the highest being 56, recorded on Jan. 20. The following papers have been read: "A German Workshop," by F. Neuhans, A.C G.I.; "The Operation of Electric Lifts," by H. Church; "The Equipment of a Sub-Station with Rotary Converters," by O. J. Davis; "The Equipment and Working of Small Private Generating Stations," by H. Purle; "The Testing of Alternate-Current Machinery," by R. J. Kaula; "Automatic Railway Signalling," by E. Fisher; "The Determination of the Correct Proportion of Condensing Plant in a Central Station," by

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P. V. Hunter; "Notes on Commercial and Experimental Testing of Continuous-Current Machinery," by L. A. Lewis; "Armature Reactions in Alternators," by H. W. Taylor; "Insulation and Insulators," by H. D. Symons; "Alternating-Current Commutator Motors," by F. Creedy, A.C.G.I.; "Some Notes on Steam-Turbine Testing," by C. G. Seeley (read at the annual general meeting on May 18, 1904). The discussions have been enthusiastically entered into, the average number of students taking part being seven.

*Visits.*—During the session visits have taken place to the following works: County of London and Brush Company's supply station, City-road, N.; Incandescent Electric Lamp Company, Hammersmith; India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown; Baker-street and Waterloo Railway tunnelling works, Lambeth; central telephone exchange of the General Post Office, Central Electric Supply Company's works; Messrs. Thornycroft and Co., Chiswick; Board of Trade Electrical Standards Laboratory; Metropolitan Electric Supply Company's works, Willesden, N.W.; Western Electric Company, North Woolwich; Electrical Power Storage Company, Millwall; Great Northern and City Railway. The visits have been very well attended.

*Easter Visit.*—During the Easter vacation a party of the Students' Section visited the Birmingham district. The number of students who took part was 42, of whom 23 were from London. The party met at Rugby at mid-day on Monday, April 11, and visited the works of Messrs. Willans and Robinson. Leaving Rugby, the party reached Birmingham the same evening, and visited the following works in and around Birmingham until Saturday, April 16: General Electric Company, Witton; Midland Electric Power Company, Tipton; Electric Construction Company, Wolverhampton; Wolverhampton Corporation electricity supply station and the Lorain surface-contact tramway system; Messrs. A. and G. Player, Birmingham; Lanchester Engine Company; Messrs. Chamberlain and Hookham; Messrs. Belliss and Morcom; Birmingham Small-Arms Company, Small Heath; Messrs. Stewarts and Lloyds, Halesowen; city of Birmingham electricity works; new Birmingham University power station; city of Birmingham municipal technical school. The party was met on Monday, April 11, at the Midland Hotel, Birmingham, by the Birmingham Local Section, when Mr. Vaudrey (the local chairman) and Dr. Sumpner (vice-chairman) gave an address of welcome to the party. On Friday evening, April 15, those taking part in the visit dined together at the Midland Hotel, with Mr. H. D. Symons, chairman of the Students Committee, in the chair, and Mr. Vaudrey and Mr. J. K. Catterson-Smith, assistant hon. local secretary, as guests. A very enjoyable evening was spent.

The committee feel that the work of the session has been satisfactory, and trust that the same enthusiasm will be shown in the future.

## ENGINEERING STANDARDS COMMITTEE.

The conference of tramway polemakers convened by the Sub-Committee on Electric Tramways, and referred to in a recent issue, took place at the Institution of Civil Engineers. The conference appears to have been a most successful one, and the following gentlemen were present: Messrs. A. P. Trotter (chairman), Forbes Higginson, J. H. Ryder, H. M. Sayers, R. H. Scotter, A. M. Sillar, J. J. Steinitz, A. H. Walton, Frank Herbert (Messrs. Stewarts and Lloyds, Limited), W. James Higgs (Messrs James Russell and Sons, Limited), E. L. Robbins (Messrs. the National Tube Company, Limited), T. Harris Spencer (Messrs. John Spencer, Limited), A. C. Williams (Messrs. the British Mannesmann Tube Company, Limited), Leslie S. Robertson (secretary), C. le Maistre (electrical assistant secretary)

The CHAIRMAN, in opening the proceedings, drew the attention of those present to the position of affairs with regard to the proposed standardisation of three-section tramway poles. He remarked that the sub-committee had commenced work upon this problem early last autumn, since which time a large amount of valuable and interesting information had been gathered by correspondence. In the first place, a circular dealing with tramway pole details had been drafted and forwarded to the manufacturers for their consideration. The replies have been collated in tabular form, and the committee had held several meetings to carefully consider this information. As the result of their deliberations a further circular had been drafted, in which certain proposals were made for standardising three-section tramway poles, as far as possible embodying the views of the committee and those of the manufacturers. This circular was forthwith issued to a large number of the tramway engineers in the kingdom. Some time necessarily elapsed before the replies could be all received and collated, but the *résumé* which was ultimately laid before the members evidenced the fact that a large majority of the users were in favour of the suggestions put forward. The sub-committee then proceeded to draft a standard specification for three-section tramway poles with the aid of the evidence and information which they had now gathered. Before, however, finally adopting this specification it was thought advisable that the makers should have a further opportunity of considering the recommendations of the committee, and of making any final criticisms they might desire. With this object in view the proposed specification was issued confidentially to the makers, and as the replies were not entirely in accord with the proposals, this conference had been decided upon. A list of questions which was to form the basis for the discussion at the conference had previously been circulated to the members, and these were taken seriatim by the chairman. The classification and the over-all length of poles, as well as the length of telescope joints, which were proposed by the committee, were agreed to by all present.

A discussion took place with reference to the lengths of the sections proposed as standard, and some of the members were in favour of a slight alteration being made on the score of economy, suggesting that the two top sections should be made of equal length. The committee had proposed certain figures for the outside diameters of the poles, which were chosen with due regard to interchangeability and so forth. The witnesses were, however, not altogether in favour of the figures proposed, as in their opinion these would not represent the most economical pole which could be produced to stand the stipulated bending tests. A long discussion ensued, resulting in a definite proposal being made to increase the suggested diameters by an even amount. This important proposal, we are informed, is now receiving the very careful consideration of the committee. The proposals as to standardising similar diameters and over-all lengths for both sectional and taper poles, as well as making the bases interchangeable, was, on account of its obvious desirability, carefully gone into.

Questions relating to the proposed drop test bending and permanent set tests, as well as many other practical details with regard to standardisation of tramway poles, were discussed at length with gratifying results.

In bringing the conference to a close, the Chairman tendered the thanks of the committee to those present for their attendance at the conference, and for the courteous manner in which they had placed their information at the disposal of the committee. He hoped that, with the help of the information already supplied and the personal views of the makers before them, the committee would be enabled to revise their proposed standard specification in such a manner as to meet the views and serve the best interests of all concerned.

## POWER STATION DESIGN.*

BY C. H. MERZ, MEMBER, AND WM. MCLELLAN, ASSOCIATE MEMBER.

(*Concluded from page 853.*)

*Connections to Oil Switches.*—Obviously, in order to carry out without great expense complete sub-division of the connections, as well as of the 'bus bars and switches, it is necessary to carefully consider the location of the switches in reference to the 'bus bars, so that the former may be directly above or below the latter. In order to avoid all possible risk it is essential that the switches should be next the 'bus bars themselves—*i.e.*,

* Paper read before the Institution of Electrical Engineers.

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that no apparatus of any kind should intervene between the switch and the 'bus bars. Probably one of the greatest dangers to reliability of supply, and one likely to show itself prominently in the near future, is the excessive carelessness with which cables connecting machines or feeders to the switchboard have in the past been cramped together indiscriminately in a trench or tunnel. If big currents or large powers are to be conveyed, whether in a power station or under a motor coach, nothing short of complete isolation (or, failing this, several inches or feet of air space depending on the potential and power) will ensure freedom from failure, or keep the damage within proper limits in case of the failure of any part. It is not sufficient to attend to this point on the switchboard itself, it must be attended to from the machine terminals to the outgoing feeder. In the case of a power station it is unsafe to lay cables carrying large powers, whether high or low tension, even spaced some inches apart in tunnels or manholes, unless each cable is in its own duct, or in some other way protected by a properly-earthed metal shield.* In order that these connections may be as far as possible completely subdivided, the feeder or machine should preferably be kept directly below or opposite to the main switch. Between the switch and the machine or feeder cables the various transformers for the operation of instrument and relays should be installed. (See Figs. 14 and 16.)

*Instruments.*—All instruments should be worked through transformers, thus greatly simplifying the alternating-current switchboard problem, as recording wattmeters, power factor indicators, ammeters, voltmeters, and relays can be (and should be) supplied from one set of transformers, so reducing the complication on the main circuits to a minimum. Although by the above method the main connections are not complicated by the installation of additional instruments, yet for the sake of simplicity and saving in first cost the number of instruments installed should be reduced to the lowest limit.†

*Methods of Operation.*—The desirability of locating the machine and switch panels directly opposite their respective generators or cables has been previously referred to, but this arrangement necessarily involves a switchboard extending the whole length of the station. It is evident that the switches on such a board must be operated from some central point in the station—*i.e.*, the switches must be controlled from a distance. There are three ways of effecting this: (1) electrically, as has lately been successfully adopted and developed by the General Electric Company of America; (2) mechanically, as railway points are now worked from a signal cabin (in this case automatic devices must be electrically tripped); (3) pneumatically, simply substituting compressed air as the operating agent. There is very little difference between the three methods so far as adaptability is concerned—for reliability we prefer either (1) or (2). In each case the operating platform can be kept small, so that all the gear is under the eye of the operator. In fact, its length is really limited by the room taken up by switchboard instruments more than by any levers, switches, or valves necessary for the mechanical, electrical, or pneumatic operation. Generally speaking, the longer the board the more desirable does electrical operation* throughout appear to be.

*Automatic Devices.*—Under oil switches we have referred to the necessity for opening all circuits by the switch rather than by fuses. This means that it is almost essential that automatic overload devices should be installed, so as to operate the switches on each outgoing feeder. When automatic switches first replaced fuses, such overload devices were manufactured on the same lines as an ordinary direct-current traction circuit breaker. This design, while entirely satisfactory in the case of an ordinary direct-current traction supply, where a momentary stoppage is of relatively small importance, is quite out of the question in the case of a power system from which not only lighting and power are supplied, but on which revolving synchronous sub-station machinery may be running. The shut down of a feeder means the shut down of a sub-station, and this is a serious matter. It was found that such circuit breakers were apt to operate with instantaneous overloads which would have cleared themselves had pressure been maintained. In order to avoid this trouble, clockwork time-limit devices were tried with equally unsatisfactory results, as when the clockwork devices were set so as to keep the switch "in" on small short-circuits such as were likely to clear themselves they refused to open sufficiently rapidly on bad shorts, so upsetting the whole system.

*Automatic Devices on Feeders and Machines.*—It was suggested, therefore, by several engineers and manufacturers independently that what was required was an automatic device which imitated the action of a fuse—that is to say, an automatic adjustable circuit breaker having a time lag inversely proportional to the magnitude of the overload. Various manufacturers have endeavoured to meet this condition in different ways,† but though great improvements have been effected, it cannot yet be said that any protective devices have been perfected which can be depended upon under all conditions on

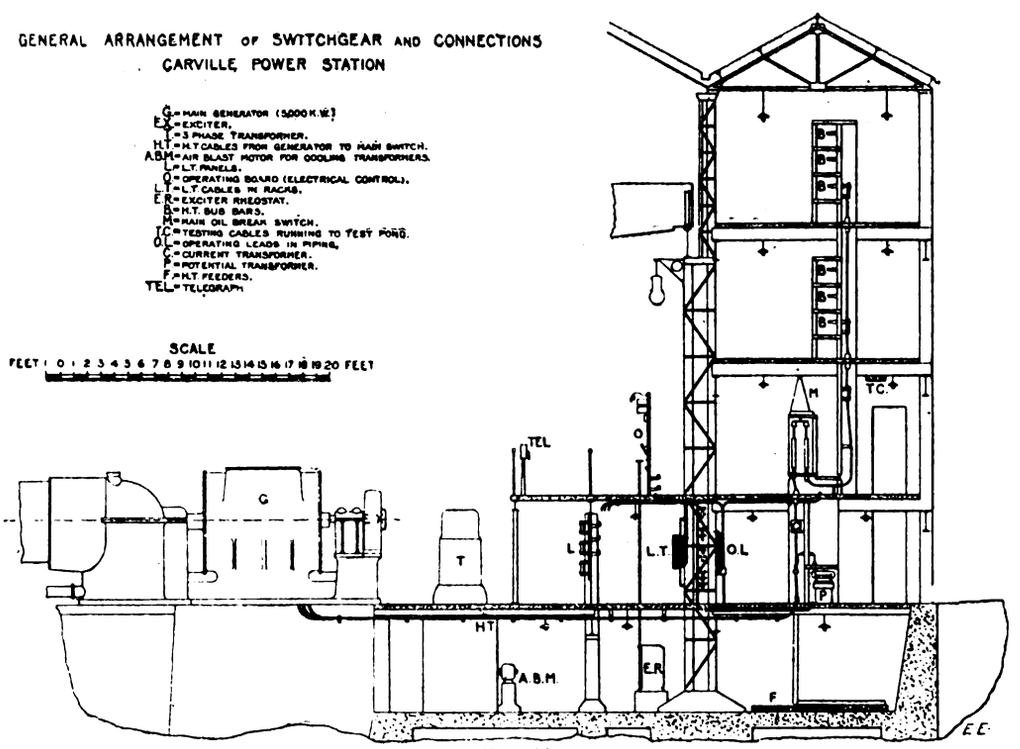


FIG. 16.

* Three-core cables with a complete copper shield embracing all three cores should be used for these connections when earthed iron shields are inadmissible. In both this country and the United States it was until recently the universal practice to run bare lead-covered cables in manholes, with the natural consequence that in the event of one of the cables failing it was no uncommon thing for all the cables in the manhole to get damaged. The authors have known lead-covered cables give way due to an incandescent lamp lying against them. Arcs are frequently started between large power cables by the fusing of some minor wires—possibly pilot wires—which had nothing to do with them.

† The following list gives all the instruments that are absolutely essential: machine panel—main ammeter on one phase, voltmeter for synchronising, field ammeter; feeder panel—ammeter on one phase. The recording wattmeters may be put on the machines for the reasons stated later; it is safer to put the recording wattmeters on the machines than on the 'bus bars, as the arrangement avoids any apparatus being connected with the 'bus bars except through an oil switch,

* It is desirable that the operating leads should be kept entirely separate from the instrument leads, and further, that the leads for each machine should be kept separate and run in accessible positions.

† See "Protective Devices for High-Tension Electric Systems," by W. B. Woodhouse, British Association, September, 1903.

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a complicated system to cut out a faulty feeder or machine without affecting the working of other apparatus. Outgoing connections from the 'bus bars may be more or less satisfactorily protected as above, but if similar overload devices are used in the machine circuits, it is practically impossible by any graduation to ensure that the feeder and not the machine circuit will open in the case of an outside short-circuit, while it is equally difficult to so discriminate that the faulty and not a sound machine is cut out in the case of a short-circuit occurring on one of the generators. Endeavour has therefore been made to fit relays which would only operate with reverse current* having a time limit inversely proportional to this reverse current, but which would not respond to any overloads or shorts so long as a positive direction of current was maintained. This latter arrangement would at first sight appear a satisfactory solution of the problem, but in practice it is very far from being so. All such reverse devices so far put to commercial use depend for their action on a potential coil. It is just when the short-circuit is most severe that these devices are wanted, and the difficulty is that with a severe enough short-circuit the potential may drop considerably before the faulty machine is cut out, with the result that the apparatus fails to operate. Another objection to the present type of relay (both overload and reverse) is that in the case of a heavy fault, when the whole of the network may be affected, the cut-outs in other sub-stations than the one at the end of the faulty feeder operate and thus shut down supply. This is especially liable to happen on polyphase systems when the fault develops between two phases only, or between one phase and earth; in this case all motors and transformers on the system immediately tend to pump current into the fault. The authors are of opinion that at the present time automatic protective devices require more attention than any other subject in connection with reliability of supply.

*Low-Tension Switchgear and Connections.*—Hitherto we have dealt with the main board and high-tension apparatus only; the low-tension switchgear and connections may, however, represent a large part of the total expenditure on switchgear, as they control all the auxiliary apparatus, the exciting circuits, and all the lighting for the power station and adjoining yards and shops. The same points which have been referred to in detail when dealing with the main board and connections apply to the low-tension apparatus and cables, though, of course, in lesser degree. It is certainly important that all low-tension connections should be kept entirely separate from high-tension connections or cables, in order that no fault of the former may affect the latter. The authors have a strong preference for wiring on insulators as against wiring in pipes for all small wires and for all lighting work. It is cheaper, it gives less trouble in practice, and any fault is more readily seen. This system, however, can only be carried out in cases where proper sub-division is resorted to and where the circuits are not crowded together.

### 6. Measuring Apparatus and Records.

*Importance of Boiler-House Records.*—In general, while very complete station records are kept of the data directly affecting the electrical side of the generating plant, scant attention is paid to boiler-house records so far as the factors governing the economy of the boilers are concerned. This would appear to be a mistake, as it will almost invariably be found that the boiler-house equipment will give a greater return for any trouble taken with it than will either the engine-room or the electrical apparatus. The efficiency of the electrical and engine-room apparatus are comparatively easily ascertained by fairly accurate instruments. On the other hand, tests on the boiler-house apparatus are frequently of so rough and ready a description as to at once arouse doubts as to their accuracy, and as a consequence they are taken less and less frequently. It is, however, possible, and it is certainly desirable, to get data from the boiler-house plant of very approximate accuracy. Complete records should be kept showing the performance of the various component pieces of apparatus throughout the whole process of generating electricity from coal, and an assistant with some chemical knowledge should be made responsible for the boiler-house economy and for keeping accurate data in connection therewith. We will briefly refer to the apparatus necessary for keeping a check on the economy of the station.

*Coal-Weighing Apparatus.* — The coal-weighing apparatus should consist of: (*a*) a main coal truck weighbridge for checking the railway company and the colliery; (*b*) an apparatus for weighing the coal fed to each boiler from the overhead bunkers (if these are erected). The latter may be used either continuously or for special tests. The weighbridge should certainly be used continuously.

*Coal Analysis.*—It is as important to check accurately the calorific value and the percentage of ash contained in the coal purchased as it is to check its weight, and an analysis should therefore be taken from weekly samples of the coal used.

* Messrs. Brown-Boveri have developed a reverse-current circuit breaker similar in type to their overload circuit breaker. The introduction of a reliable reverse-current relay will also solve the problem of cutting out a faulty feeder from the sub-station end where two or more feeders feed on sub-station.

*Apparatus for Analysing Flue Gases.*—Records of the flue gas composition are also of importance. There are several instruments in the market for taking continuous records, but none of them seem likely to displace the Orsett apparatus.

*The Measurement of Temperature.*—Ready means should also be provided for obtaining the following thermometric records: temperature of superheat, temperature of air-pump discharge, temperature of feed water before and after economiser, temperature of flue gases before and after economiser and at various positions along the flue.

*Water-Measuring Apparatus.*—Continuous records should be kept of the whole of the feed water, the make-up water, and the water purchased from the water company. Permanent arrangements should further be made for measuring the air-pump discharge of any one unit. This is comparatively inexpensive, yet it is to be found in very few stations. The simplest way to obtain this information is to have a two-way valve on the air-pump discharge, one way of which is connected to a special pipe leading to duplicate measuring tanks, so that the discharge from any unit may be accurately ascertained for any period of test.

*Pressure Gauges.*—The steam and vacuum gauges call for no remark. Draught gauges are of more importance in stations fitted with mechanical draught than they are in stations fitted with natural draught, and it is only by frequent observation that the best draught, the best thickness of fire, and the best speed of stoker travel can be maintained.

*Output Meters.*—The wattmeters may either be placed on the main 'bus bars between the feeder panels on each individual machine, or on each of the outgoing feeders. These meters necessarily complicate the switchgear materially, but it is absolutely necessary to provide them. In order that it may be convenient, without alteration to the connections, to test the output of a main generating unit at any time, it would seem to be correct to place them in the generator leads. A further advantage of this is that in a modern station it involves fewer meters than if they be placed in the feeder cables. Power-factor indicators are only of importance where the power factor is under control, as in the case of a station having a combined synchronous and induction motor load.

Having installed all the above instruments, the only item necessary to complete the equipment required for accurate special tests is a water resistance to absorb the energy generated by the plant under test. It is worth while providing permanent arrangements for connecting this water resistance to any generator at will. To sum up, complete *permanent* apparatus should be provided for taking all necessary tests, thus avoiding the unreliability and uncertainty of makeshift arrangements.

### Conclusion.

In discussing the general principles governing power station design, and in illustrating their application to certain parts, we cannot pretend to have dealt with all the components which go to make up a complete power station, since however much the designer may endeavour to simplify the problem, it still remains a complicated grouping together of apparatus. The parts of a power station to which we have not particularly referred are the boiler-house equipment and the piping systems. Throughout we have avoided discussion of the actual design of individual pieces of apparatus (such as the boiler, the steam-turbine, or the dynamo), this being rather a question for the manufacturer than for the designer of a power station. The function of a power station designer is to choose from standard apparatus that which best fulfils the conditions to be met, and to assemble it in the most economical way. It is only by a rigid application of this principle to the individual parts that the essential condition of low capital cost can be complied with. If any excuse be necessary for calling attention (at perhaps too great length) to well-known principles, it must be found in the fact that the success of power supply on a large scale depends entirely upon their being correctly applied to all the component parts of a power scheme. Electrical energy from public supply as against the provision of isolated plants is possible in this country with its relatively dense population in a way that is not possible in America or on the Continent, where industrial centres are separated from each other by wide tracts of country. Although in many ways disappointingly late, realisation during the next few years of our almost unique position in this respect is likely to have a marked effect both industrially and socially.

## TRADE NOTICES AND NOVELTIES.

### G.E.C. New Telephone List.

We have received from the General Electric Company, Limited, a copy of the ninth edition of their telephone list, which contains everything relating to the subject, including a collection of G.P.O. standard apparatus made at the company's Manchester works. Several of the firm's specialities for their electric traction telephone system are described and illustrated. We understand this system is now in use on most of the electric

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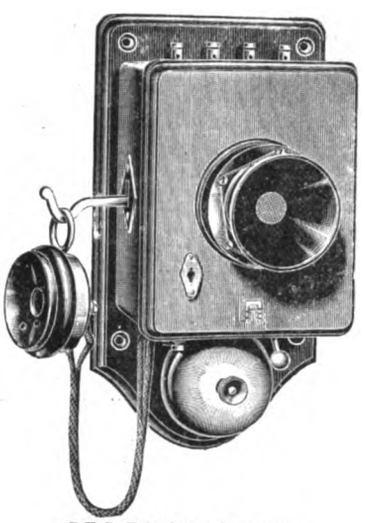
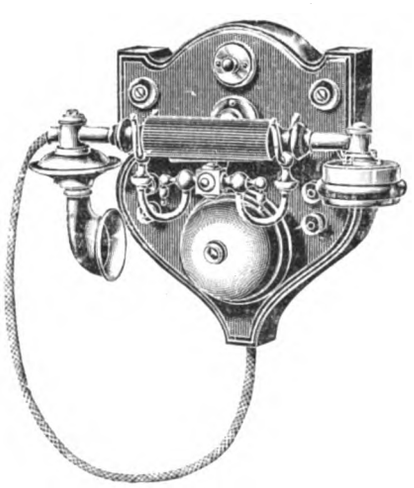
tramways throughout the country, including the London County Council lines. The complete telephone is fitted in a cast-iron box, and can be adapted to any feeder pillar or post or fixed in a wall. We note there have been many new departures made in connection with intercommunication telephones, the demand for which is increasing very rapidly. The sales of the "S. R." wall type in particular have, we are told, reached a very high figure. It is claimed for this instrument that it is the most up-to-date, and possesses many advantages over other forms. The selection is made by means of "push buttons," which replace themselves automatically when conversation is finished.



G.E.C. Telephone Apparatus.

Among the G.P.O. standard apparatus an illustration is given of a secondary cell charging switchboard which calls for attention. This board allows of cells being charged from day to day and connected into the charging circuit without in any way interfering with the working of the line. The arrangement entirely overcomes the difficulty involved in maintaining the cells at a constant voltage, for by the movement of the lever which controls the "barrel" switch, different sets of cells are brought into use periodically, without stopping the line current for a single moment. Another feature in the list is that part devoted to the company's system of fire brigade alarms. This system is in use in several towns and was recently installed at Brighton. The annunciator board has been carefully designed



G.E.C. Telephone Apparatus.

and leaves little to be desired, the whole being substantially constructed and well finished. The special forms of telephones for naval and military use are also dealt with, the latter offering special facilities for communcating between the target and the firing line on rifle ranges. Special attention is drawn to the reduction in prices.

## Condensing Plants.

The Blake and Knowles Steam Pump Works Company, 179, Queen Victoria-street, London, E.C., have just issued a new catalogue dealing with the different types of condensing plants erected by them, and feed-water heaters. This catalogue is of handy size, and contains a mass of information and data relating to condensing plants, which should render it extremely useful for reference purposes.

## Replacing Frogs.

A circular which we have received from Mr. Fred. T. Down, 6, 7, and 8, Crutchedfriars, London, deals with replacing frogs for electric tramways and light railways, which, it is claimed, will replace any derailed cars to any rail by gravitation from the replacers, at a great saving of time over other methods.

## British Westinghouse Publications.

From the British Westinghouse Electric and Manufacturing Company, Limited, we have two circulars, of which No. B 1,072 describes the company's No. 90 M tramcar controller, and No. B 1,080 their No. 200 tramway motor.

## Ediswan Publications.

From the Edison and Swan United Electric Light Company, Limited, we have received two further catalogue sections of their 1904 series. These comprise Section VII. (glass and silk shades) and Section X. (telephones). The first contains a large number of illustrations of glass shades which show up very well on a black background, and include many styles, from the ordinary conical to the most elaborate cut glass, some of the designs being of an entirely novel kind. This applies particularly to the "Art Nouveau" drop shades, which have the appearance of long, trumpet-shaped flowers, and when combined with suitable fittings present an unique effect. There are also some very beautiful patterns with satin and other finishes. Many patterns of candle clips and shields are shown, and the list concludes with a selection of bead and silk fringes in a large variety of colours. The telephone catalogue comprises a large number of the best selling lines, from domestic to municipal telephones, and a special feature is made of intercommunication sets, for which there is now an ever-increasing demand. There are also some very neat wall instruments at extremely moderate prices. The list, being of convenient size and not overloaded with special patterns for which there is not much call, should prove a handy reference catalogue to the buyer, who will also find that prices have been reduced owing to the large demand.

## PORTSMOUTH TELEPHONES.

Herewith we give abstracts of various accounts of the Portsmouth Corporation telephone department for the year ended March 31, 1904. The capital expenditure to that date amounted to £29,100.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Line repairs | 314 | 1 | 10 |
| Instrument and exchange repairs | 465 | 10 | 5 |
| Salaries | 250 | 0 | 8 |
| Wages—office | 162 | 8 | 11 |
| Wages—operators | 522 | 0 | 6 |
| Post Office royalty of 10 per cent. on exchange rentals and local tolls | 567 | 19 | 10 |
| Terminal fees account—fees payable to National Telephone Company | 126 | 7 | 1 |
| Printing and stationery | 129 | 12 | 7 |
| Rents, rates, taxes, and insurance | 348 | 18 | 2 |
| Wayleaves | 39 | 18 | 3 |
| Contributions to borough accountant's department | 30 | 0 | 0 |
| Gas and electric lighting | 57 | 13 | 9 |
| Miscellaneous | 185 | 0 | 0 |
| Bad debts written off | 43 | 1 | 6 |
| Reserve for bad debts | 60 | 0 | 0 |
| Trunk and telegram fees payable to Postmaster-General | 587 | 14 | 1 |
| | 3,890 | 7 | 7 |
| Balance to net revenue account | 2,680 | 4 | 10 |
| | £6,570 | 12 | 5 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Exchange rentals | 5,154 | 1 | 4 |
| Private rentals | 89 | 11 | 3 |
| Local tolls | 608 | 8 | 0 |
| Public telephones | 18 | 17 | 4 |
| Post Office commission account—amount receivable on collection of trunk fees | 35 | 6 | 11 |
| Terminal fees—amount receivable from National Telephone Company | 54 | 11 | 2 |
| Extra insertions in directory | 2 | 14 | 7 |
| Shifts and sales | 19 | 7 | 9 |
| Trunk and telegram fees—fees receivable from subscribers | 587 | 14 | 1 |
| | £6,570 | 12 | 5 |

NET REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Instalment of principal and interest transferred to loans fund | 1,464 | 8 | 3 |
| Net profit carried to balance-sheet | 1,233 | 18 | 2 |
| | £2,698 | 6 | 5 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Gross profit from revenue account | 2,680 | 4 | 10 |
| Interest on deposit notes | 18 | 1 | 7 |
| | £2,698 | 6 | 5 |

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BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—3 per cent. stock | 25,500 | 0 | 0 |
| Amount due to treasurer on capital cash account | 3,600 | 3 | 9 |
| Sundry creditors on revenue account | 626 | 10 | 7 |
| Reserve for bad debts | 60 | 0 | 0 |
| Sundry subscribers—proportion of rentals unexpired | 4,238 | 19 | 11 |
| Balance at credit of net revenue account | 1,259 | 13 | 0 |
| | £35,285 | 7 | 3 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital expenditure to date | 29,100 | 3 | 9 |
| Amount in hands of treasurer on revenue account | 852 | 1 | 6 |
| Ditto on deposit and interest thereon | 2,018 | 1 | 7 |
| Petty cash in hands of general manager | 18 | 3 | 11 |
| Sundry subscribers' accounts outstanding | 2,865 | 13 | 2 |
| Royalties unexpired | 418 | 13 | 4 |
| Sundry debtors | 12 | 10 | 0 |
| | £35,285 | 7 | 3 |

STATISTICS TO MARCH 31, 1904 (FIRST COMPLETE YEAR OF WORKING).

| | 1903. | 1904. | Increase. |
|---|---|---|---|
| Number of subscribers' lines | 742 | 1,384 | 642 |
| Extension and other lines | 129 | 293 | 164 |
| Exchanges | 4 | 6 | 2 |
| Underground cables | 6 | 8 | 2 |
| Ditto distributors | 61 | 68 | 7 |
| Metallic circuit wire, overhead (miles) | 308 | 566¼ | 258¼ |
| Ditto underground ,, | 1,207 | 1,224 | 17 |

## GRAYS THURROCK ELECTRICITY WORKS.

In his report on the working of the Grays Thurrock electricity department for the year ended March 31, 1904, the engineer, Mr. E. D. Long, gives a statement of the expenditure and revenue for the year, from which we have abstracted the following figures.

| *Expenditure.* | £ | s. | d. |
|---|---|---|---|
| Coal and other fuel | 351 | 5 | 0 |
| Water, oil, waste, etc. | 99 | 13 | 3 |
| Street lamp renewals and repairs | 62 | 15 | 8 |
| Wages of workmen | 447 | 16 | 2 |
| Repairs to buildings, plant, etc. | 139 | 5 | 0 |
| Rates and taxes | 114 | 19 | 2 |
| Insurances | 43 | 2 | 0 |
| Management expenses and salaries | 222 | 18 | 1 |
| Other items as per ledger account | 37 | 2 | 5 |
| Total expenditure | 1,518 | 16 | 9 |
| Gross profit | 1,085 | 4 | 10 |
| | £2,604 | 1 | 7 |

| *Revenue.* | £ | s. | d. |
|---|---|---|---|
| Receipts for private lighting | 1,573 | 3 | 9 |
| Street lighting | 923 | 4 | 11 |
| Meter rents | 54 | 10 | 6 |
| Other charges | 53 | 2 | 5 |
| Total revenue | £2,604 | 1 | 7 |

## KINGSTON-ON-THAMES ELECTRICITY ACCOUNTS.

These accounts for the year ended March 31, 1904, show a total expenditure on capital account to that date of £86,468. The following is an abstract of the revenue account.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 3,370 | 0 | 5 |
| Distribution of electricity | 132 | 10 | 8 |
| Attending and repairs to public lamps | 286 | 11 | 7 |
| Management expenses, salaries, etc. | 645 | 9 | 9 |
| Rents, rates, and taxes | 212 | 7 | 6 |
| Interest on loans, etc. | 2,141 | 6 | 3 |
| Principal | 2,711 | 12 | 9 |
| Architect's fees | 94 | 8 | 0 |
| Advising engineer's fees | 140 | 0 | 0 |
| Fitting chain-grate stokers to boilers | 165 | 10 | 4 |
| To credit balance | 102 | 15 | 10 |
| | £10,002 | 13 | 1 |

| Cr. Receipts. | £ | s. | d. |
|---|---|---|---|
| Sale of current per meter | 7,982 | 5 | 1 |
| Ditto for launch and battery charging | 101 | 16 | 0 |
| Rental of meters and other apparatus | 254 | 0 | 9 |
| Sale of current for public lighting | 1,513 | 15 | 0 |
| Sundry sales and receipts | 150 | 16 | 3 |
| | £10,002 | 13 | 1 |

## BURNLEY ELECTRICITY ACCOUNTS.

From the accounts of the Burnley Corporation electricity department for the year ended March 31, 1904, it appears that the total expenditure on capital account amounted to £85,604. Abstracts of the revenue account and general balance-sheet are given herewith.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Coal | 2,078 | 15 | 6 |
| Oil, waste, water, and engine-room stores | 269 | 14 | 7 |
| Wages at generating station | 1 212 | 13 | 4 |
| Maintenance of works and plant | 1,600 | 11 | 7 |
| Repairs, maintenance, etc., of mains, etc. | 361 | 14 | 0 |
| Attending, repairs, and renewals of public lamps | 20 | 9 | 9 |
| Rents, rates, taxes, and insurance | 730 | 9 | 11 |
| Engineers' salaries | 438 | 7 | 5 |
| Accountant and clerical staff | 194 | 15 | 11 |
| Town hall charges for collectors, etc. | 380 | 0 | 0 |
| Printing, stationery, and stamps | 60 | 10 | 10 |
| General establishment charges | 51 | 5 | 4 |
| Total costs | 7,399 | 8 | 2 |
| Balance carried to net revenue account | 9,439 | 2 | 1 |
| | £16,838 | 10 | 3 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| By sale of current, less discounts, etc. | 16,478 | 1 | 6 |
| Meter rentals | 252 | 2 | 0 |
| Charges for work done, less expenditure | 71 | 6 | 3 |
| Motor rentals, less depreciation | 17 | 1 | 6 |
| Arc lamp rentals, less depreciation | 19 | 19 | 0 |
| | £16,838 | 10 | 3 |

GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received, less paid off | 66,756 | 11 | 0 |
| Sundry creditors—materials | 1,352 | 2 | 2 |
| Consumers' deposits | 396 | 11 | 3 |
| Reserve fund account | 7,008 | 1 | 7 |
| Amount owing to borough fund | 6,116 | 9 | 3 |
| Sinking fund | 11,767 | 9 | 0 |
| | £93,397 | 4 | 3 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended as per capital account | 85,604 | 0 | 2 |
| Stores on hand at March 31, 1904 | 2,190 | 15 | 5 |
| Sundry debtors for current, etc., supplied | 5,592 | 8 | 8 |
| Cash on hand | 10 | 0 | 0 |
| | £93,397 | 4 | 3 |

## REDDITCH ELECTRICITY ACCOUNTS.

From the accounts of the Redditch electricity department for the year ended Dec. 31, 1903, it appears that the total expenditure on capital account to that date amounted to £21,534. Abstracts of the revenue account and general balance-sheet are given herewith.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 1,942 | 1 | 11 |
| Distribution of electricity | 90 | 8 | 7 |
| Attending and repairs to public lamps | 54 | 2 | 5 |
| Rates and taxes | 122 | 0 | 6 |
| Management expenses | 274 | 17 | 6 |
| Special charges, insurance, etc. | 390 | 5 | 10 |
| Amount carried to net revenue account | 460 | 8 | 11 |
| | £3,334 | 5 | 8 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current, less allowances | 2,008 | 13 | 1 |
| Public lighting | 917 | 5 | 0 |
| Meter rents | 69 | 7 | 5 |
| Sundry accounts | 270 | 3 | 8 |
| Free wiring rents | 68 | 16 | 6 |
| | £3,334 | 5 | 8 |

GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 18,911 | 0 | 0 |
| Sundry creditors | 2,860 | 6 | 11 |
| Balance due to treasurer | 1,196 | 16 | 6 |
| Balance at credit of net revenue account | 666 | 18 | 4 |
| | £23,635 | 1 | 9 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 21,222 | 9 | 5 |
| Stores on hand | 308 | 19 | 2 |
| Sundry debtors for current supplied | 918 | 18 | 4 |
| Public lamps | 233 | 5 | 0 |
| Sundry accounts | 931 | 6 | 11 |
| Cash in hand | 20 | 2 | 11 |
| | £23,635 | 1 | 9 |

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# LEGAL INTELLIGENCE.

## ILLUMINATED SIGNS.

A case at Worship-street Police Court, in which the London County Council prosecuted the proprietor of some Russian baths in Brick-lane, Spitalfields, raised the question whether an illuminated advertisement or sign affixed to the front of his premises and over the footway was "a structure" or an "erection" for which the consent of the London County Council had not been obtained. It appeared that the proprietor of the baths had substituted for three large, heavy, and somewhat dangerous lamps which had been suspended by arms from the wall, a construction in the nature of a box with glass sides and front, on which the baths were advertised, the box being illuminated from within at night by electric light. This was supported by brackets, and had above iron braces hooked into eyes let into the wall. It was suggested that these braces, being removable, took the construction out of the character of a "structure in the nature of a building."

**Mr. Lawley** admitted that the Council had taken the two summonses under different sections (73 and 22) because they could not say whether the construction was an "erection" or a "structure."

The **Magistrate** stated that, had he been left to his own judgment, he should have decided that the construction was neither an "erection" nor a "structure," but the King's Bench had already come to that conclusion in the cases of the London County Council *v.* Hull and the London Illuminated Advertising Company. In dismissing the case, the magistrate commented upon the action of the London County Council as involving a waste of public money, as, if the Council thought such constructions undesirable, they had powers to pass a by-law.

## INTERFERENCE WITH TRAMWAY POINTS.

At Cardiff Police Court a boy of 10, named William Nute, was summoned by the Corporation tramway department for interfering with tramway points at the junction of Castle-road and Newport-road. Mr. H. F. Ensor (from the town clerk's office) remarked that the offence was a very serious one. The defendant had opened four separate sets of points, and had two cars been coming in opposite directions a collision would have been inevitable. Corroborative evidence was given by a pointsman.

It being stated that the lad had undergone parental chastisement, the magistrate adjourned the case for a month to see how he behaved.

## CARTS ON TRAMLINES.

A carting agent named Bartle was summoned at the Leeds Police Court for committing a breach of the tramway by-laws by impeding a car in North-street.

**Mr. Saunders**, for the Corporation, stated that the defendant was driving a light cart in front of a car coming from Chapeltown, and refused to leave the lines to allow the car to pass. The obstruction extended from Skinner-lane to the junction of Briggate and North-street.

Evidence was given on behalf of the defendant that he was travelling at a "fast rate."

The **Magistrate** said that if the by-law on which the prosecution relied meant that the tramways had an exclusive use of the road, he should not uphold it. There was nothing to compel a man who was driving at a reasonably fast rate to turn his conveyance aside. The Corporation were claiming the right of tramcars to monopolise the road.

**Mr. Saunders**: I submit there is evidence to prove that the defendant wilfully stayed on the track.

The **Stipendiary**: Why shouldn't he?

The **Defendant** denied that he obstructed the car, and said he was driving ahead at the rate of 12 miles an hour.

**His Worship** observed that there was no obligation on other vehicles to obey the behests of the driver of a tramcar, but it was illegal for them to wilfully impede a car. Other conveyances had as much right to travel on the tramlines as on any other part of the road. The only offence the defendant had committed was that he had been highly offensive in the use of language. Finally, he decided that the defendant had omitted a breach of the by-law, but of such a character that it could be dismissed under Section 16 of the Act of 1879.

# COMPANIES' MEETINGS AND REPORTS

## GEORGE M. CALLENDER AND CO.

The first annual general meeting was held on Tuesday at the Westminster Palace Hotel, under the presidency of Mr. George M. Callender (chairman of the Company). Particulars of the report appeared in our last issue.

The **Chairman**, in the course of his remarks, stated that the new works at Bow had been in operation for six months, the saving effected amounting to £1,252. 8s. 1d., the difference between the price paid to the Callender Cable and Construction Company, Limited, under the old arrangement and the actual cost of manufacturing. Without being too sanguine, he anticipated that the saving under this head will be proportionately increased during the present year, as the Company were fitting-up some new plant. The home trade during the last six months had not been what was hoped, owing to the general financial depression which had affected the business of the country. A much greater feeling of confidence now existed, and within the last few months there had been a decided all-round improvement. The business for the present year promised very well. At the present time the Company had over 100,000 square yards of sheeting already specified or actually ordered, and as, in addition, several large contracts are in negotiation, he predicted a large quantity of work at remunerative prices for the current year. In the prospectus it was stated that the sales of sheeting for the first year of the Company's existence were estimated at 100,000 square yards. The actual sales reached the very substantial figure of 136,000 square yards, or an increase of about 36 per cent. over the amount estimated. The sales of sheeting for the first year are 50 per cent. larger than the sales for 1902, the year previous to the business being taken over by the Company. The business in South Africa continues to grow. During the year the Company have supplied its sheeting for lining dams at the following mines: Village Main Reef, Village Deep, Geldenhuis, Jupiter, Jumpers Deep, South Nourse, Kimberley, Roodeport; also the Government at Pretoria. The Company had dispatched a considerable amount of the sheeting to Durban, Cape Town, etc., and hoped to receive shortly some good contracts from the Natal coast. Material had also been shipped to Australia, the United States, Roumania, and other countries. Recently some good contracts had been obtained from Egypt. One of the directors, Mr. Allan Greenwell, had succeeded in introducing the Company's articles in several Eastern markets. In regard to the Continental business and the proposed formation of a new company to deal with this, it was proposed to make the capital £15,000, £7,500 being paid in shares to this Company for the European rights, and the balance reserved for working capital. It is proposed to offer the working capital shares to the shareholders of this Company only, *pro rata* with their present holding. The chairman concluded by moving the adoption of the report.

**Mr. C. Neville** seconded the motion, which was carried unanimously.

The remuneration of the directors was fixed at £300. Messrs. W. Ward, A. Greenwell, and W. T. Grahamsley were re-elected directors, and Messrs. W. W. Macalister were reappointed auditors.

A vote of thanks was accorded to the directors and staff.

## CHADBURN'S (SHIP) TELEGRAPH.

The sixth annual meeting was held on Tuesday at Liverpool, Mr. William Chadburn presiding.

The **Chairman**, in moving the adoption of the report (particulars of which appeared in our last issue), stated that the directors had felt justified in recommending an increase of the dividend from 8 to 9 per cent. for the year, and in addition they had written off £6,759 for depreciation, and were carrying forward £7,326. The new works were giving both efficiency and economy.

The report was adopted.

## INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The half-yearly general meeting of this Company, presided over by the Hon. H. Marsham, was held at the Company's office on Tuesday, when a proposed interim dividend of 2½ per cent., or 5s. a share, free of income tax, was adopted. The draft of new articles of association, to supersede those registered on March 31, 1864, was approved. The alterations embodied in the new articles are of a formal character. A special meeting will be convened to ratify the adoption of the new articles.

## LISBON ELECTRIC TRAMWAYS.

The sixth ordinary general meeting was held at 1, London-wall-buildings on the 9th inst., Colonel Sir Charles Euan-Smith, K.C.B., C.S.I. (chairman of the Company), presiding. Particulars of the report appeared in our issue of the 3rd inst.

The **Chairman**, in moving the adoption of the report, stated that a paragraph appeared in it to the effect that £19,000 had been expended, mainly on the cost and erection of an additional unit to the power-house. He might remark that at the time the Company's engineers designed their power station, although ample space was provided in the building for an extension of the plant, no such development in the Company's business was anticipated in the immediate future as that which had actually taken place. He believed that this development would be not only maintained but extended.

**Mr. Ludwig Breitmeyer** seconded the motion, which was carried unanimously, without discussion.

Mr. Ludwig Wagner was re-elected, and Sir A. H. Markham appointed director.

Messrs. Deloitte, Dever, Griffiths, and Co. were reappointed auditors for the ensuing year at a fee of 50 guineas.

The directors were voted, in addition to their usual fee, 1,000 guineas, free of income tax, by way of a bonus in acknowledgment of their services to the Company.

## MEXICO ELECTRIC TRAMWAYS.

The seventh ordinary general meeting of the shareholders of the Mexico Electric Tramways, Limited, was held at the registered offices, 1, London-wall-buildings, on the 9th inst., under the presidency of Colonel Sir Charles Euan-Smith, K.C.B., C.S.I., the chairman of the Company. Particulars of the report appeared in our issue of the 3rd inst.

The **Chairman**, in presenting the annual report and balance-sheet, remarked that Messrs. Wernher Beit and Co. were creditors for £96,334, which sum was advanced by them from time to time for the extensions rendered necessary by the great growth of the traffic, and was not provided for in the original scheme of the capitalisation of the Company.

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The measures for the consolidation of this debt into the capital of the Company had not yet been decided upon, but were receiving the attention of the Board. Owing to the rapid development of the traffic the Company had found it necessary to order a considerable addition to the rolling-stock. There was every reason to anticipate that for the current year the system would develop considerably. After prolonged negotiations the Company had concluded the purchase of a controlling interest in the Banos Line Company, the only section of tramways in Mexico which had remained out of its control.

The report was adopted.

## BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The revenue for the year ended March 31 amounted to £44,513, as compared with £36,008 for the previous year, but £4,395 has to be deducted for loss on the Nueva lines. After payment of the London administration expenses and interest on the debentures, there remains £11,584, from which £2,150 has been transferred to debenture reserve funds and £3,726 to income bondholders' interest account, leaving £5,708 to be carried to a contingency fund. It is proposed to pay interest at the rate of 5 per cent. per annum for the year on the income bonds. A concession for the electrification of the Company's system has been obtained from the municipality for a period of 55 years. For the purpose of this electrification the Company has issued £300,000 conversion debenture stock. A concession for the electrification of the Nueva system has also been obtained on identical terms, and the Nueva Company has made its corresponding issue of £150,000 conversion debenture stock.

## UNITED RIVER PLATE TELEPHONE.

The report of the directors of the United River Plate Telephone Company, Limited, for the year ended March 31 last states that the gross receipts in sterling for the year in the River Plate were £134,824, as against £124,470 for last year. Deducting debenture interest and interim dividends on preference and ordinary shares, and adding interest on investments and transfer fees, there remains a profit of £39,215, to which must be added £3,713 brought forward from the previous year, leaving an available balance of £42,928. After putting aside £10,000 to a reserve for renewal of plant, and transferring the sum of £15,000 to the reserve fund, the directors recommend that a final dividend of 5 per cent. be paid upon the ordinary share capital of the Company, making, with the interim dividend paid Dec. 31 last, a return of 8 per cent. for the year, free of income tax, and that the balance of £3,428 be carried forward. To provide for the continued expansion of the business it is proposed to increase the authorised capital of the Company, as referred to in the notice calling the general meeting. It is intended to make an early issue of £60,000 in ordinary shares, which will be offered to the ordinary shareholders.

## COLLIE PROPRIETARY COALFIELDS OF WESTERN AUSTRALIA.

The report of the Collie Proprietary Coalfields of Western Australia states that the electric plant has been completed, and arrangements have been made to supply electricity for lighting purposes to the Collie township, an arrangement which is bringing in a satisfactory revenue to the Company. The machinery on the mine has been maintained in a high state of efficiency, and since the close of the financial year the electric pumping equipment has been increased to cope with the extra flow of water encountered in the mine.

## NEW COMPANIES REGISTERED.

**Penmachno, Corwen, and Bettws-y-coed Light Railway Company, Limited.**—Capital, £3,000. Objects: to construct or acquire light railways and tramways in the counties of Carnarvon, Denbigh, and Merioneth, or elsewhere; to equip, maintain, and work the same by horse, steam, electrical, or other power.

**Cutting Bros., Limited (81,178).**—Capital, £6,000. Object: to acquire and carry on the business of electrical engineers of Cutting Bros., Derby and London, as electrical engineers and contractors, etc. Registered office: 165, Parliament-street, Derby.

### Liens Registered.

**W. and E. Summer and Clementson, Limited (Mechanical and Electrical Engineers, Liverpool).**—Issue on May 28 of a debenture for £500, part of a series created Feb. 24, 1903, to secure £2,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,500.

**Northern Counties Electricity Supply Company, Limited.**—Issue on June 3 of a mortgage debenture for £5,000, part of a series created Feb. 18, 1904, to secure £100,000 charged on the company's undertaking and property, present and future, except uncalled capital. Holders—T. E. Hodgkin and J. W. B. Pease, Collingwood-street, Newcastle. No trustees. Total amount previously issued of same series, £20,600.

**R. L. Motor Engineering Company, Limited.**—A debenture, dated May 13, 1904, to secure £200, charged on the company's undertaking and property, present and future, has been registered. Holder—A. F. Rubery, 45, Argyle-road, Ilford.

**Severn Electric Launch Company, Limited (Stourport).**—Four hundred pounds first mortgage debentures, created Feb. 27, 1904, and dated May 25, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered No trustees.

## PERSONAL.

Mr. Costar, late of the British Insulated and Helsby Cables, Limited, has now joined the staff of the St. Helens Cable Company, Limited, of Warrington, as dry-core and paper specialist.

The following increases to the salaries of the undernoted officials in the Edinburgh electricity department were agreed to on Wednesday: chief assistant engineer, from £350 to £375 per annum: station engineers (five), from £160 to £200; second assistant to superintendent of mains, from £120 to £160; superintendent of meters, from £250 to £275; clerical assistant to engineer, from £200 to £220; and assistant clerk, from £110 to £120 per annum.

The Dudley Town Council are continuing the present arrangements with Mr. Wilson, chief electrical engineer, for a further 12 months.

The Greenock Corporation propose to increase by £100 per annum the salary of Mr. Robertson, electrical engineer.

There are 88 applications for the position of assistant electrical engineer at Wakefield, at a salary of £150 a year.

There are 224 applications for the post of assistant engineer to the Bolton tramways department. The following six applicants are before the committee: J. W. Astley, Bolton; C. Beech, Stockport; G. H. Burton, Birmingham; D. A. Hamilton, Lancaster; G. Myerscough and F. Taylor, Manchester.

On Friday evening last Mr. W. J. Allbright, who is leaving the Brompton and Kensington electricity works to take up the post of resident engineer to the Crystal Palace District Electric Supply Company, Limited (recently acquired by the Blackheath and Greenwich District Electric Light Company, Limited), was presented with an illuminated testimonial signed by about 60 of the staff and employés, together with a gold watch. Mr. H. W. Bowden, the manager and chief engineer, in making the presentation, referred in eulogistic terms to Mr. Allbright's ability, and the regret which his departure caused in all departments, assuring him he had everyone's heartiest wishes for his future success and prosperity in his new undertaking.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Heston and Isleworth**—The Council invite tenders for electricity meters. Tenders by July 4. See advertisement.

**Amelia (Perugia, Spain).**—The Municipality require tenders for an electric light installation. Tenders by Aug. 18.

**Villanueva de la Serena.**—The Municipal Authorities require tenders for the electric lighting of the town by June 25.

**Rochdale.**—The Corporation require tenders for alterations, etc., of switchboards. Tenders by 27th inst. See advertisement.

**Edinburgh.**—The Council require tenders for cables for the year ending May 15, 1905. Tenders by June 27. See advertisement.

**Rochdale.**—The Corporation invite tenders for the supply of a 413-kw. steam dynamo. Tenders by July 1. See advertisement.

**East Ham.**—The Council invite tenders for wiring and fittings, etc., at the new technical college, Barking. Tenders by 21st inst. See advertisement.

**St. Pancras.**—The Borough Council require tenders for (1) lead-covered, armoured cables and (2) arc lamp carbons. Tenders by 28th inst. See advertisement.

**Penrith.**—The Council require tenders for oil or gas engines, dynamos, switchboard boosters, storage battery, and mains. Tenders by July 5. See advertisement.

**Sofia.**—Tenders are required for an electric installation in the Government printing works, estimated at £400. Tenders by July 4 to Finance Commission of District.

**Leigh.**—The Corporation invite tenders for (1) one 350-kw. steam-driven set, (2) switchboards. Specifications may be obtained from the Town Clerk. Tenders by June 21.

**Talavera de la Reina (Province of Toledo, Spain).**—The above municipality require tenders for public lighting by electricity from July 1, 1904, to Dec. 31, 1908.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao, including supply of material and rolling stock, by July 6.

**Manchester.**—The Tramways Committee invite tenders for the supply of car wheels and axles. Specifications, etc., may be obtained from the Tramways Manager. Tenders by 18th inst.

**Guantanamo (Cuba).**—Tenders are required for the establishment and working of a telephone system. Deposit, 200dol. Particular from Direction Générale des Communications, Havana.

**May-Oatway Fire Appliances, Limited**—The Scottish office this company invite tenders for wiring five installations. Tenders by 22nd inst. Full particulars in our advertisement columns.

**Almeria.**—The Harbour Commissioners require a motor launch. The estimate is 29,000 pesetas, and the deposit required 1,450. Particulars from the Secretary of the above. Tenders by July 6.

**Alford.**—The Urban District Council invite tenders for lighting the town with gas or other light from Aug. 14, 1904, to May 14, 1905 Tenders to Mr. J. E. H. Sergeant, clerk, Alford, by 28th inst.

**Wigan.**—The Corporation invite tenders for 12 bogie cars, single-deck, two-motor equipment. Specifications, etc., may be obtained from the Borough Electrical Engineer. Tenders by 12 noon on 21st inst.

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**Isle of Thanet.**—The Electric Tramways and Lighting Company, Limited, invite tenders for 12 months' supply of electricity meters. Specifications, etc., may be obtained from the Manager, Power Station, St. Peter's, Kent.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

**Bristol.**—The Electrical Committee invite tenders for the construction of switchrooms at the Temple Back electricity works. Specification, etc., can be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders by noon on 20th inst.

**Erith.**—The Urban District Council invite tenders for (1) rails, fishplates, and bolts; (2) permanent-way construction. Specifications, etc., may be obtained from Mr. C. H. Fry, Council Offices. Tenders by 12 noon on July 11. See advertisement.

**Maidstone.**—The Electricity Committee of the borough invite tenders for the supply and delivery of coal to their electricity works, Fair Meadow, Maidstone, until June 1, 1905. Specifications, etc., may be obtained from the Borough Electrical Engineer.

**Suakim.**—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

**Manchester.**—The Electricity Committee invite tenders for various stores for 12 months, including incandescent lamps, rubber goods, etc. Specifications may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. Tenders by 18th inst.

**Loughborough.**—The Gas and Electric Lighting Committee invite tenders from manufacturers for electric cables (including laying), switchboard, steam, feed, blow-off, and other piping, and feed pumps, including erection, by 25th inst. See advertisement in last issue.

**Finchley.**—The Council invite tenders for supply and erection of one 350-kw. high-speed engine and dynamo combined, with spare armature and spare parts. Specifications, etc., may be obtained from the Council's Electrical Engineer. Tenders by 5 p.m. on 20th inst.

**Exeter.**—The Corporation require (A) alternative tenders for a 200-kw. triple-expansion engine, traction generator, condenser, etc., or a turbo-generator and condenser; and (B) a 200-kw. two-phase generator, switchboard, etc. Tenders by July 1. See advertisement.

**Deptford.**—The Borough Council invite tenders for the supply, delivery, and erection of (1) two 25-kw. steam dynamos and a booster, (3) switchboard. Specifications, etc., may be obtained from Messrs. F. H. Medhurst and Lloyd, 13, Victoria-street, S.W. Tenders before 4 p.m. on June 21.

**Cheshire.**—The Committee of Visitors of the Parkside Asylum, Macclesfield, invite tenders for (1) electric light wiring and fittings, (2) electric light plant. Specifications, etc., may be obtained from Messrs. Lacey, Sillar, and Leigh, 78, King's-street, Manchester. Tenders by June 20.

**Cardiff.**—Tenders are invited for a motor-driven tower wagon, to be used in connection with the electrical equipment of their tramways system. Particulars can be obtained from Mr. Arthur Ellis, M.I.M.E., M.I.E.E, borough electrical engineer and manager, Central Offices. Tenders by 9 a.m. on 23rd inst.

**Philippopolis (Bulgaria).**—The Municipality require tenders for the concession to instal and work the electric lighting of the town and electric tramways in the town and to Stanimako for 50 years. A guarantee of £6,000 is required. Conditions (16s.) may be obtained from the Municipal Secretary. Tenders by Aug. 16.

**Great Yarmouth.**—The Education Committee invite tenders for installing the electric light at the following schools at Great Yarmouth: Nelson (girls), St. George's (girls and infants), St. James's, Northgate, and Priory. Specifications, etc., may be obtained at the office of the Borough Surveyor. Tenders before noon on 27th inst.

**Ealing.**—The Council invite tenders for the supply to their electricity works of best cylinder oil, crank-chamber oil, paraffin, engine oil, mutton cloths, best rope waste, stoneware pipes, and cement. Particulars can be obtained from the Business Manager, Electricity Department, Town Hall, Ealing. Tenders by noon on July 1.

**Bridgend.**—The Committee of Visitors invite tenders for supply and erection of complete telephone and fire-alarm installation for the Angleton and Parc Gwyllt Asylums. Specifications, etc., may be obtained from Mr. W. E. R. Allen, Glamorgan County Council Offices, Cardiff. Tenders by 18th inst. See advertisement in last issue.

**Manchester.**—The Electricity Committee invite tenders for the supply of direct-current motors, motor starters, low-pressure cables, cable troughing (iron and wood), service fuse boxes, bitumen, and box compound. Specifications, etc., may be obtained from the Secretary, Electricity Deparment, Town Hall, Manchester. Tenders by 30th inst.

**Stepney.**—The Borough Council invite tenders for laying on a complete electric light installation at their public baths in Goulston-street, Whitechapel, E. Specifications, etc., may be obtained from the Borough Engineer, 15, Great Alie-street, Whitechapel, E., on and after June 6, between the hours of 10 a.m. and 12 noon. Tenders by June 20.

**Finchley.**—The Urban District Council invite tenders for the supply and fixing of brackets and all necessary work for adapting light railway centre poles in the Great North-road as columns for incandescent street-lighting by electricity. Specification, etc., may be had on application at the Council Offices. Tenders by 5 p.m. on 20th inst.

**West Ham.**—The Education Committee invite tenders for the electric wiring and fittings for an installation of electric light at the West Ham Park Elementary Schools, Stratford, E. Specifications, etc., may be obtained from Mr. W. Jacques, A.R.I.B.A., 2, Fen-court, E.C., before the 9th inst. Tenders by 5.30 p.m. on the 20th inst.

**Walthamstow.**—The Urban District Council invite tenders for three Westinghouse gas-engines, starting appliances, piping and accessories, and three continuous-current dynamos, and a spare armature with usual measuring instruments and switchboards to take the same. Specifications, etc., may be obtained from Mr. J. Enright, 68, Lincoln's-inn-fields, W.C. Tenders by 5 p.m. on 23rd inst.

**Dartford.**—The Urban District Council invite tenders for the supply and delivery of various goods during year ending June 30, 1905, including electric meters, demand indicators, and fuse boxes, house service cable, jointing material and accessories for electric lighting department, general stores for electric lighting department. Particulars may be obtained from Mr. W. Kay, clerk to the Council. Tenders by 4 p.m. on 22nd inst.

**Greenwich.**—The London County Council invite tenders for the supply, delivery, and erection of three 3-ton electric travelling jib cranes and two electric locomotives upon the wharf of the electricity generating station now being erected by the Council at Greenwich. The jib cranes will be operated by three-phase alternating currents, and the locomotives by direct current. Certain parts of the locomotives—viz., the motors, controllers, wheels, and axles—will be delivered to the contractor by the Council. Specifications, etc., may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on July 12.

**Madrid.**—Tenders for the concession for an electric tramway from Ubeda to Santuario de la Yedra, in the province of Jaén, will be adjudicated on June 20 next. Persons desiring to tender must present their offers, with a document showing that £79 has been deposited. The adjudication of the tenders will turn in the first instance on a reduction of the tariff for the conveyance of passengers and goods by this electric tramway, as set forth in the *Gaceta*. The full conditions, together with a partial translation, as supplied by the British Embassy in Madrid, may be consulted on application at the Commercial Intelligence Branch of the Board of Trade.

**Reichenberg (Austria Hungary).**—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Maffersdorf, and Dr. Richard Pirkl, Reichenberg.

## RESULTS OF TENDERS.

**Hampstead.**—The Borough Council have accepted the tender of Crook, Davies, and Co. for the supply of Welsh coal for the electri lighting station.

**Bangor.**—The City Council have accepted the tender of Messrs Bryan Donkin and Clench for a pair of 10,000ft. exhausters, with engines, at £155.

**Coventry.**—The Electric Light Committee have accepted the tende of Kelley and Son, at £945. 19s., for the extension of the engine-hous at the electric light works.

**Portsmouth Dockyard.**—The tender of Messrs. Kirk and Randall, Woolwich, has been accepted for the erection of a generating station for the electric light in the dockyard.

**Stretford (Manchester).**—The Electricity Committee have accepte the tender of the Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester, at £2,663, for 400-kw. steam-driven generator.

**Poole.**—The Town Council have accepted the tender of F. Bacon for the installation and maintenance for five years of an electric indicator and connecting wire between the sewage pumping station and Constitution-hill.

**Roxburgh District Asylum.**—The Roxburgh, Berwick, and Selkirk District Board of Lunacy have accepted the estimate of Mr. J. B. Meiklejohn, Glasgow, for providing an electric installation at the cost of £236. 15s. 4d. for 10 cottages.

**Whitby.**—The Electric Lighting Committee have accepted the following tenders: Mirrlees, Watson, and Co., at £552, for the installation of the surface condensing plant at the electric works; W. Chapman, at £54. 16s. 6d., for the construction of a well for the circulating pump at the central station.

**Wolverhampton.**—The Town Council have accepted the tender of H. Willcock and Co., Wolverhampton, for car-shed extension at £2 587; British Thomson-Houston Company, Rugby, for four single-deck and six double-deck cars at £2,460; Milnes and Co., Hadley, for car bodies at £255 per car. Sanction has been given to order the equipment from the Lorain Company.

**Bo'ness.**—The Town Council have received the following tender for gas producer plant: Messrs. Tangye, £500; Otto Crossleys, £518; and Campbell, Glasgow, £512; and have accepted Messrs. Tangye's offer for the whole producer plant direct driven. The following tenders were accepted: Hart Company, at £316. 11s., for accumulators; J. Sinclair, Bo'ness, at £39, for switchboard.

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**Kilmarnock.**—The Corporation have accepted the following tenders for the supply, delivery, and erection of (Specification No. 11) overhead equipment, trolley wires, poles, and brackets, etc.; (12) rolling-stock; (13) wiring of generating station and car-shed: (11) Robert W. Blackwell and Co., 59, City-road, London, E.C., at £3,216. 13s. 9d.; (12) Hurst, Nelson, and Co., Motherwell, at £5,713. 5s. 8d.; (13) Cox-Walkers, Darlington, at £385. 5s. 2d.

**Portsmouth.**—The Electric Light Committee have received the following tenders for the new intake and discharge pipes to be laid from the station in Gunwharf-road to the Outer Camber, to give an additional salt-water supply for cooling purposes at the condensers:

| | |
|---|---|
| Blake and Knowles | £5,212 |
| Yates and Thom | 5,313 |
| G. J. Weir | 5,220 |
| Sir Hiram Maxim and Co. | 4,849 |
| J. Spencer and Co., Wednesbury (accepted) | 4,425 |

**Bray.**—The Urban District Council have received the following tenders for repairing and putting in thorough working order Easton and Anderson engine: Ross and Walpole, £216; Johnson and Phillips, £150 (accepted); Tuck and Co., £185. 15s. 6d.; Coates and Co., £240. The following tenders for electrical supplies have been recommended for acceptance: Vacuum Oil Company, lubricating oil at 1s. 2d. per gallon, and cylinder oil at 1s. 7½d.; W. T. Glover and Co., lead-covered cables; W. T. Henley and Co., house wires and twin cables; General Electric Company, flexible twin wires, jointing material, tapes, etc., lampholders, fuses, switches, bell material, etc.; Premier Electric Lamp Company, incandescent lamps; Crompton and Co., arc lamp carbons.

**London County Council.**—The following tenders have been received for the supply, delivery, and erection of the main switchgear required for the first portion of the Greenwich generating station:

| | | | |
|---|---|---|---|
| British Westinghouse Electric and Manufacturing Company, Limited, London | *£22,910 | 0 | 0 |
| British Thomson-Houston Company, Limited, Rugby | 25,591 | 10 | 0 |
| Electric Construction Company, Limited, Wolverhampton | 32,000 | 0 | 0 |
| Elliott Bros., London | 36 706 | 5 | 8 |
| Dick, Kerr, and Co., Limited, London | 37,019 | 0 | 0 |
| Electric and Ordnance Accessories Company, Limited, Birmingham (incomplete tender) | 3,627 | 15 | 8 |
| Cowans Limited, Manchester (incomplete tender) | 3,881 | 0 | 0 |

*Recommended for acceptance under certain conditions referred to in another column.

The following tenders were received for the supply, delivery, and erection of the 10 additional water-tube boilers, etc., required for the first portion of the Greenwich generating station:

| | | | |
|---|---|---|---|
| Stirling Boiler Company, Limited, Edinburgh | *£16,271 | 0 | 0 |
| Richardsons, Westgarth, and Co., Limited, Hartlepool | 18,131 | 0 | 0 |
| R. Hornsby and Sons, Limited, Grantham | 18,131 | 17 | 0 |
| J. Musgrave and Sons, Limited, Bolton | 18,131 | 17 | 0 |
| B. R. Rowland and Co., Limited, Reddish | 18,845 | 0 | 0 |
| Babcock and Wilcox, Limited, London | 18,978 | 0 | 0 |
| Stirling Company, Manchester and U.S.A. | 23 200 | 0 | 0 |
| J. Thompson, Wolverhampton | 27,700 | 0 | 0 |

* Recommended for acceptance.

**Rochester.**—The Tramways Committee have received the following tenders for the construction of a line of tramways from the boundary of the city on the New-road to the bottom of Star-hill:

1. Permanent-way construction.

| | | | |
|---|---|---|---|
| Dick, Kerr, and Co. (accepted) | £5,256 | 12 | 0 |
| J. Mowlem and Co. | 5,395 | 13 | 0 |
| J. Brunton | 5,420 | 14 | 10 |
| E. Taylor | 5,471 | 12 | 11 |
| W. Griffiths and Co. | 5,472 | 9 | 2 |
| J. A. Ewart | 5.531 | 6 | 4 |
| J. G. White and Co. | 5,667 | 6 | 10 |
| T. W. Pedrette | 5,800 | 11 | 10 |
| Peerless, Dennis, and Co. | 5,839 | 17 | 6 |
| British Electric Equipment Company | 5,873 | 3 | 4 |
| W. Underwood and Bros. | 5,897 | 11 | 11 |
| Macartney, McElroy, and Co. | 6,907 | 5 | 2 |
| R. W. Blackwell and Co. | 5,914 | 0 | 2 |
| G. Law | 6,127 | 7 | 1 |
| Fry Bros. | 6,298 | 3 | 8 |
| Pethick Bros. | 6,395 | 4 | 4 |
| West Bros. | 6,941 | 11 | 10 |
| E. Nuttall and Co. | 7,762 | 13 | 4 |
| W. Kennedy, Limited | 9.109 | 15 | 1 |
| J. and W. S. Briscoe | 16.208 | 18 | 6 |
| J. Riley | Informal | | |

2. Overhead equipment.

| | | | |
|---|---|---|---|
| British Electric Equipment Company | £940 | 16 | 6 |
| J. G. White and Co. | 966 | 5 | 0 |
| Dick, Kerr, and Co. (amended tender accepted) | 967 | 11 | 1 |
| British Thomson-Houston Company | 1,007 | 16 | 3 |
| R. W. Blackwell and Co. | 1,021 | 15 | 7 |
| G. Law | 1,038 | 12 | 0 |
| Brush Electrical Engineering Company | 1,062 | 17 | 4 |
| W. Griffiths and Co. | 1,062 | 17 | 4 |
| W. Kennedy, Limited | 1,062 | 17 | 4 |
| T. W. Pedrette | 1,062 | 17 | 4 |
| Pethick Bros. | 1,100 | 0 | 0 |
| British Insulated and Helsby Cables, Limited | 1,109 | 0 | 0 |
| J. Riley | 1,149 | 17 | 0 |
| Macartney, McElroy, and Co. | 1,300 | 9 | 5 |
| G. Hill and Co. | 1,409 | 2 | 11 |
| J. and W. S. Briscoe | 1,767 | 11 | 6 |

**Glasgow.**—The Corporation have received the following tenders, for 12 months, for the supply of (1) main cables, (2) electricity meters, and (3) carbons: Callender's Cable and Construction Company, low-tension cables; W. T. Glover and Co., high-tension cables; Crompton and Co., 150,000 pairs of 18mm. core and 12mm. solid carbons, and 15,000 pairs of 16mm. core and 11mm. solid carbons; Mr. D. M'Naughton, agent for Fabius Henrion, Nancy, for the same quantities of similar carbons; Reason Manufacturing Company, 100 3-amp. meters; Electrical Company, 25 3-amp. 50 5-amp., and 25 10-amp. meters; Chamberlain and Hookham, 400 3-amp., 600 5-amp., 100 10-amp., 100 25-amp., and 50 50-amp. meters, reserving under the last-mentioned offer right to the Corporation to order such further quantities of any of the sizes of meters therein specified as they may require during the year.

# BUSINESS NOTES.

## TRACTION.

**Ilford.**—The first year's working of the electric tramways has resulted in a profit of £4,000.

**Southampton.**—The Tramways Committee are to report upon the advisability of appointing a manager.

**National Electrical Traction Co.**—The petition for the winding up of this company has been dismissed.

**Blackpool.**—A proposal to issue annual tickets at £1. 10s. for certain stages was rejected by a large majority.

**Burnley.**—A Corporation car was engaged for a novel purpose the other day. The car, labelled "special," was chartered for a wedding.

**North-Eastern Railway.**—It is reported that the company contemplate the electrification of the line from Sunderland to Seaham Harbour.

**Bristol.**—All opposition to the Tramways (Extension) Bill having been withdrawn, the measure has been referred to the Select Committee on Unopposed Bills.

**Brighton.**—The last few days have seen the completion of the Dyke-road tramway, and a satisfactory trial trip was made over the new track during the week.

**Buenos Ayres and Belgrano Tramways.**—The traffic receipts for the week ended May 15 amounted to £3,373; corresponding week last year, £3,192—increase, £181.

**Halifax.**—Another extension is suggested from Bailiffe Bridge to Whitehall, Hipperholme. This would give a circular route for Hipperholme, Brighouse, and Bailiffe Bridge.

**Pemberton.**—Reference was made at the last meeting of the District Council to the delay in the reconstruction of the tramways. It was stated to be attributable to the late delivery of some of the equipment.

**Accidents.**—The President of the Board of Trade has ordered an enquiry to be held into the death of Patrick Flood, who was recently killed through stepping on to a live rail on the Lancs. and Yorks system.

**Middlesbrough, etc., Bill.**—The Bill promoted by the Imperial Tramways Company, and passed by the House of Commons Committee, is to be opposed in the Upper House by the Corporations of Middlesbrough and Stockton and the Norton Parish Council.

**Colchester.**—It is stated that Messrs. J. G. White and Co., the contractors for the construction of the electric tramways, have intimated that the whole of the track and the overhead equipment will be completed and ready for use by about the middle of July.

**Darlington.**—A continuous service on the Harrogate and Cockerton routes of the newly-opened system was provided last Sunday, and was largely patronised. The Sabbatarian section of the community have expressed disapproval, but regular Sunday running has been decided upon.

**Poole.**—Further evidence has been taken in connection with the arbitration between the Poole Tramways Company and the Bournemouth Corporation, to decide the price to be paid by the latter for the company's undertaking. The matter will be further proceeded with on the 20th inst.

**Manchester.**—The Corporation's Bill to authorise certain tramways has been allowed by the House of Lords Committee. The Corporation agreed to withdraw Clause 21, relating to the carriage of merchandise, a provision being substituted which gives them restricted powers for the conveyance of goods.

**Bradford.**—The Corporation are to apply in the next session of Parliament for powers authorising the extension of the Wyke tramway to Bailiffe Bridge. It has been decided to provide the Wyke section with double lines, and application is to be made to the Board of Trade to sanction the expenditure.

**Automatic Point Shifter.**—The electric automatic point shifter made by S. Dixon and Sons, of Leeds, which was described in our issue of the 3rd inst., has now been fixed experimentally at the tramways junction at the top of High-street, and it was operated for the first time on Tuesday, apparently with complete success.

**Coseley.**—The Urban District Council have appointed a deputation to confer with the South Staffordshire Tramways Company upon the tramway question, the company having intimated their intention of discontinuing the service of steam cars. We referred last week to the action taken in this connection by the Wednesbury Town Council.

**Falkirk.**—The result of the *plébiscite* is that 2,097 votes were recorded in favour of Sunday cars and 1,108 against. The committee of the Town Council will report the result to a meeting of the Council

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on Monday, when it is expected that permission will be given to the company who are promoting the tramways to run the cars on Sundays.

**Electric Traction in Australia.**—With reference to the remarks in our issue of the 27th ult, we notice in the *New South Wales Railway Budget* that arrangements have now been made between the Governments of South Australia and Victoria to jointly engage an expert to report upon the conversion of the suburban steam lines to electric traction.

**Beckenham.**—Terms have now been arranged between the Urban District Council and the British Electric Traction Company. A bond is to be given to the Council as security for the performance by the company of their part of the contract. The question of laying (temporarily) single instead of double lines over part of the route is to be discussed.

**The Underground.**—The Fulham Borough Council have been granted a *locus standi* on the District Railway Bill when it comes before the House of Commons in committee. They object to the zone fares, luggage limit, and absence of provision for workmen's trains. Three or four of the other borough councils are in sympathy with the Fulham authorities.

**East Anglian Light Railway.**—The Board of Trade have, after modification, confirmed an order made by the Light Railway Commissioners entitled the Lowestoft Corporation (East Anglian Transfer) Light Railways Order, 1904, transferring to the Corporation of Lowestoft the powers conferred upon the East Anglian Light Railways Company by an order made in 1902.

**Cardiff.**—The Corporation tramways manager, Mr. Arthus Ellis, in conjunction with the Corporation auditor, has issued a statement in vindication of the annual report presented on March 31. The suggestion that items not properly so chargeable have been debited to capital is denied. The matter has been referred to the sub-committee appointed to deal with this subject.

**Chester.**—The Tramways Committee have agreed to recommend an advance of ½d. per hour in the wages of the employés. The City Surveyor having submitted his report upon the position of the sewers, gas and water pipes, the Corporation have confirmed the Boughton extension scheme as originally approved. There will be a double line from City-road to the Fountain.

**Whitefield.**—At the meeting of the District Council it was stated in reply to a question that, as noted in our last issue, the Salford Corporation expected to commence in a few days the laying of the line from the Unsworth boundary. It was also reported that the Corporation would begin the line from Besses to Heaton Park as soon as the Bury New-road length was completed.

**Liversedge.**—The District Council have decided to write to the British Electric Traction Company requesting them to at once proceed with the widening near the Swan Hotel, Millbridge, in accordance with their scheme. No definite reply has yet been received from the Board of Trade respecting the Council's communication as to the abandonment by the company of the line from Hightown to Cleckheaton.

**North Lincolnshire Light Railway.**—Interrogated in the House the other day as to whether he would recommend the Chancellor of the Exchequer to grant assistance in the construction of this line, authorised in 1899, the President of the Board of Trade stated that the order did not contemplate any State aid, and that if any such assistance were now desired, an amending order would be necessary.

**Paisley.**—The new electric tramway service promoted by Mr. William M. Murphy for Paisley and district was commenced on Tuesday. For the present the cars are running only between the Glasgow terminus at Hawkhead and Paisley Cross, but as the line from Paisley to Johnstone is completed, it is expected that it will also be opened in the course of a week or two. The new car service was extensively patronised.

**Cawnpore.**—An application, says *Indian Engineering*, has been made by Messrs. Begg, Sutherland, and Co., of Cawnpore, with the consent of the Municipal Board, under the Indian Tramways Act, for an order authorising the construction of an electric tramway along the Harrisganj Viaduct to the Sirsaya Ghât, with a branch from the canal bridge in Collectorganj to the overbridge of the Oudh and Rohilkhand Railway station.

**West Hartlepool.**—The Tramways Committee reported that in reply to the communication of the Corporation to the tramway company, suggesting that the tenure of the original Hartlepool line should be made to coincide with that of the Park and Foggy Furze sections, a letter was received from the company intimating that they were not able to agree to any other terms than those already submitted by them, which the Corporation decided to decline.

**Torquay.**—The Tramways Bill promoted by the Dolter Electric Traction Company has now passed both Houses, a Select Committee of the House of Lords presided over by Lord Hawkesbury confirming the decision of a committee of the House of Commons that the preamble had been proved. Clauses having been adjusted, the Bill was ordered to be reported to the House for third reading. The electrolytic clause is to remain in the measure.

**British Electric Traction Co.**—The receipts of all the associated companies for the week ended 3rd inst. amounted to £24,874, as against £32,639 for the corresponding week (Whitsun week) last year, on a total route mileage this year of 401¼ miles, against 383½ miles last year. The aggregate receipts to the same date since the commencement of the year amounted to £498,623—an increase of £44,413 as compared with the corresponding period last year.

**Swansea.**—The special committee appointed to enquire into a complaint that in the construction of the tramways a proportion of spruce had been used on certain gradients instead of pine as specified, has prepared a report recommending that the contractors be requested to either take up those portions of the line which have been laid with a mixture of spruce, or to allow the Corporation to retain for five years after the completion of the contract an amount equal to the cost of laying the same with pine.

**Manchester to Warrington.**—It is reported that a proposal is on foot for establishing an electric car service between Manchester and Warrington. The Salford Corporation lines are laid as far as Peel Green, and there is a strong feeling in favour of the Corporation being approached to continue the lines as far as the Cadishead boundary, and the Warrington Corporation being asked to connect. The various local authorities are said to favour the project. The Warrington Corporation has not yet been consulted.

**Preston, Chorley, and Horwich Tramways.**—A committee of the House of Commons presided over by Sir E. Strachey has passed this measure. Last year the promoters obtained powers to construct a tramway connecting Wigan and Bolton with Preston by way of Bamber Bridge. The present Bill authorises the substitution of a route by way of Lostock Hall instead of Bamber Bridge. This alteration resulted from the objection of the Walton-le-Dale District Council. The Lancs. and Yorks Railway opposed.

**Baker-street and Waterloo Railway.**—Lord Hawkesbury's Committee of the House of Lords considered on Wednesday the Baker-street and Waterloo Railway Bill, under which authority is sought to raise £384,000 additional capital with which to carry out several works for the improvement of the underground tube railway already authorised. The greater part of the line between Baker-street and Waterloo has been constructed, and will be opened in about 18 months. The committee allowed the Bill to proceed.

**Liverpool to Stockport.**—A correspondent sends a northern journal interesting details of a trip between these towns by tram (except for one mile between Clifton and Pendlebury). The stages are: Pierhead, Liverpool, to St. Helens, 6d.; to Haydock, 3d.; Hindley, 4d.; Atherton, 3d.; Four Lane Ends, 2d.; Great Moor-street, Bolton, 2d.; Mosesgate, 1d.; Clifton, 2½d.; walk to Pendlebury; tram to Manchester, 3d.; to Stockport, 4d.—the total being 2s. 6½d., which is 3d. less than the train fare.

**Leyton.**—A Select Committee of the House of Commons has passed the Bill promoted by the Leyton Urban District Council. The Bill contained proposals for over 30 lines of tramways, most of them short, within the district, over which certain tramway companies and the London County Council would run by agreement. The Bill was opposed by the Great Eastern Railway and the Lea Bridge, Leyton, and Walthamstow Tramway Companies. The Bill also proposed an extension of the electric lighting to outside local authorities.

**Aberdeen.**—The Aberdeen Suburban Tramways Company expect to have cars running on their Deeside section in a few days. The permanent way is all but completed, and the engineers are engaged in finishing off the overhead equipment, all of which is completed with the exception of some little work to be done at the Maunofield end of the line. The work of construction was started about two months ago, and has been rapidly pushed forward. It is expected that the section will be examined by the Board of Trade by the end of the week.

**Steyning East.**—It is possible that a satisfactory solution may be arrived at in connection with the matter at issue between the Steyning East Rural Council and Brighton in reference to the Dyke-road tramway. A portion of the line along this route skirts the district of the Steyning East authority, and the Steyning authorities contend that in the laying of the line the stipulated width of road has not been left on the west side. The proposal of the Steyning Council is that a sufficient width of the western footway be thrown into the road, and that Brighton secure a piece of land on this side to replace it.

**Charing Cross, Euston, and Hampstead Railway.**—The Select Committee of the House of Lords have considered this Bill for sanction to deviations of route. The only part of the Bill which was opposed was that which dealt with the line where it crossed Oxford-street at the junction of Tottenham Court-road. The company had had placed upon it the obligation to construct certain subways under the street for the convenience of the public, and in order to make a stairway up from the subways to the pavement it had been found necessary to acquire a small portion of the cellarage of the Meux Brewery. To this proposal the brewery company objected. The committee approved the Bill.

**Harrow-road and Paddington Tramways.**—Lord Balfour, acting chairman of committees of the House of Lords, had before him on Wednesday as an unopposed measure the Harrow-road and Paddington Tramways Bill, seeking powers for widening and altering roads and acquiring lands in the counties of Middlesex and London. It also authorises the sale of the undertaking to the Metropolitan Electric Tramways Company, and provides for the dissolution and winding-up of the Harrow-road and Paddington Tramways Company. Lord Balfour, having heard formal evidence in proof of the preamble, postponed the report of the Bill to the House until certain outstanding matters had been settled.

**Wolverhampton.**—The Board of Trade have passed tramway No. 2, commencing in Five-ways and passing thence along Horseley-fields and Willenhall-road and terminating in Willenhall-road at the junction of Stowheath-lane. The Board have also notified their consent to the proposed laying of a single line of tramway on the Waterloo-road and Stafford-road routes. The Lorain surface-contact system is being used. It is proposed that an order be given to the Lorain Steel Company for the electrical equipment of the extensions of the Wednesfield-road route, conditional upon the Corporation Bill, 1904, receiving the Royal assent. The House of Lords' Committee have allowed the Corporation's Bill for extending their tramways.

**Newcastle.**—Reference is made in another column to the decision of the House of Commons Committee granting the Tyneside Company, Limited, running powers over the Corporation lines. On Wednesday a meeting of the Executive Committee of the Association of Municipal Tramway Corporations was held at the Westminster Palace Hotel,

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The proceedings were private, but it is understood that it was decided to call a further conference of the various corporations owning and working tramways with a view to their taking steps to oppose the passing of the Bill when it comes before the House of Commons on the report stage. It is stated that Mr. Plummer, M.P., the senior parliamentary representative of the city, will move to strike out the clause conferring running powers.

**The Patent Renewable Tramrail.**—The syndicate has received the following letter from the manager of the City of Birmingham Tramways Company, Limited: "With reference to your patent two-part centre-bonded rail, I may say that we have had a piece of line laid on this system in Suffolk-street, Birmingham, for the past five months. The ordinary traffic, with a service varying from five to two minutes, has been running over it during that period. I have made a careful examination, and do not find that the rails have moved in any way, and the bonding appears to be satisfactory. The joints have not moved, and appear to be perfectly good." The Wolverhampton Town Council decided some months ago to experiment with the rails over a section of their system, but up to the present the trial has not taken place.

**Kirkcaldy.**—The financial statement for the year to May 15 shows that while the whole system has not been in operation during the whole of the twelvemonth, the total number of car miles has been 301,779; total number of passengers carried, 2,770,936; total number of units to tramways (at 1¾d. per unit), 395,071; population last census, 34,063; number of times population carried, 81·3; units per car mile, 1·309; passengers carried per car mile, 9·1; and average traffic receipts per passenger, ·87. The number of ½d. passengers was 1,320,992, and the receipts £2,752. 1s. 4d.; 1d., 1,040,695—receipts, £4,336. 4s. 7d.; 1½d., 293,273—receipts, £1,832. 19s. 1½d.; 2d., 96,427—receipts, £803. 11s. 2d.; 2½d., 19,549—receipts, £203. 12s. 8½d.—a total of 2,770,936 passengers and of £9,934. 8s. 7d. in drawings. No assistance from the rates will be necessary.

**Proposed Malvern and Gloucester Light Railway.**—At the Worcester County Council meeting the report of the Joint Committee of the Gloucestershire and Worcestershire County Councils upon the proposal for the construction of a light railway to serve the Upton-on-Severn and Newent districts was presented. The committee were unanimously of opinion that, although the line would be of advantage, they were unable to say that there was such a reasonable prospect of the scheme paying its way as to justify them in recommending the Councils to guarantee a share of the cost. A councillor suggested that this was an instance in which the committee should recommend the Exchequer to pay half the cost. It was stated that the cost of the scheme would be £100,000 for 18 miles of railway. A suggestion was made that motor-vehicles should be tried. The further consideration of the matter has been postponed.

**Southport.**—The annual report of the Tramways Committee shows that the gross receipts amount to £17,646. 13s. 1d., as against £16,387 last year, and the working expenses have fallen from £11,231 to £10,986. Of the balance of £6,660, £3,303 has been paid as interest and £3,918 in sinking fund. This leaves a deficit of £341, as against £1,223 last year. The number of miles run has been increased from 418,324 to 431,019, whilst the number of passengers carried shows a total of 3,837,208, an increase on the year of 301,774. The pence per car per mile have increased from 9·018 to 9·279. The High Park route has carried the greatest number of passengers—viz., 1,041,041. The only decrease is on the Inner Circle, where 954,429 passengers were carried as against 1,060,801 last year. This, however, is accounted for by the remarkable increase on the Cemetery route, which has during the year got into full working order. The operating costs have decreased by £245, notwithstanding the increased mileage and number of passengers.

**Lanarkshire.**—Since the introduction of the trolley cars from Glasgow to Cambuslang there has been some speculation as to when the Lanarkshire company would commence extending the line from Blantyre to Cambuslang. It is stated that preparations are now being made for the construction of this line so as to connect with the Glasgow system. Negotiations are proceeding with the County Council as to the roads and surveys made by civil engineers. Some difficulty is experienced with regard to the bridge crossing the River Calder, a mile from Blantyre, as there are steep gradients; in addition, the road is of zig-zag description at this point. At Holepark, Cambuslang, there is also a bridge that will probably require to be built again across the Burgie. Notwithstanding these obstacles, it is expected that the city system and that of the Mid and Upper Lanarkshire systems will be connected by the end of the year. This will give over 25 miles of service—Paisley to Glasgow, thence to Cambuslang, Hamilton, Motherwell, Wishaw, and other places.

**Preston and Blackburn Tramways.**—The Bill promoted by the Preston and Blackburn Tramway Company to authorise the construction of a tramway connecting Preston and Blackburn was before the Committee of the House of Commons presided over by Sir E. Strachey. The Bill, which had been passed by a committee of the House of Lords, was opposed by the Lancashire and Yorkshire Railway Company on the ground of competition. It was stated that every local authority in the district was in favour of the Bill, and that so far as the railway company was concerned there was no real competition, because the tramway line would be at least 2½ miles away from the railway, and the termini in Preston and Blackburn were far removed from the railway stations. Several witnesses were called, including the town clerk of Preston. Evidence was given that the company had completed the financial arrangements. On behalf of the Lancashire and Yorkshire Company it was urged that the railway had spent a large sum in providing communication for the two towns. The Bill was rejected.

**Wigan.**—At a meeting of the Tramways Committee a letter was read stating that the Hindley District Council would give their consent to the reconstruction of the Platt Bridge tramways if the Wigan Corporation would pay the amount required for the property to be acquired for widening the road in Hindley. It was resolved that the committee accept the terms offered by the Hindley District Council. A further letter was read stating that the Hindley Council could not accept terms for the suggested lease of the Hindley tramways similar to those offered to the Ince District Council. It was resolved that the committee adhere to the former resolution, as they could not see any reason to offer the Hindley District Council any further terms than those already offered to the Ince District Council, and it was further resolved that the contractors be instructed to proceed at once with the reconstruction of the Higher Ince section to the boundary of Ince and Hindley at Amberswood Common. The contractors have been instructed to proceed with the reconstruction of the Platt Bridge section forthwith.

**Dartford.**—An arrangement has been arrived at with Messrs. J. G. White and Co., Limited, to construct the tramways which will connect with the Bexleyheath system at a cost of £83,000. The contractors are to work the tramways for five years on a lease, under which they will pay the Council the amount of interest and sinking fund on capital, and also to pay in addition 20 per cent. of any profits. The Council will have the option at the end of five years either of taking over the tramways themselves or of calling upon the contractors to enter into a further lease of five years on similar conditions, and also a third lease of five years if the Council choose. The contractors are to take the town's current at the price of 2d. per unit for the first 100,000 per annum, at 1¾d. per unit for 100,000 to 150 000 units, and at 1½d. per unit for over 150,000, and will pay all working and maintenance expenses. The Council have decided to apply to Parliament for power to continue the system to Swanscombe, so as to form a junction with the Gravesend tramways. This will mean a continuous line from Gravesend to London.

**Stockport.**—The negotiations between the Stockport Corporation and the Stockport and Hazel Grove Tramways Company with reference to the purchase of the company's undertaking appear to have reached a further stage, as a special meeting of the company has been called to receive a report from the directors in connection with an offer from the Corporation. The proposed purchase price is not stated. The company originally asked £27,000, which the Corporation considered too high. A member of the Tramways Sub-Committee stated in an interview that terms would probably be arranged. The value of the undertaking at the market price was about £21,250. He considered that to purchase the undertaking, electrify the system, and put it in good working order would cost at least £80,000, and to earn interest and sinking fund alone on that amount they would have to make £5,600 a year net profit. The line runs for about three-quarters of a mile through the district of the Hazel Grove-cum-Bramall Council's district, and an agreement with this authority had practically been arrived at, by which the Hazel Grove Council would be repaid in the form of rent.

**Aston.**—A trial run was made last week on the Aston Manor line. The result was considered very satisfactory. Excellent progress has been made with the laying of the double lines in Victoria-road, which is nearly a mile in length. When this portion is ready for the running of cars it is proposed that these lines shall be connected with Park-road for the city, and with Lichfield-road for the Gravelly-hill route. It is reported that terms for through running were agreed with the Birmingham Corporation on Wednesday, and that the service commenced yesterday. The Birmingham Corporation have undertaken to provide the necessary cars until the Aston authorities are in a position to put on their own vehicles Ultimately the latter will provide one-fifth of the total number of cars required. The division of fares will be upon the following basis: of the total receipts 5 per cent. of the fare will be reserved to Birmingham in respect of passengers riding exclusively in the city; the remaining 95 per cent. will be divided in the proportion of four-fifths to Birmingham and one-fifth to Aston. The agreement extends to Dec. 31, 1905, but at the end of 12 months either party may call for a revision of fares.

**Victoria.**—The State Cabinet has sanctioned the construction of the proposed Essendon and Flemington electric tramway. Some months ago the Irvine Government decided against the proposal, basing its objection on the assumption that the new tramway authorities might enter into an agreement with the Melbourne Tramway Company for through tickets from Essendon and Flemington to the city, and so affect injuriously the railway traffic; but the promoter had since offered to enter into an undertaking that he would not agree with the Melbourne Tramway and Omnibus Company for a reduction of the fares for the carriage of through passengers. The agreement between the promoter and the municipal councils enables them to take over the tramway at the same time as the Melbourne tramways become public property. By giving notice, the councils may at that time purchase the ways and rolling-stock and lands at the original prime cost, plus 4 per cent. simple interest. If the councils do not purchase at that time, they may do so at the end of 20 or 25 years at the then value. Failing a purchase at any of these periods, the ways, works, rolling-stock, etc., become the absolute property of the councils at the end of 30 years. The cost of the whole scheme will run into about £100,000, and there will be a uniform fare of 2d. over the lines.

**London County Council.**—The Council's Tramways and Improvements Bill has been read a third in the House of Commons, but the clause relating to the proposed extension of the system from Hampstead-road down Tottenham Court-road was rejected. The Highways Committee propose that fresh efforts should be made in the next session of Parliament to obtain powers for the Westminster Bridge and Victoria-embankment scheme. A through service of cars is now provided from Westminster to Greenwich, *via* Camberwell. The reconstruction of the Streatham route is expected to be finished in a day or two. A recommendation was submitted at the last meeting of the Camberwell Borough Council that the Council be asked to obtain powers in the next session of Parliament for the construction of a tramway, commencing at a point in the authorised tramway from Camberwell Green

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to Forest Hill, near the junction of London-road and Sydenham-hill, and proceeding thence along Sydenham-hill to the Crystal Palace. The traffic returns for the week ending June 4 show that the receipts amounted to £11,948. 14s. 1½d. In the corresponding week last year the receipts were £12,776. 4s. 7d.. thus showing a decrease of £827. 10s. 5½d. The number of passengers carried numbered 3,024,331. At present there is a mileage of 38½ open, against 39⅞ at this time last year.

**Sunderland.**—The Sunderland District Electric Tramways, Limited, has issued its prospectus, the share capital being £270,000. The company was formed for the purpose of acquiring the Houghton-le-Spring and District Tramways Order, 1900, and constructing and working the tramways authorised thereunder. The order authorises the construction of a main line of tramways between Easington and Sunderland, with branches from Houghton-le-Spring to Fence Houses Station on the North-Eastern Railway, and from New Herrington to Penshaw Station on the same line. It is stated that the construction is proceeding rapidly. The principal portion of the overhead equipment and the cables have already been manufactured. The work in connection with the building and equipment of 30 cars is under contract, and six miles of permanent way has been already laid. Mr. S. B. Cotterell, of the Liverpool Overhead Railway, has reported favourably upon the scheme. The traffic returns for the past month are as follows: Passengers carried, 1,353,379, as compared with 1,167,383 last year; mileage, 128,019, against 116,428 last year; receipts, £5,683. 6s. 10d., compared with £4,954. 3s. 0½d. a year ago; receipts per car mile 10·6d., last year 10·2d. These figures show increases under the various heads as follows: Passengers carried, 185,996; mileage, 11,591; receipts, £729. 3s. 9½d.; and receipts per car mile, ·4d. This was the first increase per car mile for over 12 months.

**Birmingham.**—The following are details of the extension proposals referred to in our last issue. Four new lines are to be constructed, three of which will have branches, so that altogether they will open up seven new districts. The four new main lines are Harborne, All Saints', Washwood Heath, and Bordesley Green. In the centre of the city loops will be substituted for blind termini, and communication will be established between the different lines. The scheme proposes to increase the number of main lines of tramways (excluding loops and branches) in Birmingham to 14, as follows: Stratford-road, Moseley-road, Mary-street, Bristol-road, Harborne-road, Dudley-road, Newhall-street (All Saints'), Great Hampton-street, Newtown-row, Aston-road, Great Lister-street, Nechells, Bordesley Green, and Coventry-road. Of these the Harborne-road, Newhall-street (All Saints'), and Bordesley Green lines will be entirely new, the Saltley (Great Lister-street) route will be entirely rearranged and doubled in length, and there will be important extensions of the Coventry-road, Stratford-road, Mary-street, and Nechells lines. The Coventry-road and Moseley-road lines will reach the centre of the city by shorter routes than at present. The Old-square circle will be abolished, reducing the congestion of traffic in Hill-street. Suggestions are made in some quarters that a circular system should be adopted. The City Council on Tuesday commenced the consideration of the scheme. Several suggestions for varying some of the routes were made.

## LIGHTING AND GENERAL.

**Basingstoke.**—A site for the proposed electric lighting station has been found at the town yard.

**Japan-Korea Cable.**—The Great Northern Telegraph Company, Limited, notify the restoration of the Japan-Korea cable.

**Worthing.**—Application is to be made for sanction to borrow the sum of £1,600 for electricity distributing main extensions.

**Bournemouth.**—We understand that a canvass is being made concerning the establishment of a municipal telephone exchange.

**Walsall.**—The Electric Lighting Committee recommend extensions of the electric mains to cost £195, £132, and £120 respectively.

**Newport (Mon.).**—The Walsall Electrical Company have prepared plans of the lighting and telephone installation at the workhouse.

**Llanelly.**—The surveyor has been directed to report to the Council upon the cost of lighting the streets by other illuminants than gas.

**Stamford.**—Sites have been approved for the erection of five arc lamps in the streets by the Urban Electric Supply Company, Limited.

**Southport.**—The electricity department last year made a net profit of £3,616, of which £2,250 has been devoted to the relief of the rates.

**Thornhill.**—The Yorkshire Electric Power Company have given formal notice of their intention to lay electric cables in Ravensthorpe-road.

**Leyland.**—The Urban District Council intend to apply for an extension of the electric lighting order for a further period of three years.

**Bangor.**—Application is to be made for sanction to borrow £300 for the purpose of completing the renewal of the negative battery plates.

**Standish.**—The District Council are conferring with the Lancashire Electric Power Company with regard to the supply of electric energy in bulk.

**Aberdeen.**—Tenders for new plant for the electricity works, amounting to £5,000, were accepted at the last Town Council meeting.

**Dewsbury.**—The Dewsbury Tradesmen's Association have appointed a sub-committee to consider the charges for electricity in the surrounding boroughs.

**Ayr.**—During the month of May the number of new connections were equivalent to 1,841 8-c.p. lamps, and the number of motors now connected is 24.

**Dudley.**—The Electrical Committee have re-engaged Mr. Wilson for another year.

**Chester.**—The reserve fund of the electric light undertaking last year was £6,204, and with the proposed addition this year will be brought to £8,404.

**Whitworth.**—The Highway and Lighting Committee are conferring with the Lancashire Electric Power Company with reference to the supply of power in the district.

**Bury.**—The electrical engineer (Mr. L. P. Greig) in his last report stated that during the past month four new applications had been received, nearly equal to 200 8-c.p.

**Kirkcaldy.**—The supply of electricity for lighting and power has exceeded anticipation. A profit is shown on the undertaking, and the number of customers is increasing steadily.

**Louth.**—The Town Council propose to carry out themselves an installation for electric light and power, but the works will be contracted for and open for public competition.

**Whitby.**—Application is to be made for sanction to borrow an additional sum of £1,100 (£3,100 in all) for machinery and plant at the electric lighting station, if and when required.

**Exeter.**—The Electric Lighting Committee are conferring with the Urban District Council of Heavitree relative to the price at which the City Council would supply current at Heavitree.

**Lincoln.**—It has been decided to create Corporation 3 per cent. redeemable stock for £20,426, which includes an amount for the electricity undertaking and street improvements.

**Heywood.**—The consumption of electricity for the month of April, 1904, was 4,262 units, as against 2,572 units for the corresponding period of last year, showing an increase of 1,690 units.

**Barnsley.**—Application is to be made for sanction to the borrowing of £800, the estimated cost of standards and arc lamps required for the proposed extension of street-lighting by electricity.

**Hessle.**—The Urban Council have resolved to apply for a provisional order to put in force the Electric Lighting Acts, and to apply electricity within the urban district and the adjoining parish of Anlaby.

**National Telephone Co.**—The transfer books of 3½ per cent. and 4 per cent. debenture stocks will be closed from the 17th to 30th inst., inclusive, for the preparation of the warrants for interest due July 1.

**Woolwich.**—With regard to the proposal to fit the infirmary with the electric light, the Borough Council, as well as outside firms, have been asked to give estimates for supplying generating plant for the institution.

**Taunton.**—The Electricity Committee's balance-sheet shows a balance in hand of £3,527, equal to 5¾ per cent. on the capital outlay. The cost of electricity has fallen from 5¾d. to 3d. per unit during the last five years.

**Gillingham.**—The members of the Dockyard Engine Fitter Apprentices' Association were recently shown over the local electric power station by Mr. Chalmers (the borough electrical engineer) and Mr. Ryan (first assistant engineer).

**Kidwelly.**—At the meeting of the Town Council on Tuesday the Mayor brought forward the question of lighting the town by electricity, and said negotiations had been proceeding with the new tinworks company. A committee was appointed.

**Halifax.**—Last year's working of the electricity department show a profit of £5,835 for the year, which is £2,007 more than the committee originally estimated. The Tramways Committee return a profit of £496, as against an estimated loss of £32.

**Hammersmith.**—The premises of 18 additional consumers, representing a maximum of 1,274 8 c.p. lamps, have been connected to the mains, and 11 consumers disconnected. The present number of consumers taking current from the mains is 1,477.

**Clyde Valley Electric Power Bill.**—The County Council of Lanark having withdrawn its petition against this Bill, it will now go through its remaining stages unopposed. The Bill has already passed through all its stages in the House of Lords.

**Kilmarnock.**—Mr. J. B. Wilson, convener of the Electric Committee, stated at the last meeting of the Town Council that the offers accepted up to date for the electric lighting and traction scheme were nearly £2,000 below the estimate submitted by the engineers.

**Coatbridge.**—The Scottish House-to-House Electricity Company, Limited, are about to establish two testing stations for testing the supply of energy. The electric lighting contract for the Carnegie public library between the Council and Messrs. King and Co. has been signed.

**Clonmel (Tipperary).**—The management is favourably considering a report by Mr. Harris, electrical engineer, on the proposed installation of electric plant at the lunatic asylum. The cost of electric lighting is put down at £495. 10s., as against £680 for gas. A gas-engine is proposed.

**Goole.**—A motion "that the electric lighting departmental finances be kept separate and independent from the gas and water finances, having its financial results so far as related to profit or loss directly responsible to the general district fund," has been recommitted to committee.

**Northwich.**—The deputy clerk has reported upon an interview between the Postmaster-General and the deputation of telephone subscribers. The Postmaster-General promised to recommend a concession to the Government which would benefit several towns in North Wales.

**Stockton.**—With regard to supply of current to large consumers it has been agreed that electric lighting units which shall not exceed 20 per cent. of the total amount taken for power purposes, be charged at a flat rate of 2½d. per unit; all lighting units taken above this amount to be 6d. per unit.

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**Nantwich.**—At the last Urban District Council meeting the Southern Electricity Company submitted terms upon which they were prepared to erect electric lighting works. The sanction of a loan for the provision of electric lighting works having been refused, the Council could not entertain their offer.

**Northfleet.**—The Corporation of Gravesend intend to apply for a provisional order to light Rosherville with electricity. At present the Northfleet Council have made more than verbal arrangements with the Kent Electric Power Syndicate for the sale of the Council's order, and an agreement is being prepared.

**Wednesbury.**—At the last Council meeting Councillor Griffiths mentioned that towards the 3,000 lamps required to be connected with the electricity mains before the undertaking would pay, already promises of 1 000 had been received, and he believed that before long they would get the required number.

**Newport Telephones.**—At Tuesday's meeting of the Council the recommendation of the Parliamentary Committee to arrange terms on the question of wayleaves with the National Telephone Company was referred back on the ground that the company should grant intercommunication to Post Office subscribers.

**Camberwell.**—The Board of Trade recently approved of the Blackheath and Greenwich District Electric Light Company, Limited, and the Crystal Palace District Electric Supply Company, Limited, entering into agreements for the transfer of the latter company's undertaking, powers, duties, and liabilities to the former body.

**Transfer Books.**—The closing of transfer books is notified as follows: Metropolitan Electric Tramways debenture stock, from 17th to 30th inst. inclusive; Bournemouth and Poole Electricity Supply debenture stock, from 17th to 30th inst. inclusive; City of London Electric Lighting first and second debentures, from 16th to 30th inst. inclusive.

**Faversham.**—The municipal electric lighting installation was opened on the 9th inst. by the Mayor. The three-wire continuous-current system has been adopted. For ordinary street lamps, the Nernst (80 c.p.) has been adopted, and there are at present 10 arc lamps of 2,000 c.p. each. Several business establishments and private residences have already been wired.

**Morley.**—The last report of the borough electrical engineer, Mr. J. E. Ellis, shows that the output from the electricity works during the month ending April 30 was 10,089 units, against 10,304 the same period of last year, being a decrease of 215 units. There were 88 lamps connected during the month, the total number of lamps connected at that date being 11,738.

**Awards.**—The following awards for electric motors were obtained at the International Printing Trades Exhibition recently held: silver medal and first-class certificate, Electromotors, Limited, Openshaw, Manchester; bronze medal and first-class certificate, J. H. Holmes, Newcastle-on-Tyne; bronze medals, Electromotor and Dynamo Company, London, and H. F. Jeel, London.

**Rhyl.**—The Urban District Council have agreed to continue to supply current to the Queen's Palace subject to an agreement being entered into according to which the company take a minimum supply of 40 000 units per year for five years. The Council will charge 3½d. per unit on condition that the company undertake not to generate or supply any portion of their own current during the period.

**Bristol.**—The current generated during the last year amounted to 5,317,284 units; 4,299,504 units were sold, including 3,686,191 by meter, 613,313 for public lighting, and 1,017,780 used on works. The public arc lamps number 674, and there are five 16-c.p. and three 75-c.p. incandescent lamps in use. The total possible maximum demand was 7,022 kw.; the figure actually reached was 3,444 kw.

**St. Marylebone.**—The London County Council decided on Tuesday to lend the Borough Council £1,415,000 on or before Oct. 31 next for the purpose of the purchase of the electric lighting undertaking. The Council intend to apply to the London County Council for sanction to borrow £436,500 for the purchase of a site and the erection of an electric generating station to admit of a direct supply and self-contained system.

**Harrogate.**—The electricity department has now 759 flat-rate customers at £6. 0s. 1½d. per customer, and 304 customers on the demand indicator system, who pay an average of £28. 12s. There are six extraordinary large consumers, but on the 298 consumers the average is said to be £21. 10s. The flat rate will be reduced from 6d. to 5½d., and the demand indicator system from 6d. to 5½d., and that for street-lighting from 2d. to 1½d. per unit.

**Windsor.**—The Local Government Board having notified their preparedness to sanction a loan of £6,000 for the provision of a refuse destructor, a disinfecting house, and other buildings on the Corporation Field, at Dedworth, on the condition that the local authority will not manufacture material for sale, but will only sell such surplus products of the plant as they cannot themselves use. It has been decided to advertise for tenders.

**Horsham.**—The accounts of the electricity department since the beginning of the undertaking show a total deficiency of £1,257. 14s. 4d., after paying off £795. 16s. 6d. on account of principal. Last year the working expenses were met, and they came within £60 of the interest on the undertaking. This year there was a balance of some £431. In the case of a company this would be equivalent to paying something like 2¾ per cent. dividend. Mains are to be extended at a cost of £340.

**Longton.**—The Corporation Gas and Electricity Committee find the use of electricity for motive power purposes gradually extending and coming into favour with manufacturers and tradesmen, and have reduced the charges for current used for motive power as follows: for 500 units per quarter or less, 2½d. per unit; above 500 units and under 1,000 per quarter, 2¼d. per unit; above 1,000 units and under 1,500 per quarter, 2d. per unit; above 1,500 units and under 2,000 per quarter, 1¾d. per unit.

**Brighton.**—It has been agreed to pay the £6,959, profits of the electric lighting undertaking, to reserve fund. In addition to the accounts already given, the following figures as to the output for the year ended March 31, 1904, are available: quantity generated in B.T. units, 8,443,872; quantity sold—public lamps, 969,702; tramways, 1,774,988; private consumers by meter, 4,853,384—total sold, 7,598,074; quantity used on works, 345,496; total quantity accounted for, 7,943,570; quantity not accounted for, 500,302; number of public lamps, 372 arc lamps, 1,549 incandescent lamps.

**Chepstow.**—At Chepstow Petty Sessions on Tuesday, the Chepstow Gas and Coke Consumers' Company, Limited, summoned the Chepstow Electric Light and Power Company, Limited, for omitting to give the required notice before commencing to dig trenches for the purpose of laying down new electric lines and other works in various streets. Of the five justices on the bench three were more or less interested in one or the other of the companies and could not adjudicate, whilst the chairman had to leave the court at one o'clock, consequently the case had to be adjourned until Friday, the 17th inst.

**Lowestoft.**—The Electric Lighting Committee reported on Wednesday that there were on June 3 513 consumers connected to the mains, representing 25,290 8-c.p. lamps. During the month 13 new consumers had been connected, representing 466 8-c.p. lamps. The new system of charging at 5½d. per unit is to be commenced as from July 1 next. The engineer is to report as to the cost of a siding which would have to be constructed from the Great Eastern Railway to the works. The committee's estimate for the next half-year amounts to £6,002, including £2,300 for coal, £2,160 repayment of loans and interest, and £540 for wages. Among the receipts were put down £2,810 from private lighting, £794 from public lighting, and £1,783 from the tramways for current, and other sums, which left a balance of only £100 to be provided for out of the rate.

**Leek.**—An illustrated souvenir has been issued in connection with the opening of the electricity generating station, which we noted in our last issue. Mr. R. M. Carr, A.M.I.E.E., is the resident electrical engineer and Mr. E. W. Monkhouse, M.I.E.E., the consulting engineer. The contractors were: for the generating station, W. Turner, Leek, £2,374; engines and dynamos, Industrial Engineering Company, Newton, Hyde, £1,860; stoneware casings, T. Wragg and Sons, £335. 5s. 7d.; wrought-iron manhole covers, W. Smith Bros., £42. 4s.; cable work, Callender's Cable, etc., Company, £813. 2s. 11d.; switchboard, Crompton and Co., £623; balancing transformers, Industrial Engineering Company, £478; storage batteries, Ashmore, Benson, Pease, and Co., £718. 15s.; travelling crane, Carrick and Ritchie, £189—£7,433. 7s. 6d. The total loan sanctioned was £10,061. The generating plant consists of two "Stockport" gas-engines by J. E Andrew and Co., each of 100 h.p., coupled direct by means of a flexible coupling to two 60-kw. dynamos by the Industrial Engineering Company.

**Stock Exchange.**—The Stock Exchange Committee have appointed June 22 a special settling day for British Electric Traction Company, Limited, £250,000 4½ per cent. second debenture stock, and have ordered the said securities to be quoted in the official list, as well as Electrolytic Alkali Company, Limited, further issue of 50,000 ordinary shares of £1 each fully paid, Nos. 152,219 to 202,218, and a further issue of 50,000 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 50,001 to 100,000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Anglo-Argentine Tramways Company, Limited, 120,000 ordinary shares of £5 each, fully paid; to appoint a special settling day in Rhodes Electrical Manufacturing Company, Limited, 6,135 ordinary shares of £1 each, fully paid, Nos. 35,001 to 41,000, and 43,101 to 43,235, and 38 000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 35,000, 41,001 to 43,100, and 43,236 to 44,135; and to allow to be quoted in the official list British Electric Traction Company, Limited, further issue of 1,235 ordinary shares of £10 each, fully paid, Nos. 232,067 to 233,301; and Underground Electric Railways Company of London, Limited, £3 599,200 5 per cent. profit-sharing secured notes, Nos. A 1 to A 8,450 of £100, B 8,451 to B 9,561 of £200, C 9,562 to C 10,335 of £500, and D 10,336 to D 12,480 of £1,000 each, in lieu of the fully-paid provisional certificates now quoted.

**King's Lynn.**—The balance-sheet for the electricity works for the year ending March 31, 1904, shows an income of £5,685 and an expenditure of £5,199, including capital charges, and a net profit on the year's working of £486, compared with a deficiency of £47 on the previous year's working. The net profit of £486 will be applied towards payment of the overdraft on the previous year's working. In the year 1903 the total output was 323,175 units, whilst for the past year it has been 388,472 units, being an increase of over 65,000 units. The sale of current had brought in £2 783 for private lighting, £512 for the supply to motors, and £1,991 for street-lighting, including the renewal of lamps. The revenue from the hire of meters was £156, and the profit on fittings £243, making a total revenue from all sources of £5 685. The cost of generating and distributing the current came to £2,333, from which shows a gross profit of £3,352, or 7½ per cent. on the total capital expenditure of the undertaking. The increase in the revenue this year was £631, whilst the increase in working expenditure has only been £98, the interest (£1,286) and £1,580 was paid towards redemption of capital, leaving the net surplus of £486 above referred to. The cost of production has again been reduced, and is this year 1·29d. per unit. The capital expenditure to March 31, 1904, was £45,833, being an increase of £752 during the year. The total amount written off capital was £6,490, so that there is now only a debt of £86 for every £100 spent. During the year the number of consumers increased from 401 to 459, the number of motors from 25 to 37, and the total horse-power of motors from 109 to 174¼.

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**Wolverhampton.**—In connection with the opening of the Corporation refuse destructor at Wolverhampton, it is proposed to lay down an electrical generating plant to utilise the steam produced by the combustion of the refuse. Cables will be laid in the vicinity of the destructor at a cost of £2,800, and application made for sanction to a loan of £10,000 for the present and future extensions of the lighting system.

**Mersey Docks.**—The Board have agreed to the provision of electric lights at the new Brunswick river entrances and at the 100ft. passages to the Coburg Dock, and the carrying out of certain other work in connection with existing lights in the locality, at a total estimated cost of £1,150. Current is taken from the Corporation mains, but the question of a complete installation upon a large scale is under consideration.

**Hampstead.**—The Borough Council have adopted a report of the Finance Committee stating that the proper proportion of the general establishment expenses of the Council which should be borne by the electric lighting undertaking during the last financial year was £1,400. The undertaking will be debited with that amount for the year ended March 31, and in future a *pro rata* charge is to be made according to the number of consumers at the end of each financial year.

**Wakefield.**—In his annual report, Mr. Cookson, the electrical engineer, says that the undertaking is in a very flourishing and prosperous condition. The surplus net profit for the year, after paying sinking fund and all charges, has been £1,893, and with £1,480 in hand as unappropriated profits of former years, there is a balance of £3 374, which it is proposed to retain as a working balance. The output has almost doubled in two years. It is proposed to reduce the charge to consumers from 4½d. to 4d. per unit.

**West Bromwich.**—A memorial signed by the senior employés in the electricity department has been forwarded to the town clerk, protesting against the interference of Alderman Pitt in the organisation of the staff. Upon being read at a special meeting of the Electricity Committee, Alderman Pitt said, in order to avoid further friction, he would undertake to stop his frequent visits to the electricity works, and would only attend when on official business, and that he would duly notify the manager of any official visits he intended to make.

**Yarmouth.**—The electric light undertaking earned during 1902-3 enough, after paying interest and sinking instalments, to allow £500 to be appropriated in relief of the rates, and for the past 12 months the receipts from the sale of current amounted to £13,486, and the expenses, after defraying all costs of production, left a gross profit of £5,870. From this sum £4,577 has been paid as interest, in rebates, and for capital repayments, leaving the ratepayers with a profit of £1,293, which shows that the undertaking is making a clear profit of over £100 a month.

**Uphall.**—Specifications have been issued for the electric lighting of Uphall and Broxburn, and offers have been advertised for. The specifications provide for an oil-engine and dynamo to be erected in a central station near the Holmes, with a balancer set for keeping pressure equal over the system, which is to be three-wire, and also a main switchboard for distributing the current over the circuits. Two main circuits will be laid down, with branches for side roads, and distribution boxes will be placed at intervals along the pavements. Arc lamps of the Jandus pattern and ½-ampere Nernst lamps will be adopted.

**Richmond.**—The Richmond (Surrey) Electric Light and Power Company, Limited, have notified that they will undertake in approved cases the free wiring of premises for electric light on payment of a rental of from 4½d. per lamp per quarter, the consumer to have the option of purchasing the installation outright at any time; or they will arrange for the wiring and fitting of premises on the hire-purchase system, whereby repayment of the cost of the installation is spread over a period of years. In either of the above cases the charge for supply of current would be at the company's usual rate of 6d. per unit.

**Hove.**—In a report on the supply of electricity for the electric lighting of Aldrington, it is recommended that a contract be entered into with the Brighton Corporation for the supply of current in Aldrington for private lighting, subject to such conditions as might be considered advisable and necessary by the Council's solicitors and engineers. The Council are giving notice to the Brighton Corporation that they intend to exercise their powers under Section 16 of the Electric Lighting (Clauses) Act, 1899, and carry out the work themselves in Hove in the laying of the proposed electric cable from the Southwick electricity works into Brighton.

**Dundee.**—The estimates of the electricity department contain the following additional details: private lighting, ordinary consumers, 819,500 units, at 4d., £14,158; private lighting, special consumers, 10,000 units, at 3½d., £145; private lighting, special consumers, 91,400 units, at 3d., £1,142; private lighting, special consumers, 160,000 units, at 2d., £1,333; private motors, 189,000 units, at 2d., £1,575; tramways, 1,620,000 units, at 1⅓d. (net), £9,000; public lamps (71), at £15 each per annum (net), £1 065. Deducting discounts (£805) and bad debts (£50), the total estimated revenue is given at £27,588, which gives an estimated surplus of £168.

**Machine Belting, etc.**—A demonstration was given last Friday at the works of Messrs. Marshall and Hyatt, Limited, of the operation of a machine, the invention of Mr. J. W. Hyatt, which, it is stated, will manufacture fabrics at a speed greatly exceeding that of ordinary weaving. It is claimed that by it machine belting 6in. in width and ⅛in. thick can be produced at the rate of 75ft. per hour, and that it has been shown by Kirkaldy's test to be double the strength of the most powerful belting hitherto obtainable. Outer covers for motorcar tyres are other articles which the inventor expects the machine will facilitate the production of. The cost of manufacture is stated to represent a great economy over existing rates, owing to the rapidity of production. A company is to be formed for working the invention, which has been patented in all the chief European countries, as well as in the United States.

**Sunderland.**—In addition to the accounts of the electricity department, the following figures as to the cost of production per unit sold are available: coal, 1904 ·510d., 1903 ·589d.; oils, ·054d. (·068d.); wages, ·208d. (·213d.); repairs, ·145d. (·176d.)—total works costs, ·017d. (1·046d.); rents, etc., ·155d. (·221d.); management, ·227d. (·235d.); sinking fund and interest, 1·034d. (1·113d.)—total costs, 2·333d. (2 615d.). The works costs are now ·917d., and the total engineering costs 1·299d.; sinking fund and interest require 1·034d.; making a grand total of 2·333d. It will be noticed that the sinking fund and interest per unit sold is less than last year, and will now be on the descending scale.

**Southampton.**—Mr. Blakeway, at the last Town Council meeting said, with regard to the rumours which had been circulated with reference to their works, that from time to time the buildings had been completed up to the present there had not been any settlement in them of any sort or kind that they had been able to trace, and he trusted that this false statement would be dispelled. A report by the borough engineer to the Electricity Committee concerning the applications received for a supply of electricity from householders in private streets and roads situate in the borough has been adopted, in which he suggested that the Council should apply to the Board of Trade for consent to lay mains and services. The town clerk is about to prepare the necessary memorial.

**Amazon Telegraph Co.**—A meeting of debenture holders will be held at the offices of the company, 42, Old Broad-street, London, E.C., on the 23rd inst., at 2 p.m., for the purpose of receiving and considering a report of the trustees for the debenture holders with regard to the position of the company, and of considering and passing, if thought fit, an extraordinary resolution or extraordinary resolutions giving time to the company for payment of interest due and to become due on the debentures, and for redemption of the debentures by drawings and suspending the operation of the sinking fund for payment of interest and redemption of the said debentures, and for modifying the rights of the debenture holders and the liabilities of the company accordingly.

**H.M.S. "Clyde."**—The coils of cable for the electric light which is to be installed on H.M.S. "Clyde" (late "Wild Swan") have arrived in Aberdeen. On the preparations for laying the cable from the side of the dock to the ship, the *Weekly Free Press and Aberdeen Herald* says a raft is moored close to the bow of the "Clyde," and the cable is being uncoiled from the drums on to the raft, where it is again coiled in 25ft. lengths. The cable will be laid along the bottom of the dock from the new lock at the New Regent Bridge, passing under the present temporary bridge on the south side, about 10 yards from the steps. A dredger is to cut a trench for the cable to lie in along the bottom of the dock up to the temporary bridge, but thereafter divers will probably have to be employed to continue the trench under the bridge to the lock. The cable will be led on board the "Clyde" through the port side hawser hole. The trench is necessary so that the cable will be clear of all shipping passing through the dock. The laying of the cable and construction of the installation plant is under the superintendence of Mr. W. Church, who is in charge of a staff of electrical fitters from Sheerness Dockyard.

**Heston and Isleworth.**—The Urban District Council will shortly be in a position to supply electric current for light and power. No charge will be made for current for the first month the works are running. The charges will be as follows: lighting, 5d. per unit for any quantity, subject to the following discounts if accounts paid at Council's office within one month from demand: consumption exceeding 200 units in winter quarters and 150 units in summer quarters, 5 per cent.; exceeding 300 and 200 ditto, 7½ per cent.; exceeding 400 and 300 ditto, 10 per cent.; meters from 1s. per quarter. Power: consumption not exceeding 750 units per quarter, 3d. per unit; consumption exceeding 750 units per quarter, 2d. per unit; meters from 2s. per quarter. Premises will be wired and fitted on receipt of approved applications free of all initial cost to the consumer. In these cases current will be supplied at 5½d. per unit. The consumer will have the right of purchasing the installation outright at any time. The Council are prepared to make arrangements with owners of houses which they do not themselves occupy for wiring and fitting houses, repayment to be made by instalments or otherwise.

**Brighton Telephones.**—The revenue account for the telephones shows a total expenditure to March 31, 1904, of £379. 1s. 5d. and an income of £416. 16s. 6d., giving a trading surplus of £37. 15s. 1d. Charges for interest, etc., however, amount to £1,915. 16s. 3d., so that the deficiency is £1,878. 1s. 2d. The expenditure on capital account during the year was as follows: building switch-room, £1,059. 4s. 4d; underground construction, £12,382. 18s. 2d.; overhead construction, £4,604. 8s. 10d.; exchange construction, £1,767. 4s. 1d.; instruments, £3,054. 12s. 3d.; plant and tools, £357. 16s. 9d.; furniture and fittings, £257. 5s.; preliminary and general expenses, £1,430. 5s. 8d.; engineer's commission, £1,192. 17s. 6d.; general (capital) stores, £608. 11s. 11d.—total, £26,735. 4s. 6d. The total amount authorised to be borrowed in 1902 was £42,000, and the discounts and costs of issuing stock for that amount came to £3,859. 9s. 1d., making the total debt created £45,859. 9s. 1d. In the present year sanction was given to borrow £4,666, but, according to the balance-sheet, this had not been borrowed at March 31. The committee have approved the opening of an exchange at Hurstpierpoint at a cost of £180.

**London Gazette.**—The partnership between Alfred William Marshall and Maurice Walter Woods, electric light engineers and manufacturers, 2, Gray's-inn-road, Holborn, and Shepherd's Bush, London, and at Northwich, trading as Marshall and Woods, has been dissolved by mutual consent; Maurice Walter Woods will continue the business. The partnership between Arthur Guy Enock, Charles

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William Vavasour Biggs, and Henry Chawner Hine Senton, consulting civil and electrical engineers, first at 21, Great College-street, Westminster, and subsequently at 17, Victoria-street, Westminster, trading as Enock, Biggs, and Shenton, has been dissolved by mutual consent. The partnership between George Newby, jun., and Thomas Wray, electrical engineers, Imperial-chambers, James-street, Harrogate, Yorks, trading as Newby and Wray, has been dissolved by mutual consent; George Newby, jun., will continue the business. The partnership between William George Pearson and William Henry Lake, manufacturers of electrical accumulators, Dirleton-road, West Ham, Essex, trading as Pearson and Lake, has been dissolved by mutual consent; William George Pearson will continue the business. The final meeting of the Electric Photo Company, Limited, will be held in the office of Mr. J. B. Bateley, Central-buildings, Blyth, Northumberland, at 3 p.m. on July 14.

**London County Council.**—On Tuesday it was agreed to lend the Hammersmith Borough Council £10,634 for electric light installation and meters. The acceptance of the tender of the British Westinghouse Electric and Manufacturing Company, Limited, amounting to £22,910, was recommended for the tramways switchgear. The list of tenders appears in another column. On the proposal of the company to sublet various portions of the work included in the contract, it was recommended: (*a*) That, subject to the result of the usual enquiries proving satisfactory, the tender, amounting to £22,910, of the British Westinghouse Electric and Manufacturing Company, Limited, London, be accepted for the supply, delivery, and erection of the main switchgear required for the first portion of the electricity generating station being established by the Council at Greenwich in connection with the electrical working of portions of its tramways. (*b*) That the British Westinghouse Electric and Manufacturing Company, Limited, be allowed to sublet the following portions of the work in connection with the switchgear referred to in the foregoing resolution to the undermentioned firms or to such other persons or firms as may be approved by the engineer under the contract—namely: (1) to Messrs. Everett and Edgecombe, London, the supply of the synchroscopes; (2) to the British Thomson-Houston Company, Limited, Rugby, the supply of the direct-current wattmeters; (3) to Messrs. Nalder Bros. and Thompson, London, the supply of the direct-current recording ammeters and voltmeters; (4) to Messrs. W. T. Glover and Co., Limited, Manchester, the supply of the electric cables; (5) to the Bostwick Company, London, the supply of the Bostwick gates; (6) to the St. Helens Cable Company, Warrington, the supply of the rubber mats; and (7) to Messrs. R. W. Blackwell and Co., London, the supply of the direct current circuit breakers.

**Bury.**—In addition to the accounts of the Electricity Committee, the following figures relating to costs are available for the year ended March, 1904: coal, £896—·32d. (1903, £697—·39d.); oil and stores, £151—·05d. (£100—·06d.); wages, £741—·27d. (£622—·35d.); repairs—buildings, £32—·01d. (£3—·00d.); plant, £128—·05d. (£114—·07d.); accumulators, £110—·04d. (£119—·07d.); instruments, £8—·00d.; mains, £456—·16d. (£177—·10d.); meters, £56—·02d. (£57—·02d.); printing and stationery, £22—·01d. (£40—·02d.); incidentals, £71—·03d. (£70—·04d.); rates and taxes, £378—·13d. (£391—·22d.); insurances, £26—·01d. (£23—·01d.); bad debts, £5—·00d. (£1—·00d.); auditor, £15—·00d. (£15—·01d.); salaries, £559—·20d. (£520—·29d.); generating costs, £3,654—1·30d. (£2,929—1·65d.); bank interest, £773—·28d. (£266—·15d.); interest on loans, £1,465—·52d. (£1,382—·78d.); sinking fund, £1,465—·52d. (£1,409—·80d.); total cost, £7,357—2·62d. (£5,986—3·38d.); profit, £566—·20d. (£21—·01d.); average price obtained, £7,923—2·82d. (£6,007—3·39d.). Some difference under the heading of generating costs may be noticed when compared with the borough treasurer's statement. The cost of carbons and attendance to public lamps has been deducted from the revenue received for public lighting, and the repairs to hired motors deducted from the rental, as it would be misleading to express these costs as a cost of generating the units sold for all purposes. The cost of generating has been reduced by ·35d., or 21 per cent., and the total costs by ·76d., or 22 per cent. per unit sold. The average price obtained has been less by ·57d. per unit, a reduction of 17 per cent. on the price for the previous year, due to the larger percentage of units sold at the lower rate for power purposes. The quantity of fuel used per unit sold has increased by 2 per cent., and the average price paid has been 6*s.* 6½*d.* per ton, compared with 8*s.* 3*d.* for the previous year. The use of a cheaper and inferior quality of slack has reduced the cost from ·39d. to ·32d. per unit sold.

## PROVISIONAL PATENTS, 1904.

JUNE 6.

12725. **Improvements in electro-mechanical apparatus for automatically operating the rail and electrical conductor points on electric tramways and railways from the tram or train.** George Dudley Aspinall Parr, the University of Leeds, Leeds.

12729. **Improvements in electric railways.** Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

12737. **An improved electrical motor for variable speeds.** John Bentley, 57, Higher Ardwick, Ardwick, Manchester.

12741. **Improvements in electric ignition apparatus for internal-combustion motors.** Harvey du Cros, 14, Regent-street, London. (Société Anonyme des Anciens Etablissements Panhard et Levassor, France.)

12766. **Apparatus for gripping or holding and cutting submarine cables.** Jean Sazérat, 72, Cannon-street, London. (Complete specification.)

12755. **Improvements in coin-freed apparatus for supplying a current of electricity to persons using it after the insertion of a predetermined coin, and for indicating the strength of the current supplied.** James Carter and Samuel Henry Leheup, 66, Chancery-lane, London. (Complete specification.)

12801. **Improvements in and relating to dynamo-electric machines.** William Brooks Sayers, 46, Lincoln's-inn-fields, London.

JUNE 7.

12821. **An improved adjustable standard for holding an electric glow lamp.** Archibald John Ware, 104, Colmore-row, Birmingham.

12822. **An improved chain for suspending electroliers.** Archibald John Ware, 104, Colmore-row, Birmingham.

12840. **An electrical train describer or indicator.** David Wells, 48, Dudley-gardens, Leith, Edinburgh.

12844. **An improved Bunsen semi-dry battery.** George Franklin and Thomas Frederick Furnival, 57, Moorgate-street, London.

12860. **Improvements in incandescent electric lamps and in the manufacture thereof.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

12861. **Improvements in electric contact devices.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JUNE 8.

12947. **Improvements in or relating to electric current collectors for use in electric traction.** Sidney Mark George Teal, Electricity Works, Tottenham-lane, Hornsey, London.

12967. **Improvement in electrical ignition apparatus for explosion engines.** Alfred Ernest Dean, 82, Hatton-garden, London.

12970. **Improvements in small dynamos and motors.** Archibald Jessop Wright, 318, Upper-street, London.

12973. **Improvements in electrical measuring instruments.** Edgar Isaac Everett and Kenelm Edgcumbe, 151, Great Saffron-hill, London.

12975. **An improved lifeguard attachment for electric tramcars and the like.** Charles Henshaw, 13, Lorne-street, Chorlton-on-Medlock, Manchester.

12977. **Improvements relating to telephones.** Jason J. Nye and Marcus Peck, Fife House, Kingston-on-Thames. (Complete specification.)

13015. **Improvements relating to electric telegraphy.** Sidney George Brown, 7, Southampton-buildings, Chancery-lane, London.

13016. **Improved method of and apparatus for obtaining a constant potential current from a variable-speed dynamo.** François Loppé and La Compagnie Générale d'Electricité de Creil, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 10, 1903, being date of application in France.) (Complete specification.)

13017. **Improved method of and apparatus for obtaining a constant potential current from a variable-speed dynamo.** François Loppé and La Compagnie Générale d'Electricité de Creil, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 20, 1904, being date of application in France.) (Complete specification.)

JUNE 9.

13019. **Improvements in electrical tramway and railway overhead crossings.** Percival John Pringle, 169, Ashby-road, Burton-on-Trent.

13040. **An improvement in motor lamps burning paraffin or electricity.** Sidney Russell, Bedford Works, Walsall.

13051. **Improvements in dynamo-electric machines.** Miles Walker, 7, Skerton-road, Old Trafford, Manchester.

13061. **An improved voltmeter.** Frederik Onland van de Kasteelf, 18, Southampton-buildings, Chancery-lane, London.

13072. **Improvements in electric condensers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13073. **Improvements in collector rings for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13083. **Improvements in electromagnetic couplings.** Horace James Jordan Hummel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Julius Pintsch, Germany.)

13084. **Improvements in electric incandescence vapour lamps.** John Benjamin Butler-Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JUNE 10.

13107. **Improvements in or relating to switch mechanism for use in connection with intercommunication telephone instruments or telephone systems.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

13130. **Improvements in connection with electric radiators.** Herbert John Dowsing, 115, Cannon-street, London.

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**13136. Improvements in or relating to electrically-heated gauffer moulds and other similar apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (Société Dubois et Emery, Switzerland.)

**13158. Improved plastic composition suitable for the manufacture of buttons, electrical insulating material, or other articles, and process of manufacturing same.** Army Geipel, 55, Chancery-lane, London.

**13161. Improvements in the manufacture of filaments for incandescent lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

**13169. Improvements in and relating to electric light fittings.** Henry Lea, 18, Southampton-buildings, Chancery-lane, London.

**13173. Improvements in apparatus for providing air, light, and telephonic communication for use at fires.** James Compton Merryweather, Greenwich-road, Greenwich, Kent.

JUNE 11.

**13216. Improvements in telephone exchange systems.** William Aitken, 65, Chancery-lane, London. (Complete specification.)

**13223. Improvements in electrolytic meters.** Sydney Holmwood Holden and Chamberlain and Hookham, Limited, 4, New Bartholomew-street, Birmingham.

**13253. Improvements in the manufacture of filaments for incandescing electric lamps.** Jack Randall Crawford, Clun House, Surrey-street, Strand, London.

**13264. Improvements in continuous-current electric motors and generators.** Ludwig Torda, 40 Chancery-lane, London.

**13274. Improvements in means for controlling the trolleys of electrically-propelled vehicles.** Charles William Godson Little, 46, Lincoln's-inn-fields, London.

**13275. Improvements in rail bonds.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13276. Improvements in protective devices for electric generating and distribution systems and apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13277. Improvements in coil-winding apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13278. Improvements in electric transformers, reactances, and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13283. Improvements in and relating to means for supplying or cutting off current in connection with single or polyphase alternating-current motors.** The Union Elektricitäts-Gesellschaft, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 30, 1903, being date of application in Germany.) (Complete specification.)

**13284. Improvements in and relating to means for starting and controlling alternating-current motors.** The Union Elektricitäts-Gesellschaft, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 30, 1903, being date of application in Germany.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 30, 1904.*

1903.

**13182. Electro-deposition of metals upon aluminium, alloys of aluminium, and other metals.** Croucher.

**14167. Systems of electrical distribution.** Le Tall. (Cooper-Hewitt Electric Company.)

**14597. Machines for making bases for electric lamps.** Carolan. (General Electric Company.)

**15592. Synchronising dynamo-electric machines.** Carolan. (General Electric Company.)

**18550. Construction of commutator for dynamos and electric motors.** Maclean.

**18598. Automatic electro-mechanical cut-out.** Spagnoletti.

**20907. Telegraph systems.** Jones.

**27044a. Secondary or storage batteries.** Hardingham. (Electric Boat Company.) (Date applied for under Patents Rule 9, Dec. 10, 1903.)

1904.

**2457. Electric switches.** Wright and Acly. (Date applied for under International Convention, Jan. 31, 1903.)

**3251. Prevention of arcing in electrical apparatus.** Blood.

**3677. Regulators for alternating-current motors.** Latour. (Date applied for under International Convention, Feb. 14, 1903.)

**3694. Coherers for wireless telegraphy.** Ortega y Marquez. (Date applied for under International Convention, Feb. 16, 1903.)

**4357. Electrical transformers.** Peck. (Date applied for under International Convention, Feb. 28, 1903.)

**7012. Electric cable couplings.** Everhart and Dossert.

**9581. Electric motors.** McNeill.

**10172. Dynamo-electric machines.** Imray. (Bullock Electric Manufacturing Company.)

**10173. Combined electric switch and plug connector.** Warren and Hunter.

**10376. Electric alarm signalling apparatus.** Jacobsen. (Date applied for under International Convention, May 7, 1903.)

**10446. Controlling or regulating means for electrical apparatus.** Boult. (Entz.)

**10447. Bearings for the motors of electrically-propelled vehicles.** De Kando.

**10448. Electric motor systems.** De Kando.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅜-½ |
| Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ¼-⅜ |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3¼-3⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 87-90 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | .. | ¼-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | ⅜-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 9¼-10¼ |
| —— 5 per cent. Pref. | 5 | .. | 5¼-5⅜ |
| Crompton and Co. | 5 | .. | 1⅜-2¼ |
| —— 5 per cent. Debentures | 100 | .. | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | .. | ¼-⅜ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1¼ |
| —— 5 per cent. Debentures | 100 | .. | 75-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 73-78 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1⅜-1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2¼-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¼-9⅜ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 11¼-12¼ |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 19-20 |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | .. | 36-39 |
| —— 5 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,301-101,300 | 1 | .. | ⅜-½ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 120-125 |
| Bournemouth and Poole, Ordinary | 10 | .. | 11¼-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 9¼-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10¼-11¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10¼-11 |
| —— 7 per cent. Preference | 5 | .. | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 7-7¼ |
| —— Nos. 20,001-30,000 | 5 | .. | 7-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7¼-8 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 102-104 xd |
| Chelsea Electricity Supply | 5 | .. | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | .. | 107-110 |
| City of London, Ordinary | 10 | .. | 11-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-125 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 101-104 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5¼-6 |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | .. | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 12-13 |
| —— per cent. Debenture Stock Red | 100 | .. | 102-105 |
| Kensington and Knightsbridge and Notting Hill | 100 | .. | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | .. | 9¾-10¼ |
| London Electric, Ordinary | 3 | .. | 1¼-1¾ |
| —— 6 per cent. Pref. | 5 | .. | 4¼-5 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 95-98 |
| Metropolitan Ordinary | 10 | .. | 19¼-20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | .. | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 12¼-13¼ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | .. | 98-101 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 98 101 |
| Royal Electrical Company of Montreal. 4½ per cent. First Shares Mortgage Debentures | 100 | .. | 100-103 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | .. | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 | .. | 86-90 |
| South London, Ordinary | | .. | 3¾-4¼ |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | .. | 14-15 |
| —— 7 per cent. Pref. | 5 | .. | 8-9 |
| —— 3½ per cent. Deb. | 100 | .. | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | .. | 4¼-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4¼-5 |
| Westminster, Ordinary | 5 | .. | 12¼-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,851 | 5 | .. | 6¼-6¾ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 — | 92-95 |
| —— 4 per cent. Pref. | 100 — | 102-105 |
| —— ,, deferred | 100 — | 83 86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 — | 112-115 |
| City and South London, Consolidated Ordinary | 100 — | 50-52 |
| —— 4 per cent. Debenture Stock | 100 — | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 — | 123-126 |
| —— ,, ,, ,, '96 | 100 — | 120-123 |
| —— ,, ,, ,, '01 | 100 — | 115-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 — | 10-10¼ |
| —— Ordinary, 1-60,000 | 10 — | 3¼-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — — | 98-101 |
| Waterloo and City, Ordinary | 100 — | 89-92 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-250,007 | 5 — | 5 5¼ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 — | 131-136 |
| Blackpool and Fleetwood Tramroad | 10 — | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 — | 1¼-2¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 — | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 — | 98-103 |
| British Columbia Electric Railway Co., Ord. Def. | 100 — | 100-103 |
| —— Ord Pref. | 100 .. | 98-101 |
| —— Non-Cum. 5 per cent. Pref. | 10 .. | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 — | 102-104 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 .. | 98-101 |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 — | 10-10⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 — | 10¼-11 |
| —— 5 per cent. Perpetual Debenture Stock | 100 — | 116-119 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 — | 2⅜-3 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 — | 5¼-5⅜ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 — | 5-5¼ |
| —— 5 per cent. Deb. Stock, Red. | 100 — | 107-110 |
| —— Prov. Cert., all paid | 100 — | 101-104 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 — | 2-2¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 — | 4¼-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 .. | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 99-102 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 — | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 — | 11-12 |
| —— 4 per cent. Debentures | 100 — | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 — | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 — | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 — | 94-97 |
| Imperial Tramways Ordinary | all — | 18 19 |
| —— 6 per cent. Cum. Pref. | all — | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 — | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 — | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 — | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 — | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 — | 11-11¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 — | 103-105 |
| Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016 | 1 — | ¼-⅜ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 — | ¾-1 |
| New General Traction, Ordinary | 5 — | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 — | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 — | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 — | 12-12½ |
| —— 5 per cent. Cum. Pref. | 10 — | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 — | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 — | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 — | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 — | 101-104 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 — | 1 |
| —— £101,152 6 per cent. Preference | 1 — | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. — | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 — | 104-106 |
| —— Deferred Stock | 100 — | 85-88 |
| —— 6 per cent. Cum. First Pref. | 10 — | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 — | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 — | 5-5¼ |
| —— 5¼ per cent. Deb. Stock, Red. | 100 — | 98-100 |
| —— 4 per cent. Deb. Stock, Red. | 100 — | 103-105 |
| Oriental Telephone and Electric Company | 1 — | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 11 | 1,419 | 1,167 | + 251 | + 521h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 11 | 337 | 371 | - 34 | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 11 | 35 | — | — | — | 1¼ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 12 | 1,043 | 1,006 | + 43 | - 112 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 11 | 5,588 | 4,996 | + 592 | + 7,274 | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 13 | 1,032 | 815 | + 187 | + 660 | 24 | 24 | March 25g | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 9 | 840 | 775 | + 65 | + 668 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 11 | 585 | 901 | - 316 | - 683 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·39 |
| Bolton Corporation | ,, 12 | 1,880 | 1,994 | - 114 | - 128 | 38 | 38 | March 31g | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·67 |
| Bournemouth Corporation | ,, 8 | 1,023 | 933 | + 45 | + 504 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 11 | 4,796 | 3,608 | +1,188 | + 7,987 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 12 | 913 | 841 | + 72 | - 54h | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 10 | 5,118 | 4,722 | + 395 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 11 | 1,051 | 706 | + 345 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 12 | 331 | — | — | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 4 | 2,166 | 2,731 | - 568 | + 580 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 11 | 208 | 200 | + 8 | + 272 | — | — | ,, 31 | — | 2,216,583 | 320,129h | — | — | — | — |
| Central London Railway | ,, 11 | 6,781 | 6,812 | - 31 | - 2,665h | 6 | 6 | ,, 31 | 367,225 | 45,306,110 | 1,276,971a | 1·87 | 66·6a | 59,076 | 35·6a |
| City & South London Railway | ,, 12 | 2,628 | 2,726 | - 98 | - 2,224h | 6⅔ | 6⅔ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 9 | 558 | 671 | - 113 | - 685 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 10 | 237 | 230 | + 7 | - 155 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 11 | 204 | 218 | - 14 | - 246 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 12 | 132 | 116 | + 16 | + 207h | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 10 | 4,380 | 4,125 | + 254 | — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06h |
| Dublin S. District, Electric | ,, 10 | 1,226 | 1,041 | + 185 | | | | | | | | | | | |
| Dundee City Tramways | ,, 8 | 870 | 862 | + 8 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 11 | 766 | 689 | + 177 | + 832 | 10·75 | 10·75 | March 31g | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 11 | 15,370 | 14,624 | + 846 | - 2,715h | 124 | 124 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 1 | 224 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 1 | 3,593 | 3,935 | - 342 | + 499 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 11 | 1,304 | 1,118 | + 186 | — | 34 | 34 | March 31 | 56,631h | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·32 |
| Hull Corporation, E. S. | ,, 11 | 2,082 | 1,715 | + 366 | + 2,216 | 26 | 19 | ,, 31 | 87,707h | 21,055,989 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 11 | 495 | 396 | + 99 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 8 | 139 | 171 | - 32 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 8 | 294 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 11 | 5,990 | 5,118 | + 872 | + 3,527 | 77 | 77 | March 25g | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Leicester Corporation | ,, 11 | 1,086 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 4 | 10,831 | 12,107 | +1,276 | + 3,676 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 12 | 1,613 | 1,560 | + 53 | + 27h | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 4 | 47,248 | 44,047 | +3,201 | — | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 11 | 177 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 11 | 12,559 | 11,365 | +1,194 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 11 | 124 | 62 | + 62 | — | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 11 | 3,722 | 3,204 | + 518 | — | 38½ | 38½ | March 25g | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 11 | 507 | 368 | + 140 | + 1,321 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 11 | 1,965 | 1,589 | + 376 | + 1,778 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 13 | 136 | 123 | + 13 | — | 4½ | 4½ | March 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 9 | 469 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 13 | 4,067 | 3,533 | + 534 | + 4,499 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 11 | 137 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 12 | 4,612 | 4,022 | + 590 | + 1,637 | 53½ | 53½ | Mar. 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 9 | 1,056 | 1,331 | - 275 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 8 | 328 | 320 | + 8 | + 144 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 10 | 664 | 412 | + 252 | + 2,453 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 12 | 1,200 | 1,146 | + 54 | + 305 | 18·48 | 18·48 | ,, 31g | 59,930 | 13,987,121 | 1,270,257 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 11 | 764 | 699 | + 65 | + 250 | 10·5 | 10·5 | ,, 31g | 31,474 | 5,585,182 | 654,742 | 1·30 | 11·53 | 3,583 | 7·03 |
| West Ham Corporation | ,, 9 | 1,126 | — | — | — | 13 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 11 | 623 | 720 | - 97 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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## NOTES.

**Electrical Swingbridge.** — The new electrical swingbridge, which weighs over 300 tons, and which is to carry the railway across the Dover Docks to the landing stage of the Transatlantic boats, was swung into position on Thursday week. It has been erected in the record time of 18 weeks.

**A Large Gas-Engine.**—At the St. Louis Exhibition a Bolton firm are exhibiting a gas-engine of 3,000 h.p. Its flywheel weighs 34 tons and is 28ft. in diameter. An actual stroke of each piston is 10ft., and the number of strokes per minute 100. It will be interesting to see the results obtained from this engine on trial.

**Board of Trade Reorganisation.**—The conclusions given in the report of the Departmental Committee appointed to consider the duties of the Board of Trade and Local Government Board were summarised in our last week's issue. It is suggested that this committee should also look into the position and duties of the municipal electrical engineers in this country. If this is done, and their salaries increased by 150 per cent., the result will be most satisfactory.

**Scientific Research Endowment.** — Mrs. Percy Sladen, of Northbrook Park, Devonshire, has given £20,000 to be devoted to research or investigations in natural science, more especially to the furtherance of research in the sciences of zoology, geology, and anthropology. This fund will be termed the Percy Sladen Memorial Fund, as it is intended to perpetuate the memory of the late Mr. W. P. Sladen, who was for some time secretary and vice-president of the Linnaen Society.

**New South Wales Tramways.**—The report of the New South Wales Department of Public Works for the year ended June 30, 1903, shows that some 8¾ miles of electric tramways were completed during that period, the total length of line for all forms of traction covered by the same report being about 27½ miles. The electric traction refers to six routes, two of which are extensions. All the electric and the bulk of the steam systems are in Sydney, Newcastle and Broken Hill being the other districts with steam services. Single track is employed on most of the electric lines, all of which are equipped on the overhead system. The aggregate amount expended on tramway construction during the year was £152,440, but the proportion representing electric tramways does not appear.

**Turbine Steamer.**—On Wednesday of last week Messrs. Vickers, Sons, and Maxim launched from their Barrow-in-Furness yard the turbine steamer "Manxman," which has been built for the Midland Railway Company. The speed guaranteed is 20 knots, and the contractors expect to considerably exceed this. The steamer is fitted with Parsons turbines designed for a steam pressure of 200lb. per square inch. The dimensions of the vessel are: length, 330ft.; beam, 43ft.; depth, 26ft. The ventilation is on a novel system, being the Stewart's thermo-tank arrangement. This has been used extensively of recent years on emigrant vessels, but this is the first time it has been employed on a Channel steamer. Electric fans are used to circulate cool air in summer and steam-heated air in winter. The steering gear is controlled by electricity or steam at will.

**Engineering Apprentice Scholarship.** — In the North of England the large shipbuilding and engineering firms are encouraging their apprentices to study by premiums and increases in their weekly wages when they have attained certain proficiency. We have referred to this scheme before, but now learn that Messrs. Hawthorne, Leslie, and Co., of Newcastle, have arranged for an annual examination, the first of which has just been held at the Durham College of Science. No less than 93 apprentices sat, and the first position was secured by Mr. J. W. Hobson, age 20, who secured the first prize, a trophy and a scholarship of £10 value. The trophy is a silver bowl, which was presented by the apprentices at the works to the late Mr. F. C. Marshall when he attained his engineering jubilee. The associations connected with this bowl give an historic value to it as a trophy, and we are pleased to see the competition for it has been so keen.

**The American Visit.**—Mr. Calvin W. Rice and Mr. R. W. Pope, the organising honorary secretaries of the American visit of the Electrical Engineers, are apparently leaving nothing undone towards ensuring a most hospitable welcome to the members on their arrival in the States. We are also informed that a large contingent of the Italian Electrical Society have made arrangements to participate in the tour, and these will meet the British Institution on their arrival at Boston. The official reception of the party is to take place at the Waldorf-Astoria Hotel, New York, on the evening of Sept. 5, on which occasion all the visiting members will be the guests of the American Institute of Electrical Engineers. In view of the anticipated large number of distinguished guests from the United Kingdom and Italy, the American Institute is sparing no pains to make this a most complete and memorable trip, and everything is being done to ensure the comfort and convenience of the members throughout the journey.

**Telephoning in the States.**—Some interesting figures are given in the *Electrical World* of New York by Mr. W. M. Steuart, who is the chief statistician of the Department of Manufactures in the Bureau of the Census, as to the state of the telephone industry in the States for the year ending Dec. 31, 1902. The statistics, although interesting, we cannot reproduce in full, but they clearly show how largely the telephone has spread in the rural districts. The figures show that the telephone industry now employs some £90,000,000 of capital, with which sum 2,371,000 telephones have been equipped. With this number of instruments a total revenue of £17,365,000 is earned. Another interesting point is that the average cost per telephone installed is about £39. Of course, this includes the watered capital of certain companies, but even then it is a figure which the London local authorities would do well to consider when advising the Government on telephone matters, as they frequently do. The figures also show that the independent telephone companies have hardly yet been able to equal the business done by the Edison system.

**The United States Telegraph Service.**—A preliminary report by the Director of Census on all the telegraph systems in the United States for the year ending Dec. 31, 1902, has just been issued. It includes figures for only those commercial telegraph companies owned and operated within the United States, and does not include any foreign companies having offices there. The figures show that there were in 1902 21 different telegraph companies at work with an issued capital of £19,972,000. The gross income of these companies was no less than £7,510,490. The total expenses amounted to £5,698,044. The companies' capital distributed in dividends and interest on debentures £1,218,984. The number of miles of wire in use amounted to 1,248,602, and nearly 91 millions of messages were forwarded. The electrical energy required for this was obtained from some 635,000 primary cells and 19,639 secondary cells. These figures are of interest to compare with the returns of the British Post Office. It will be found that the average receipts per message are

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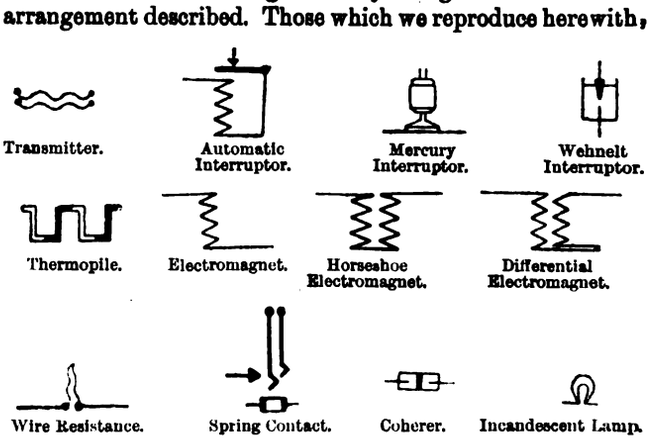
very much higher in the United States than in this country. With our much cheaper service the public is more benefited than if the Government were to charge more and use the profits to reduce taxation. It is, however, on this comparison of profits that Americans usually argue in favour of their company management over our Government undertaking.

**The Telephone Question.**—In the House of Commons on Thursday week the Postmaster-General was questioned as to whether he had come to any decision as to buying out the National Telephone Company under the clause which permits of doing so this year by compulsory arbitration by six months' notice in writing to terminate on Dec. 31. Lord Stanley, the Postmaster-General, in reply, said that after careful consideration "he had arrived at the conclusion that it would not be in the public interest to exercise the compulsory powers of purchase reserved to the Postmaster-General by clause 17 of the National Telephone Company's license. He should, therefore, not give notice to the company under that clause, and he was unable at present to say whether the negotiations now in progress with a view to a voluntary sale would lead to a satisfactory result." This answer agrees with previous rumours as to the Postmaster-General's opinion. There is no doubt that compulsory purchase by arbitration would be both costly in operation and very likely to give an unsatisfactory result, and it is a case in which private treaty is more likely to be successful. As an example on a smaller scale we would instance the St. Marylebone Corporation's purchase by arbitration of the electric supply undertaking within its area. Here arbitration awarded to the Metropolitan Electric Supply Company some £300,000 more than they had offered to accept when treating privately.

**Important Partridges.**—In the House of Commons on Wednesday, the 15th inst., the Postmaster-General was interrogated with respect to the interruption on the telephone circuit erected for life-saving purposes between Padstow and Hawker's Cove. Lord Stanley, in reply, stated: "This telephone line is regarded by the Admiralty as very necessary for life-saving purposes, as there are three lifeboats at Hawker's Cove, including the only steam lifeboat on the North Cornish coast. Colonel Prideaux-Brune, the owner of the land over which the line passes, insisted recently upon the removal of the wires, on account of the injury caused by them to his partridge shooting. A temporary cable on the ground had to be substituted for the wires, with the result that interruptions have been frequent. Negotiations to pay a reasonable rent for compensation have not been successful, and it may be necessary to re-erect the line on another route at a heavy cost." This incident shows the importance of the partridge, beside which even the efficiency of a lifeboat service is of small account. We are glad to think that the Bill now before Parliament will give the Postmaster-General more powers when wayleaves are withheld in this way for frivolous reasons. As we go to press we learn that the matter has been settled against the partridges. Colonel Prideaux-Brune is now willing to share the expense of restoring the service.

**Yellow Journalism.**—With the introduction by the halfpenny daily papers in this country of the Yellow Press systems inaugurated in the States, there has come a demand for sensationalism and vivid descriptions rather, we are afraid, than for extreme accuracy. As a result the editorial staffs of some of our contemporaries excel in description, and we need hardly say that electricity gives them a free hand to exercise their imagination. The following note, headed "A Strange Freak of Electricity," is an example of what we mean: "By a strange freak of electricity an entire railway station in Paris—the Gare d'Austerlitz—was one evening last week converted into one immense series of connected electric batteries. The cable transmitting the current to the 'live' rails became fused for a distance of several hundred yards, and as the power stations continued in full action, the electricity that continued to be poured into the station escaped in all directions, running along rails, connecting wires, point and signal levers, telegraph and telephone wires, and numerous other conductors, until the whole station literally pulsated with electricity from end to end. Sheets of flame several yards long shot from rails and wires and a score of other points, the very soil, owing to rain having damped the ballast sand, seeming to be on fire. The current at last escaped over the roofs and caused fire in an adjoining building. Only when the wire was cut at the power station did the strange spectacle end." The description of the current at last escaping over the roof makes one think that the writer looked upon the current as a kind of indiarubber plum. We should also like to have seen the whole station pulsating with electricity from end to end. It reminds one of a description which appeared some years ago in a monthly journal which devoted itself entirely to "true stories only" and discovered "De Rougemont." The story was to the effect that a rattlesnake coiled itself up on the dead-weight safety valve of a boiler and caused the pressure to rise so much that the boiler rocked in its seat.

**Uniform Signs.**—In the issue of the *Elektrotechnische Zeitschrift* for June 2, J. Baumann makes a strong plea for the use of uniform signs in representing graphically the individual parts of telephone, telegraph, fire brigade alarm, and other installations using very small currents. Loss of time results from the present want of uniformity, the author points out, especially in reference to technical journals and patent specifications. The signs which he suggests for adoption are evidently the outcome of careful consideration with a view to obtaining simplicity of form, while at the same time ensuring a ready insight of the whole arrangement described. Those which we reproduce herewith,




by way of illustration, are selected from the 62 proposed by the author to represent the most frequently recurring constructional details of small current installations. Certain of these signs have been more or less generally adopted, while others would appear to be original suggestions. While the general idea is an excellent one, the suggested signs do not lend themselves to unqualified approval. This is especially the case with regard to those representing different modifications of the electromagnet, which, in our opinion, should be indicated by spirals round cores. The zigzag line used by Mr. Baumann is employed generally in this country to represent a non-inductive resistance. Reference to the telephone connections at the Holborn exchange, reproduced in our issue of June 10, clearly shows what we mean. The author also discusses little

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divergencies which occur in drawing-office practice, such as in representing the crossing of insulated wires and the distinctions made between lead and return conductors, etc. He suggests, among other things, that when conductors of small currents are laid with conductors carrying relatively large currents, as occurs in telephone exchanges equipped with lamp call signals, a distinction should be made by representing the wires carrying small currents with a thicker line. In conclusion, he ventures the opinion that the matter is worthy the attention of the Elektrotechnischen Vereins.

**Oil for Insulating Purposes.**—We are indebted to the *Electrical World* of New York for the following editorial *résumé* of a paper recently read before the National Electric Light Association by Mr. C. E. Skinner, entitled as above, which contains an excellent *résumé* of the principal data relating to transformer oil and switch oil. With steam-turbines busily engaged in reducing the opportunities for the use of mineral oil, there is comfort for the central-station engineer in the reflection that many hundreds of thousands of gallons of oil are being used annually for the insulation of transformers and similar apparatus. If the adoption of electric lighting sets a limit to the classical cry for oil because our lamps have burned out, at least it sets up partial restitution by the modern cry for oil because our transformers have burned out. We must have oil to insulate with, even though we do not have oil to burn. The paper points out two very significant facts in connection with mineral transformer oil—namely, that one-thirtieth of 1 per cent. of water in the oil markedly reduces the dielectric resistivity, and, moreover, that after one-fifteenth of 1 per cent. of water is present, the further reasonable increase in the quantity of water does not reduce the dielectric resistivity much further. Thus, according to certain tests cited, a sample of dry oil showed that 9·5 kilovolts were required to disrupt a gap of 75 mils, or 1·9mm., between brass rails ½in., or 1¼cm. ,in diameter. The effect of one-fiftieth of 1 per cent. of water mingled with the oil appears to have brought the disruptive voltage for this gap down to five kilovolts, or nearly one-half. On the other hand, about one-fourth of 1 per cent. of water only reduced the voltage to 3 6 kilovolts. The moral of this tale is "keep your oil dry," like the old watch-word of the flint-lock age, "keep your powder dry." Fortunately, the heat liberated within transformers when in use promotes evaporation of moisture, and thus tends to maintain high dielectric resistivity. It would seem likely for the same reason that high-tension transformers would be more apt to break down, tensionally, after some weeks' or months' disuse, when moisture had somehow succeeded in condensing into the oil. The paper also shows how misconceived and erroneous are the ordinary notions concerning the inflammability of oil. The popular idea is that oil is highly inflammable, derived from observations of conditions in which oil is spread out into thin layers, readily capable of being heated to the burning point. In bulk, it is shown that oil is almost like water in its non-inflammability. The author of the paper describes experiments that demonstrate this property, and alludes to a recent case in which a blazing transformer was dropped into an oil-tank to put out the fire. This is a case of adding fuel to a flame, too suddenly for the existence of the flame. The paper is both valuable and timely. It would seem that the main dependence of the electrical engineer for insulation in dealing with high tensions must be, among fluids, upon oil and air. Of these oil is incomparably the superior, and air by far the more plentiful. In the buildings oil is being used. In the transmission lines air is relied upon. The better we can depend upon oil within doors the better we can face the problems of air out of doors.

**A New High-Tension Fuse.**—In a somewhat lengthy contribution to the *Elektrotechnische Zeitschrift*, F. Collischonn describes the outcome of some exhaustive experiments undertaken by the Elektricitäts-Allgemeine Gesellschaft vormals W. Lahmeyer und Co., Frankfurt-on-Maine, with the object in view of designing a fuse to give uniformly satisfactory results with high tensions. The fuse evolved is shown in section (Fig. 1). An important detail of its construction consists in that the fuse proper is contained in a cylinder closed at the top and with its lower end immersed in oil, so that, while the actual break occurs in air, the gases generated are discharged into the oil below. The whole consists of a glass tube closed at both ends by metal caps as shown, the upper cap being provided with a vent through which oil may be poured into the tube. These caps carry the spring jaws, which

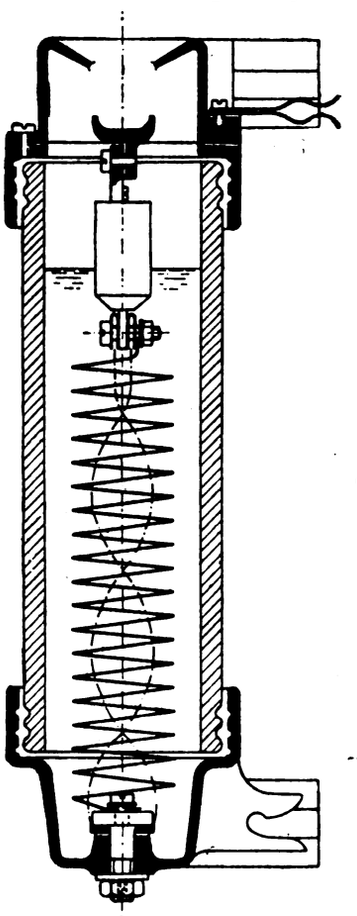

Fig. 1.

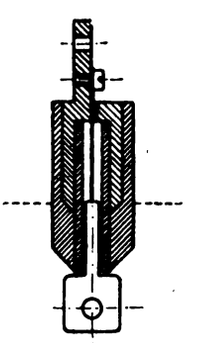

Fig. 2.

embrace the corresponding contact knives when the device is in position. The cylinder containing the fuse proper (Fig. 2) is enclosed within a stout metal case, pierced at the top to admit the fuse wire and protected with insulating material. A terminal piece attached to the fuse wire connects this through copper strands to the lower contact, the spiral wire (also shown in Fig. 1) serving solely to keep the fuse taut. The fuse itself, then, is not immersed in oil. But if the cartridge be sealed at the entrance of the fuse, then this cartridge may be entirely immersed without losing the advantage of the air space. When the fuse blows the gases generated are discharged as from a gun into the oil bath and at once cooled, no volatilised metal being diffused even with the highest tensions. The pressure of these gases at the same time ejects the terminal piece attached to the lower extremity of the fuse with considerable force, the two live poles being thus separated by a column of oil immediately after the fuse has blown. Since the fuse proper does not come into contact with

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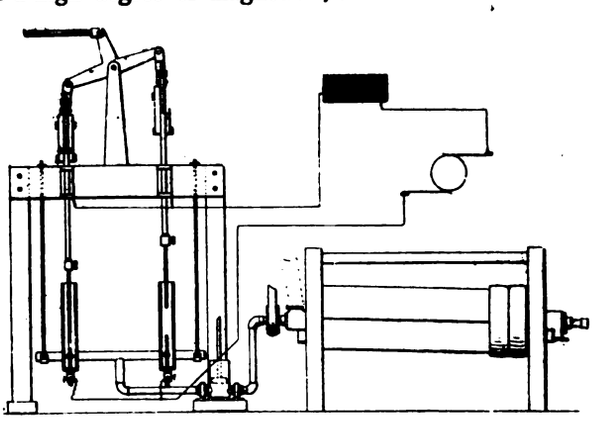
the oil at all, the reliability of its action is absolute. Experiments have shown that the fuse will carry an overload of about 50 per cent. of the normal current continuously, and a temporary (about five minutes) overload of from 70 to 80 per cent., while it will blow within two minutes from being switched on suddenly, in a cold state, to double the normal current. It seems that this type of fuse has been supplied for the Fenchurch-street sub-station of the Charing Cross and City Electric Company, Limited. In this particular instance the fuses are designed to carry 50 amperes at 10,000 volts, being mounted under the switchboard platform within a very confined space as is possible with such a compact form of fuse.

**Electrical Treatment of Flour.**—The *Western Electrician* gives an interesting description of an apparatus recently patented by Mr. James N. Alsop, of Owens Borough, Kentucky, for improving flour by treating it by certain gases produced electrically. The mixture in question is atmospheric air which has been subjected to the action of an arc or flaming discharge of electricity. The resultant gas was discovered, first by laboratory experimentation and then by actual practice on a commercial scale, to possess the property of causing a material decrease in the percentage of the carbohydrate contents of the flour subjected to its action and a practically corresponding increase in the proteids, thus greatly increasing the nutritive in contradistinction to the heat-giving qualities of the flour. It has not been possible accurately to identify by chemical formula this gaseous medium. It has been determined by chemical analysis, however, that air treated in the manner to be described contains nitrogen peroxide ($NO_2$ or $N_2O_4$) and traces of ozone ($O_3$), and is in a state of ionisation—that is to say, the air is separated into atoms or combinations of atoms, which are electrically charged, some negatively and some positively, and are thus in a condition to enter into new combinations. In the art of milling, it is desirable to manufacture flour which shall be white in colour without destroying its nutritive qualities. Flour subjected to the action of air which has been subjected to the flaming discharge of electricity will be bleached or purified, so as to render it white in colour, and this bleaching or purification of flour is effected without destroying any of the nutritive qualities thereof, as shown by chemical analysis. It is interesting from the baker's point of view to learn that the flour holds a good quantity of water. Thus, when equal portions, by weight, of the two flours are blended with water sufficient to make a dough suitable for baking, it is found that the treated flour requires more water (from 5 to 7 per cent. more). Chemical analyses of the treated flour have demonstrated that the change is largely due to the fact that there is a chemical combination of a relatively large amount of nitrogen, or nitrogenous compounds, with the treated flour. It is also believed that such chemical combination of the nitrogen with the flour is facilitated by producing a state of ionisation of the air, and it is possible that the ionised air itself in some other way acts upon the flour to assist in producing the changes herein indicated. Two chemical analyses of the flour were made—the first made to determine the extent and character of the change wrought in the constituents of the flour, and the second made to determine the amounts of nitrogen which the untreated and treated flour respectively contains. Two samples of flour were submitted for analysis to a professor of chemistry in Columbian College, Washington, D.C. One of these samples were taken from a batch of flour before its treatment by the process, and the other was taken from the same batch of flour after its treatment. The untreated flour showed the following constituents in the proportions named: water, 9·84; starch, etc., 74·11; proteids, etc., 14·99; ash, 0·44; fat, 0·62. The flour which had been treated showed the constituents in the following proportions: water, 10·13; starch, etc., 62 24; proteids, etc., 26·71; ash, 0·30; fat, 0·62. It will thus be seen that the flour which had been treated showed an increase of 11·72 parts proteids, and a decrease of 0·14 parts ash and 11·87 parts starch. The increase in the proportion of proteids relative to that of the other constituents of the flour, especially of starch and ash, is a highly advantageous result, as flour having such proportion of proteids is, of course, far more nutritive than the ordinary flour. The accompanying illustration shows the apparatus in question. The two tubes in which arcs are formed also serve as inlets to the air-pump, which forces the gases through the revolving cylinder in which the flour is treated. It will be seen that with the rocking arm the electrodes are alternately brought together and separated, thus forming long flaming arcs. In treating air by this apparatus it is possible to employ a current of low potential. With the low-potential current some means must be provided for feeding the arc, or, in other words, to meet the increased resistance offered as the electrodes are moved farther apart. This requirement is met by the introduction into the circuit of a self-induction coil, the action of which is as follows: when either pair of the electrodes is brought together, thereby causing short-circuiting of the electrifying apparatus, the coil is excited to a high degree of magnetism, and as the electrodes are



pulled apart and are followed by the arc or flash, which increases the resistance of the circuit, the strength of the magnetism of the coil will be diminished. This change in the strength of the magnetism generates an extra current in the circuit or coil in the same direction as the original current and proportional in strength to the magnetic change, as is well known. As the electrodes are drawn apart to form arcs, the resistance of the circuit is additionally increased, causing the strength of the magnetism in the coil to be additionally diminished, thereby causing the potential at the electrodes to rise to the necessary strength to meet the resistance of the air or gas between them, as the distance between the electrodes is increased until the opposite pair of electrodes are brought together and short-circuit the arcs. The contact of the electrodes lasts for an appreciable length of time, and the time during which the electrodes are in actual contact is sufficient to enable the coil to become thoroughly saturated. As a result, when the electrodes are separated to draw off the arc the potential of the current is increased in the manner explained, and not only so, but the arc is fed with current and prevented from appreciable attenuation, and maintained at a practically uniform density, which is the maximum density obtainable at the time. This may be further explained by stating that in practice the arc drawn off rarely exceeds 4½in. in length, whereas with a machine operating under the conditions described an arc 18in. can be drawn off before the arcing distance is passed.

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## WIRELESS TELEGRAPHY.

BY R. G. BLAINE, M.E, A.M I.C.E., ETC.

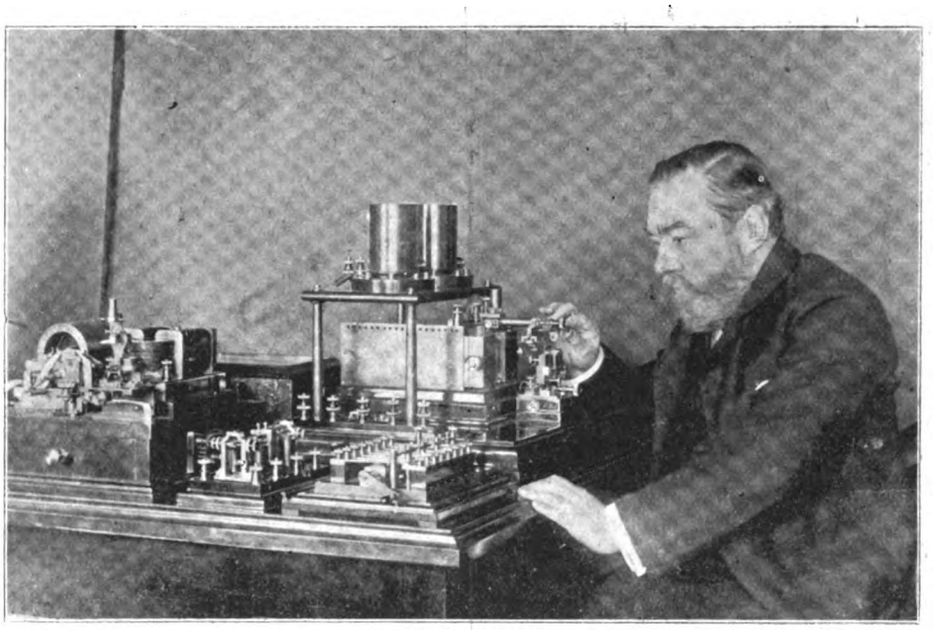
*(Continued from page 922.)*

THE LODGE-MUIRHEAD SYSTEM.

The work of Dr. Lodge in connection with space telegraphy has already been referred to frequently. He was the first, or one of the earliest experimenters, at any rate, to apply Hertz-wave methods to actual telegraphic signalling

SIR OLIVER LODGE.

and—at the suggestion, it is said, of his collaborator, Dr. Muirhead—to use the former in the production of printed records as in cable work. Whilst Dr. (now Sir Oliver) Lodge has been very busy in other ways, the development of his wireless inventions has been in good hands; though progress has not been rapid it has been solid; every arrangement and detail of apparatus has had to pass the severest practical tests before being adopted. Hence the solidity and workmanlike design, excellent finish, provision for easy renewal of parts, as well as great simplicity of manipulation which characterise the apparatus of this system.



DR. ALEXR. MUIRHEAD.

The system has not been tried over very long distances, but up to 60 or 100 miles it has shown its excellence in many practical and searching tests. A coherer is used, and whilst for long-distance work other forms of receiver may be better, a coherer has the great advantage that it can be used with a printer to give a printed record, which is not the case with receivers employing a telephone.

Referring briefly to the special characteristics of the system, they are: (1) A coherer which is extremely sensitive and constant in action, requires no tapping or decohering, and very little, if any, alteration for long and short distances. (2) The elimination of the relay and the use of the siphon recorder, with consequent diminution of complication, increased speed of working, and the use of less power. (3) And subordinate to the others, the use of a simple and effective form of interrupter by which the frequency can be

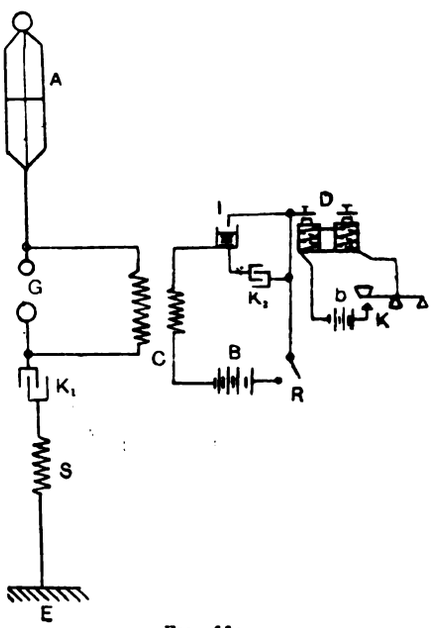



FIG. 44A.

varied at will by merely turning a screw. This is likely to prove of great importance in the future if certain methods of tuning reach the importance we anticipate. (4) The provision of an automatic transmitting arrangement by which even the unskilled may send perfectly clear and well-spaced messages. Referring more fully to these in turn, we first notice:

*The Transmitting Circuit.*—The arrangement of this circuit is shown diagrammatically in Fig. 44A, where A is the aerial with wire-cage capacity, which can readily be varied by merely pulling a rope reaching to the ground. G is the spark-gap, having at its lower extremity the capacity, $K_1$, inductance coil, S, and earth capacity, E. C is a 10in. spark induction coil of special construction, the primary of which has the sending battery, B, in its circuit, the primary switch, R, the capacity, $K_2$, and the interrupter, I, actuated by the "buzzer," D (consisting in effect of two Post Office sounders working reciprocally). There is also the sending key, K, and the local battery, *b*, which usually consists of a box of secondary cells. It will be noticed that the key only

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breaks the circuit of the *local* battery which is weak, hence the special form of key required in many other systems where heavy-current circuits have to be opened is not here necessary. The receiving circuit is shown in Fig. 44B, which will be readily understood from the references given. As shown, the arrangement is that used when the station is

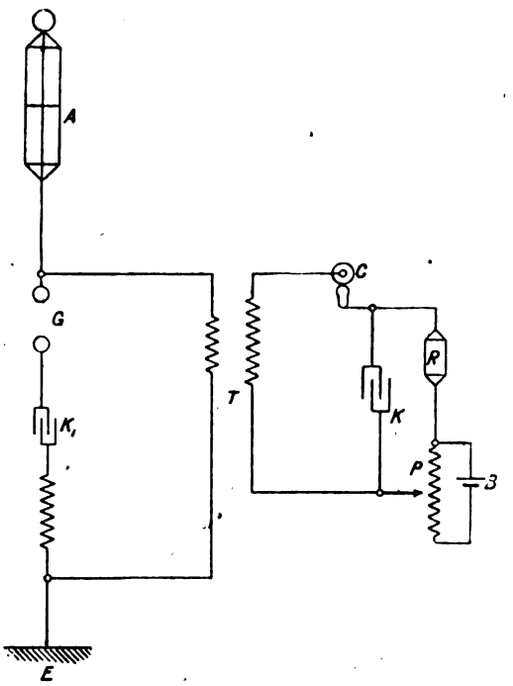


FIG. 44B.—A, Aerial; E, Earth Capacity; G, Spark-gap; T, Transformer; C, Coherer; K, Condenser; R, Recorder; P, Potentiometer; B, Battery.

"open"—that is, not tuned; but tuning has been brought to considerable perfection by the inventors, many of the methods of securing syntony now in use being described in Dr. Lodge's patents.

Referring to these items again more minutely and in the reverse order, the key does not call for any remark, but the interrupter is very important. It is shown in Fig. 45, and consists of a bent arm of aluminium with the vertical sharpened end of copper dipping into mercury, being alternately lifted and depressed by the action of an electromagnet, shown in the centre of the figure, controlled in turn by the buzzer—consisting of two Post Office sounders—

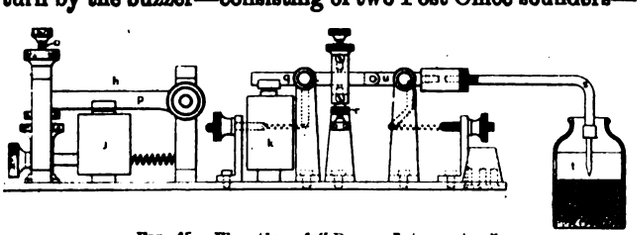

FIG. 45.—Elevation of "Buzzer Interrupter."

which, of course, cost little and remain for a long time in good order. The action will be understood from an examination of the figure. The vibrator, *t*, is shown lifted out of the mercury, which is covered with oil. When the current passes, it energises the electromagnet, *k*, attracting the arm, *q*, which, being pulled down, depresses *t*, owing to the hinge at *u*. As soon as *t* makes contact with the mercury, the circuit through electromagnets, *j*, is completed, and *p* is pulled down, breaking the former circuit, when the point, *t*, is lifted out of the mercury by the spring. This action takes place with great rapidity, a wide variation of frequency being possible. Adjustment of the speed of interrupter can be made, mainly by the milled screw to the left of *j*, and also by the other similar screws, near *k* and *s*. This can be effected whilst a message is being transmitted if necessary. A photo of the actual apparatus is shown in Fig. 46; the sparking apparatus is shown in Fig. 47, and it will be noticed that knobs or discs are not used, but simply two cylindric brass pillars with rounded ends.

The automatic transmitter is a very ingenious piece of apparatus, which is intended for use where the station is not under skilled supervision. As the system is one likely to come largely into private use, this is an important matter. A novice in sending a message according to the Morse dot-and-dash alphabet finds great difficulty in *spacing*. He may very slowly pick out his letters correctly—so many dots, then a dash, and so on—but the spacing gives great trouble, and if wrongly done spoils the message.

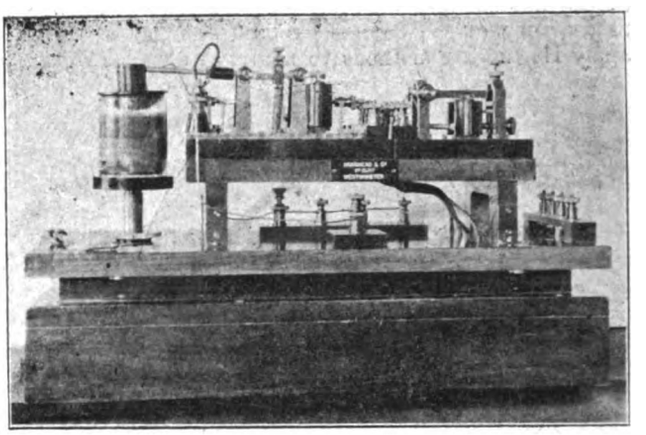

FIG. 46.—"Buzzer" Interrupter.

By means of the automatic transmitter, shown in Fig. 48, this difficulty is completely obviated. The sender sits down in front of the apparatus, which is provided with little vertical buffers, on which he impresses his message by means of blows. There are three little buffers shown to

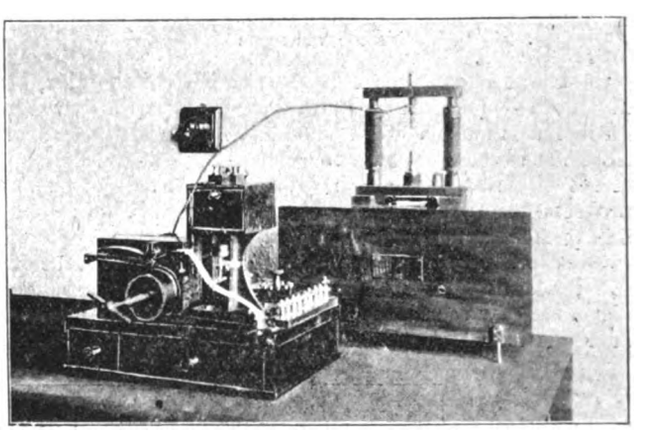

FIG. 47.—Receiving Apparatus with Siphon Recorder.

the right—the centre one giving the punched spacing for moving the strip, the left the dots, and the right the dashes. Seated in front of this apparatus, with a little hammer in each hand, or with the fingers merely, he spells out his message—dot, dot, dash, dot, etc.—by blows

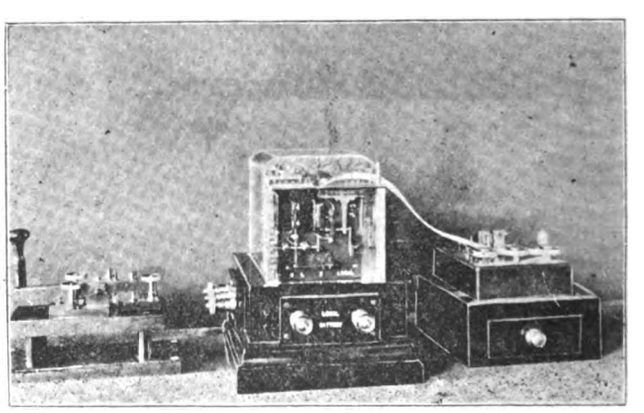

FIG. 48.—Automatic Puncher, Transmitter, and Key.

on the little buffers, paying no attention to spacing at all; the apparatus does this for him, and the message comes out punched on a moving strip of paper with perfect spacing. He has only now to lead the punched ribbon into the machine shown in the centre, and having closed his transmitting switch, sit down and watch the scintillations of the sparking apparatus as his message is sent automatically

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with a precision that no operator could exceed. A similar apparatus is used in cable work.

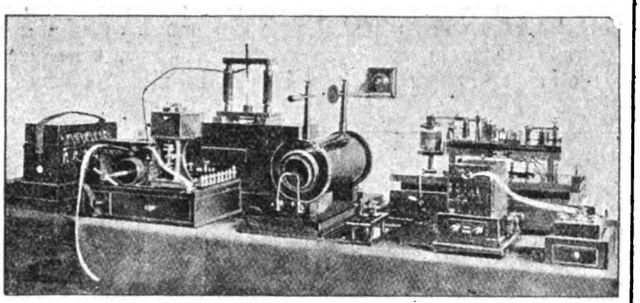


Fig. 49.—Complete Station Outfit (Sending and Receiving) Lodge-Muirhead System.

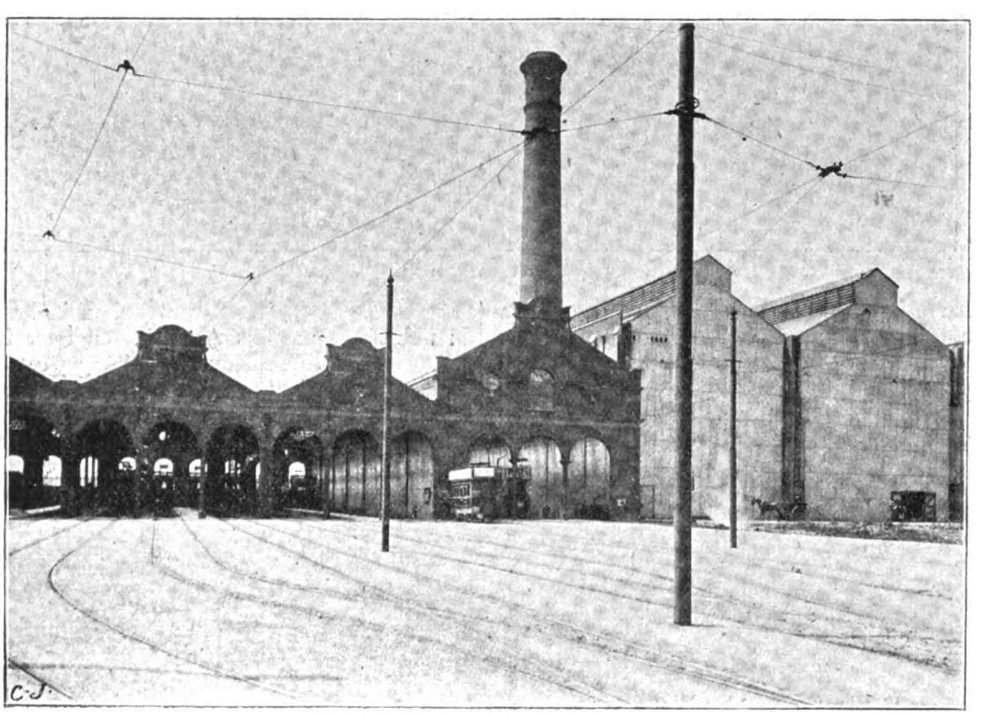
*Receiving Circuit.*—The circuit arrangements at the receiving station have already been referred to. A complete station outfit is shown in Fig. 49. By changing a plug over from the sending apparatus to the receiving portion, the operator joins the aerial to one terminal of the primary of the transformer, T (Fig. 44B), the other being connected to earth or the earth capacity, E. The secondary of the transformer is connected to the steel disc of the coherer, C, the mercury of the coherer being joined to the siphon recorder, R. The coherer has already been fully described. Shunted across the terminals of the recorder and battery is the capacity, K. The recorder having high inductance, the extra oscillations go by the capacity, and not through the recorder. The potentiometer to regulate the potential at the coherer terminals, and the battery B, are also shown. This arrangement is that adopted when the station is not tuned. The putting of the plug into the position for *sending* a message automatically short-circuits the coherer, so that it is not necessary to shut it up in a metal box in order that it may be uninfluenced by the sparks of the transmitting apparatus. When *receiving*, the plug is placed as shown in Fig. 49, where the moving ribbon is seen on which the message received is recorded. The ribbon moves by clockwork, and the siphon of the recorder squirts a tiny stream of ink on it, the undulations of the line thus traced giving the message. The siphon is a tiny tube of glass which is attached to the moving coil of a sensitive D'Arsonval galvanometer. The motion of this coil can also be made to close the circuit of a call-bell, so that the bell warns the attendant in charge of the station to be ready to receive a message. As, however, the message is printed, it can be read afterwards, even if the attendant be not present during the whole time of its reception.

Nothing that we have seen in successful use in wireless work can exceed in compactness, excellence of finish, and reliability in working of the apparatus of this system, the cost being comparatively low. The power required for distances up to 100 miles is usually obtained from three 30 ampere-hour boxes of secondary cells. They are readily recharged (if no other means be at hand) by a small dynamo driven by a tiny oil-engine kept in a hut adjoining the signalling station. A 150ft. mast with wire-cage capacity was formerly used for distances up to 100 miles. In recent experiments with aerials having several wires in parallel the height has been reduced to about 50ft. The term earth capacity has been used in the foregoing to designate the lower extremity of the spark circuit. It should be understood that in this system the earth is not used directly, as a rule. A capacity, such as a plate of metal laid on the earth, or the iron roof of a hut, is used instead. This gives a radiating system more in accordance with Hertz's original arrangement, and less subject to atmospheric influences than that in which the aerial is earthed. Recent experiments between Holyhead (Wales) and Howth in Ireland showed that the system worked perfectly over that distance, a 3in. spark being sufficient. In fact, the attendant had no more difficulty in reading the messages than in the case of those received at Elmer's End from a distance of eight miles with intervening hills; nor did the spark require to be much longer The extreme sensitiveness of the coherer and siphon recorder is such that any defect of the spark apparatus, such as the collection of dust or dirt, is at once evident to the receiver, and a message is sent back to warn the sender of the defect. The word "system"—telegraphed wirelessly and printed by the recorder—is photographed in Fig. 50, the second letter "s" having been badly sent. The

Fig. 50.—Tape Message Received by Siphon Recorder, Lodge-Muirhead System.

wavy line is that traced by the recorder; the dashes and dots were inserted afterwards by hand as explanatory of the siphon's record.

*(To be continued.)*



Electricity Works and Car Shed, Newport.

## NEWPORT ELECTRICITY AND TRAMWAYS DEPARTMENT.*

BY H COLLINGS BISHOP, BOROUGH ELECTRICAL ENGINEER.

The history of the Newport electrical undertakings dates from about 1890, when a provisional order was obtained

* Paper read before a district meeting of the Incorporated Association of Municipal and County Engineers at Newport.

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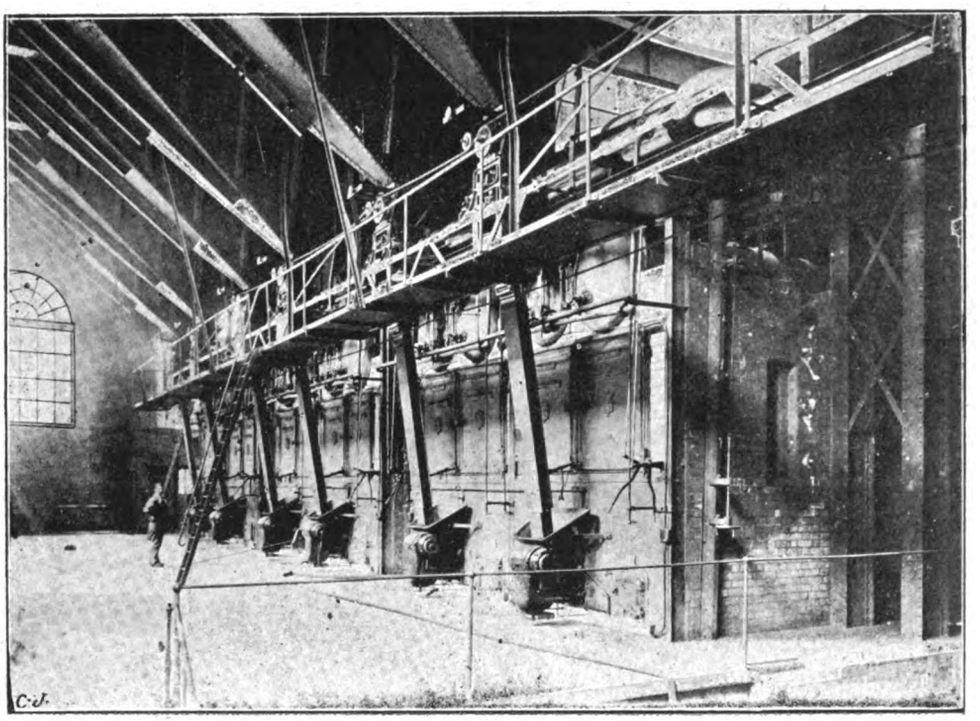
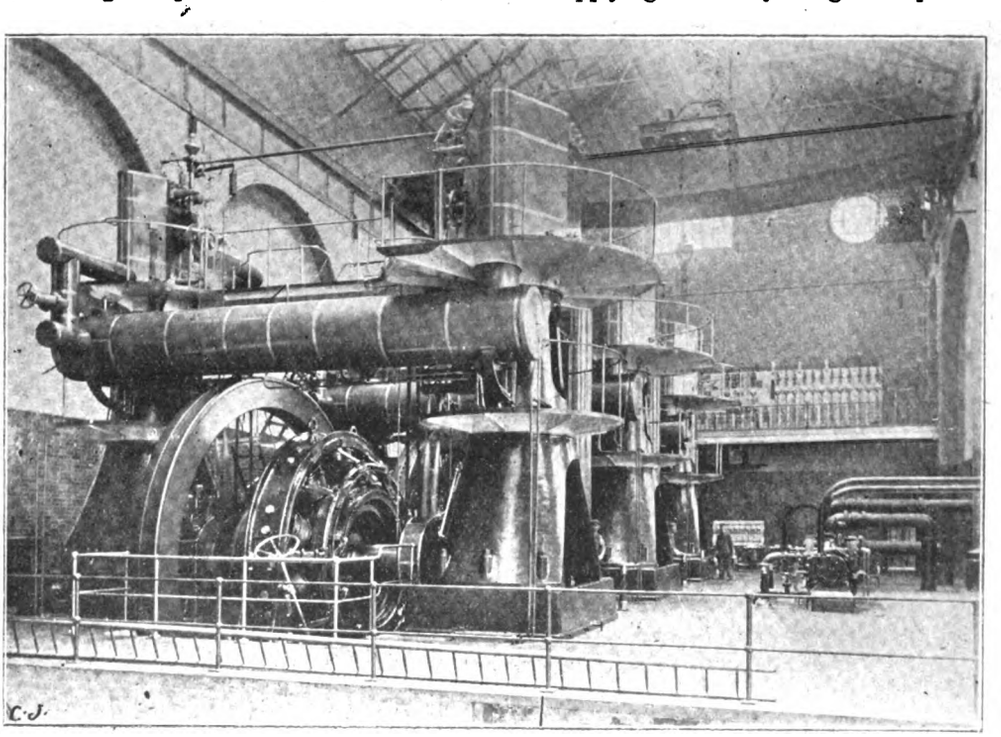
for lighting purposes. The work was not, however, carried out until 1895-1896, when a scheme, designed by Mr. Robert Hammond, was approved, and the works constructed. These works were opened in 1896 by Alderman Sanders, who was then mayor, in conjunction with Alderman John Moses, the chairman of the Electricity Committee. The original works consisted of four Lancashire boilers, of about 200 h.p. capacity each, and four slow-speed horizontal cross-compound engines, made by the Uskside Engineering Company, of Newport. These engines were coupled by ropes to four 75-kw. alternators, by Fowler and Co., Leeds, working at a pressure of 2,000 to 21,000 volts, single phase, with the odd periodicity of 87·5. The system of distribution was by high-tension concentric rubber cables, with house-to-house transformers. In 1898 it was found necessary to extend the works, and on the advice of Mr. Hammond two 300-kw. Fowler steam alternators, direct-driven sets, were installed, together with extra boilers, economisers, and the necessary extensions to the buildings. The plant now stands as described, with a total kilowatt capacity of 1,050. The Corporation then turned its attention to the tramways of the town, and obtained two Acts authorising the purchase of the old horse-car system, and also powers to convert to electric traction, and to extend the lines and build the necessary power-house. This work was taken in hand in 1901, with Mr. H. F. Parshall as consulting engineer for the electrical portion, Mr. R. H. Haynes acting as consulting engineer for the permanent way. The Corporation decided, after careful consideration, to provide in the new works plant for supplying electricity for general power work in Newport, and Mr. Parshall was in 1902 instructed to provide plant for the first requirements of the town. In 1902, Mr. Copland, the then borough electrical engineer, resigned his position in order to take up a private practice, and the Corporation, after advertising, appointed Mr. H. Collings Bishop, M.I.E.E., to the combined posts of borough electrical engineer and tramways manager, he taking up his



Boiler House, Newport Electricity Works.



Engine Room, Newport Electricity Works.

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duties on Aug. 1, 1902. The tramways were started for public purposes on April 9, 1903, and power was also supplied to private consumers at the same time. Since that time the progress of the departments has been rapid, and it has already become necessary to consider further extensions.

The new power station consists of the following plant: three vertical slow-speed, Corliss valve, cross-compound engines, by Markham, of Chesterfield, coupled direct to three 500-kw. generators, by Witting Bros., of London, the speed being 90 revolutions per minute; one Worthington barometric condenser, with cooling towers capable of dealing with 30,000lb. steam per hour; switchboards; and an overhead electric travelling crane of 25 tons capacity. In the boiler-house there are six Babcock and Wilcox boilers, each capable of supplying 10,000lb. steam per hour. The stoking is by the Underfeed Stoking Company's process, with forced draught. There are two feed pumps of the Hall type, an economiser of 590 tubes, coal bunkers with a capacity of 2,000 tons storage, and a coal conveyor capable of unloading 40 tons coal per hour. The buildings are extremely massive in construction, and are over 90ft. from floor to ridge of the roof. The tramway sheds which adjoin are built for 50 cars, in addition to the necessary repair shed, which is fitted with the necessary tools. The Corporation have at the present time 40 cars, each capable of carrying 55 passengers, the last 10 cars ordered being fitted with air brakes and slipper brakes for use on the Stow-hill route, which will shortly be completed.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

699. Show how to determine the percentage of oil in exhaust steam, samples of steam being taken from the inlet and outlet branches of an exhaust steam oil separator.—C. L. S.

700. In an engine which is governed by a throttle valve, does the loss of pressure in the valve represent a *corresponding* loss of efficiency in the engine? In other words, would the heat generated by the fluid friction in the valve (which heat would presumably be carried forward by the steam) be to any extent converted into useful work in the engine?—J. GRAY.

### ANSWERS.

*Question No.* 692.—For commercial testing, describe what you think the best equipment of a test bed for machines from 20 kw. to 200 kw., so as to procure the greatest facility in laying down, setting, etc. Describe the switching and controlling arrangements.

*Best Answer to No.* 692 (*awarded* 10*s.*).—In the writer's opinion, the best equipment for a test plate such as mentioned would be as follows: One large plate, say 36ft. by 16ft., for the larger machines, and several tables for the smaller machines, depending upon the number of machines to be tested. The large plate would consist of several small plates (see Fig. 1), laid together, levelled up, and then grouted in with concrete; of course they should be laid on a concrete foundation of, say, 3ft. deep. The smaller tables would consist of two machined plates supported on cast-iron stands—one plate would be a fixture, and the other made to slide on V-shaped slides, similar to a planing machine; this would allow of the belt being tightened up when the machine was running, and could be worked by means of a screw and nut. Each plate would be, say, 4ft. square according to requirements, and the general outline would be the same as sketch No. 1, only, of course, smaller. With regard to the larger machines, some of these would be for direct coupling to the engines, and as the enginemaker usually supplies the bed-plate, the machines would have to be mounted on temporary packing for the test. This packing would consist of cast-iron blocks, machined on both sides, and of varying thicknesses; this would allow of them being built up to the desired height. As I suggest that all machines be belt-driven (for reasons which I will give later), it will be necessary to keep a stock of test shafts for machines that are to be direct-coupled to engines, as the shaft supplied

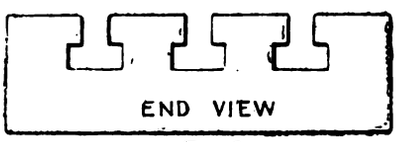


FIG. 1.

with the machine is seldom long enough. These shafts would be pressed in for the test. Of course, in some cases the spider and shaft are built up on the shaft which is to be supplied with the machine; in this case an extension shaft and coupling would have to be used. Of course, pillow blocks, bearings, clamps, bolts, pulleys, etc., would also have to be stocked.

*Electrical Equipment.*—For the large test plate there should be four distribution boxes, one at each corner of the plate. These should be controlled from a main switchboard,

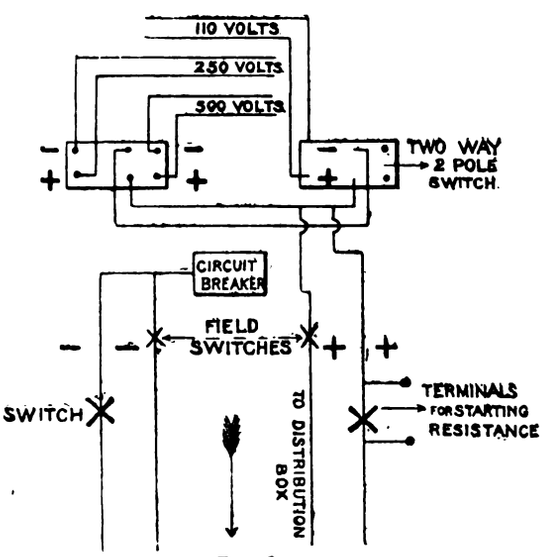


FIG. 2.

fixed in any convenient position. The boxes should be so arranged that any voltage could be obtained from any particular box; this could be done by means of a multiple-way switch. Each distribution box should have a panel on the main board, so that, if necessary, all boxes could be used at once (see Fig 2).

*Dissipating Load.*—There are several ways of doing this, but the two most common methods are by means of either water or wire resistance.

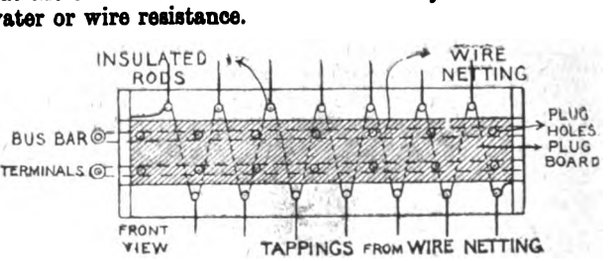


FIG. 3.

*Water Resistance.*—This should be in the form of a large tank or several smaller ones; perhaps the latter is the best, because if several small machines were on test one tank could be used for each machine, and in the case of a large machine they could be put in parallel or series, according to voltage.

*Wire-Netting Resistance.*—A very simple and inexpensive form is as per Fig. 3. This consists of an iron frame sup-

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porting insulated iron rods, which carry wire netting, tappings being taken off from the desired points. The writer does not advise the use of water resistance, as, unless large tanks are used, it nearly always gives trouble, due to the solution boiling.

*Testing Tables for Large Machines.*—These should be portable. A good type would be a square table with main switch, circuit breaker, and ammeter short-circuiting switch mounted, also field switches. As far as possible, machines should be tested on the Hopkinson principle. This should be done as follows: Belt the machine under test (No. 1) to another machine of the same or greater capacity and voltage (No. 2), to these belt a third machine (No. 3), the belt going round the first one. This machine need only be of sufficient capacity to make up the losses; this machine also controls the speed. The method of operation is as follows: Start up machine No. 3, and get No. 1 to the right speed. Then excite Nos. 1 and 2, then parallel them, then, by reducing the field strength on No. 2, a current will circulate; this can be regulated to the desired amount by adjusting the field of No. 2. In the case of a compound machine care should be taken that the compound windings of Nos. 1 and 2 are not opposing the shunt. Of course, on load No. 2 is working as a motor. The machines could be tested rigidly connected together, with the small machine driving on to the coupling, or the losses could be made up electrically, but with the belted method machines of different speeds can be used, and the pulley combination made to suit.

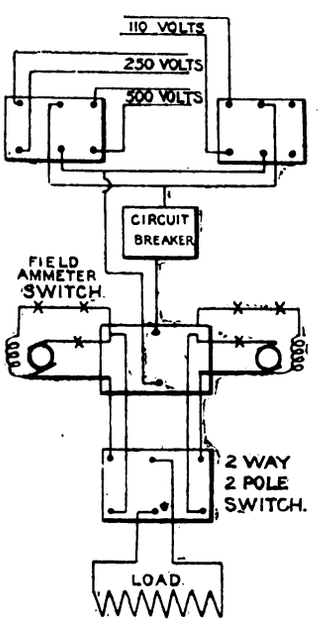
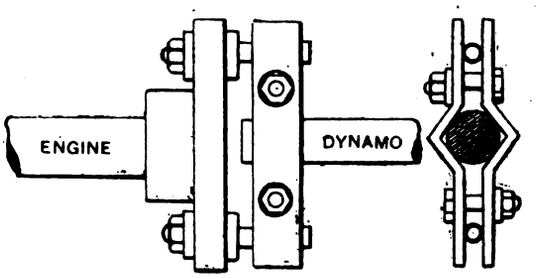



FIG. 4.

With regard to smaller machines, a direct-current machine would be used for loading up the motors. This machine could be run as a motor if the machine under test is a generator. The switchboard should be arranged for this. Connections are given in Fig. 4. The switchboard should be placed near the testing tables, and should be so arranged that any voltage could be obtained on any table. Short-circuiting switches should be provided for all ammeters. For starting up motors the load rack can be used, by placing it across the ammeter terminals. When the motor is up to speed, the short-circuiting switch can be closed; the rack can then be used in the ordinary way for loading up.

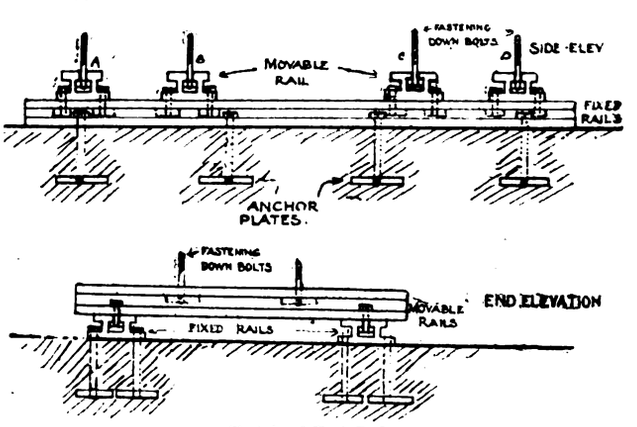
The above boards and tables could be used for measuring iron loss, etc., but as different firms use different methods, it will perhaps be advisable not to touch upon the subject. I have not touched upon the testing of alternating-current machines, as it would take up too much room.—WAVE-FORM.

*Answer to No.* 692 (*awarded* 5*s.*).—Provision should be made for both belt and direct driving. For direct driving, also for coupling machines together for the Hopkinson test, an arrangement such as shown in the figure will be found very suitable. Packing strips will be required for the smaller dynamos in order to bring them up to the correct height. With this method of driving a little want of alignment will not cause much trouble; this will be found an enormous advantage for rapid testing. Generally half the time is taken up with "preparation." A cast-iron disc on the engine shaft carries two driving pins; these pins are in slots, and may be placed at such different distances from the centre as may be found necessary. A pair of clips are bolted to the dynamo shaft and engage with these pins, giving a drive that may be arranged




without any backlash. If belt driving is to be done, a series of rails should be laid down so that the bolts sliding in these rails may be placed to suit any pitch of holding-down holes. A set of pulleys must be at hand, preferably with adjustable bushes to suit shafts of various diameters. With whichever arrangement a good overhead crane is a *sine quâ non*. Endeavour to get the engines govern as closely as possible. Testing is somewhat like chess-playing: only general rules can be given. To obtain data for compounding, etc., a good plan is to have several magnet bobbins wound with a known number of turns. The field can then be separately excited under controllable conditions. Resistances, either liquid or metallic, must be provided for machines running under load. For full-load motor tests, a Prony brake (one of the rope variety will be found most suitable) must be kept in readiness. If alternators are to be tested, non-inductive resistances will be necessary, with suitable measuring instruments. As regards switching and controlling arrangements, the fewer and simpler these are the better. Multiplicity of connections, like multiplicity of tools, stamp the amateur. The test-room should be fitted with a switchboard, and all connections go direct from this in as simple a manner as possible.—M. M.

*Answer to No.* 692 (*awarded* 7*s.* 6*d.*).—To describe fully the equipment for an up-to-date test would take up a great amount of space, so I shall answer "Tester's" question as briefly as possible. In the arrangement given for laying down and setting the machines on the bed-plate, referring to the sketch, A B C D are movable rails, which can be adjusted to suit various sizes of machines. These rails hold the fastening-down bolts for motor, which can be moved to suit the holes for foundation bolts on the machine.




Sketch of Test Bed.

In the case of one machine as motor driving the other as dynamo, the motor may be fixed between plates A and B, and the plates C and D can be moved to suit the belt. Referring to the sketch of connections of test board (which is an existent test board), the circuit, E, goes to the brake dynamo (which is a machine run as either dynamo or motor, and used to put a load on the motor being tested or run a dynamo being tested respectively). Circuit F may

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be connected to any of the circuits, or to any of the tanks, hence its pliability. A and B go to two supplies, either dynamo or town mains. Circuits C and D go to various parts of factory, or, where machines need to be tested, these circuits may be increased to any number by adding terminals to the board and ammeters to suit. The two-way switches on board are to connect it respectively to either of its two ammeters above. Any of the voltmeters, *v*, shown may be connected to any circuit by means of inserting plugs and flexible connections in $v_1$.

In starting up a machine under test a starting resistance may be placed on the board, in which case a circuit breaker will be required in cases of short-circuits, etc., or a motor starter provided with overload release can be used. It is also useful to have a reversing switch on the board, which saves altering connections on the machine when it is worked to run the machine in the reverse direction. In using the ordinary type of brake for finding the brake horse-power, etc., it is necessary to have various sizes of pulleys to fit on the motor shaft (which pulleys should be hollow to allow water to be put in to keep the pulley cool, thus preventing the brake from catching on fine and seizing). Two or three sizes of brakes should be kept for different sizes of machines.

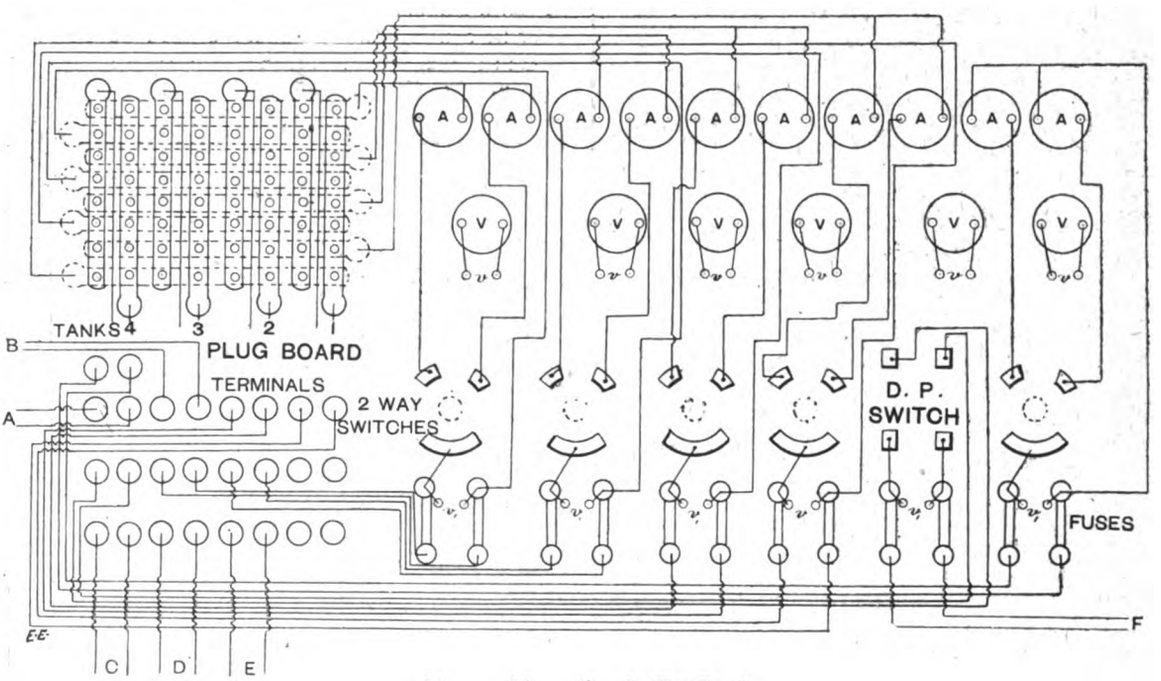


Diagram of Connections for Test Board.

The other apparatus necessary is some form of resistance bridge—such as Wheatstone's—for measuring the resistance of field coils and armature, and a portable testing set for measuring the insulation resistance. Other things necessary are such things as thermometers, speed indicator, etc.—H. A. H.

*Question No.* 693.—What will be the best size of steam generating plant and battery for the electric lighting of a large building whose maximum demand will be about 80 kw.? The maximum demand will last about two hours a day, averaged all the year round. The remainder of the time the demand will not exceed 10 kw., and will average 4 kw. or 5 kw. How would the size of the units proposed be affected if the supply company were used as a stand-by in case of accident?

*Answer to No.* 693 (*awarded 7s. 6d.*).—From the question it appears that the building is a large hotel or similar institution, and its load will vary in the same manner as an ordinary town lighting load. The average duration of the maximum load will not affect the matter much, as it is the maximum duration of the maximum load which puts the greatest strain on the plant, and it is this load which must be provided for. If the supply company's mains are used as a stand-by, it will not affect the size of the units installed, but it will absolutely settle the system and pressure of the private plant, and as the company's system may not be the best to adopt, it is advised that the idea of using their mains as a stand-by be dismissed, and that a self-contained plant designed to suit the conditions be put down. The owners of the building will then be at liberty to adopt the system and pressure best suited to the particular case, and while being able to ensure the continuity of supply by putting down reliable plant, the capital cost and working expenses will be lower than if the installation was designed to conform to the system and pressure in use by the company.

The system recommended is a simple two-wire system at 200 volts, worked in conjunction with a battery and reversible booster. Space is generally a great consideration in the type of building in question, and a cheap and plentiful supply of water for condensing is not often available. It will, therefore, be best to instal water-tube boilers with controllable superheaters, but without economisers; natural draught; high-speed, double-acting, self-lubricating engines run non-condensing, but exhausting through a feed-water heater. In considering the size of units to instal, the best way will be to divide the load in about equal proportions between one steam dynamo and the battery; the plant load factor can then be kept high, and although a large battery is expensive, yet it saves in allowing smaller engines and boilers to be used, and in these engines and boilers being able to work at an economical load all day long. It is also bad policy to instal small batteries. With this arrangement either of the steam sets or the battery may be laid off for inspection, cleaning, or repair without in any way interfering with the supply. Two boilers will be installed, either of which can comfortably manage the full load of one engine and dynamo, two feed-water heaters, one motor-driven pump, two adjustable injectors.

The various units will be best arranged as follows: Two 50-kw. dynamos direct coupled to two compound non-condensing Belliss engines of 80 b.h.p. each; a 1,600-ampere-hour battery, consisting of 95 cells, capable of giving a discharge of 225 amperes for seven hours continuously; a differentially-wound reversible booster taking a current of 225 amperes, and capable of boosting 30 volts either way; two water-tube boilers, giving a minimum evaporation of 3,000lb. of water per hour, delivering steam at 150lb. pressure and superheated 100deg. at the engine stop valve; the motor-driven feed pump; two adjustable injectors; two feed-water heaters, each capable of taking the entire exhaust steam from one engine without causing undue back pressure. The above plant would be reliable, compact, economical, and fairly low in capital cost; the cost for the whole installation, exclusive of buildings, would be about £3,000.

A competent man at a good salary should be engaged to look after the plant, and he would be able, by keeping a steam set running in the daytime for charging, and the battery and a steam set working in parallel on the heavy load, to run the plant with a 30 per cent. load factor in winter and nearly 20 per cent. in summer. The total costs of current generated, including rents, rates, taxes, upkeep,

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fuel, and stores, depreciation, and interest, could be kept well below 1½d. per unit.—W. T. W.

*Answer to No.* 693 (*awarded 7s. 6d.*).—Averaged over the year, the maximum load of about 80 kw. lasts two hours per night, but in December and January its duration will be more like 3½ hours; while we must remember that on festive occasions, or days of very heavy fog, this maximum may last five or six hours, and may have peaks of short duration 25 per cent. higher, or 100 kw., so the plant put in must be liberal enough to look after this. For these reasons it is not wise to arrange for the battery to assist the normal peak load, but the plant should be capable of carrying this comfortably, and at its nominal full rated load, the overload capacity enabling it to bear easily any

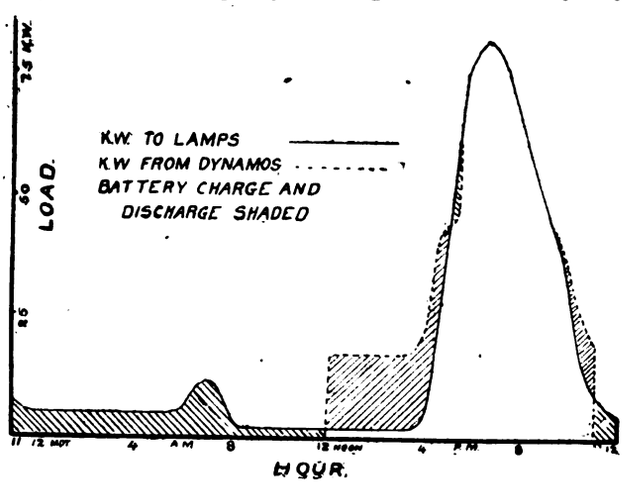


FIG. 1.—Winter Load Curve.

occasional special demand; 80 kw. of plant is required, and the next thing to decide is whether this is to be exclusive or inclusive of "spare"—or, rather, whether we are to obtain our spare from extra steam plant or from the battery. The latter course is not wise, since a defect in one engine, causing a six weeks' overhaul of that set, might throw such severe work on the battery as absolutely to ruin it. Thus we want 80 kw. of plant and also a spare set. The capital cost of small units is so much higher per kilowatt than of large that it is useless to sub-divide the plant too much; while for the sake of spare parts and stores, it is injudicious to have more than one size of unit. Economy in capital and in working costs will be best met by installing three sets rated at *40* kw. each, but they should be capable, by a by-pass valve or otherwise, of giving 55 kw. for one hour, in order to have good margin for occasional peaks, which, if due to fog, will develop very rapidly and without warning.

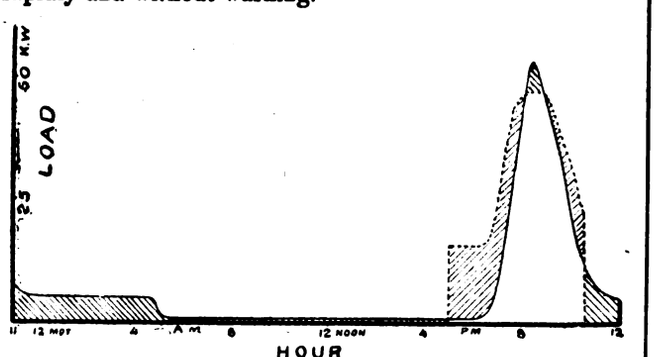


FIG. 2. Summer Load Curve.

To determine the best size of battery, we must examine the load curve and also the method of working the plant, and Figs. 1 and 2 give these respectively for typical winter and summer days. The former must be used for the present purpose, and this shows that about 60 kilowatt-hours are required between 11 p.m., when the engine is shut down, and 12 noon next day, when it is restarted. The life of the battery will be much longer if it is normally worked well within its limits, so that we may allow a 50 per cent. margin, and instal a battery rated at 90 kilowatt-hours capacity on a nine-hour discharge, and able to give 30 kw. for two hours or 45 kw. for one, the safe charging rate being about 15 kw. This will enable us to leave the battery on circuit over night in full confidence that it will be quite able to carry the load until morning, in spite of any unusual occurrence that may throw extra work upon it in the night. This battery would cost about £500, or, say, 10 per cent. of the cost of the whole electrical plant.

As to the working of the plant, not much need be said, as it is indicated on the Figs. 1 and 2, while Tables I. and II. give the same results in another form. It may be noted that on an average winter day two engines will run in parallel from 5.30 p.m. till 9 p m., and a single engine from 12 noon to 5 30, and from 9 p.m. till 11. The output per day of the battery will be 68 Board of Trade units, the input 85, and the efficiency 80 per cent. The total dynamo output per day will be 438 Board of Trade units, or an average load per engine during running hours of 30 kw. During the summer months one engine, with the help of the battery, will comfortably carry the peak, and the engine will run only from 5 p.m. to 10.30. Its output will be 172 Board of Trade units, or an average load of 31 kw. The battery will discharge 48 Board of Trade units per day, and with an efficiency of 80 per cent. will need 60 Board of Trade units while charging. It will be observed that both summer and winter the battery will be used well below its capacity, but it should always be examined first thing in the morning, to make sure that it had not been called upon in the night for any abnormal output.

TABLE I.—Average Winter Day.

| Time. | Load | | Dynamos. | | Battery. Charge. | | Battery. Discharge. | |
|---|---|---|---|---|---|---|---|---|
| | Av. kw. | B.T.U | Av. kw. | B.T.U | Kw | B.T.U | Kw. | B.T.U |
| 11 p m. to 6 a.m. | 5 | 35 | — | — | — | — | 5 | 35 |
| 6 a.m. ,, 8 ,, | 10 | 20 | — | — | — | — | 10 | 20 |
| 8 ,, ,, 12 noon. | 2 | 8 | — | — | — | — | 2 | 8 |
| 12 noon ,, 4 p.m. | 2 | 8 | 17 | 68 | 15 | 60 | — | — |
| 4 p.m. ,, 5 ,, | 20 | 20 | 35 | 35 | 15 | 15 | — | — |
| 5 ,, ,, 5 30 ,, | 50 | 25 | 40 | 20 | — | — | 10 | 5 |
| 5.30 ,, ,, 6 ,, | 70 | 35 | 70 | 35 | — | — | — | — |
| 6 ,, ,, 7 ,, | 80 | 80 | 80 | 80 | — | — | — | — |
| 7 ,, ,, 8 ,, | 75 | 75 | 75 | 75 | — | — | — | — |
| 8 ,, ,, 9 ,, | 60 | 60 | 60 | 60 | — | — | — | — |
| 9 ,, ,, 10 ,, | 40 | 40 | 40 | 40 | — | — | — | — |
| 10 ,, ,, 11 ,, | 15 | 15 | 25 | 25 | 10 | 10 | — | — |
| Total B.T.U. ..... | — | 421 | — | 438 | — | 85 | — | 68 |

TABLE II.—Average Summer Day.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 p.m. to 4 a.m. | 5 | 25 | — | — | — | — | 5 | 25 |
| 4 a.m. to 5 p.m. | 1 | 13 | — | — | — | — | 1 | 13 |
| 5 p.m. ,, 7 ,, | 1 | 2 | 16 | 32 | 15 | 30 | — | — |
| 7 ,, ,, 8 ,, | 20 | 20 | 35 | 35 | 15 | 15 | — | — |
| 8 ,, ,, 9 ,, | 50 | 50 | 45 | 45 | — | — | 5 | 5 |
| 9 ,, ,, 10 ,, | 35 | 35 | 45 | 45 | 10 | 10 | — | — |
| 10 ,, ,, 10.30 ,, | 20 | 10 | 30 | 15 | 10 | 5 | — | — |
| 10.30 ,, ,, 11 ,, | 10 | 5 | — | — | — | — | 10 | 5 |
| Total B.T.U. ..... | — | 160 | — | 172 | — | 60 | — | 48 |

The further question as to the modification in the plant if a company's supply mains are available as stand-by, cannot be answered without a full knowledge of the company's tariff and conditions of supply. They will probably require a considerable guarantee before laying a connection to convey 80 kw. at the time of their own peak, seeing that they are to be used but as a stand-by: and in this case it may very likely be satisfactory to instal two 40-kw. sets with neither spare nor battery. Supply would be taken from the mains from 10 p.m. to 5 p m. the next day, the private plant being run simply for the evening load. The wages for attendance would thus be reduced to a minimum, and this is the heavy item with an isolated plant of this size; while, seeing that the supply company would very seldom, if ever, be called on to supply current at the time of their heavy load, they would probably agree to charge "power" rates for all current consumed, subject to a special payment whenever their mains were used at the time of their peak. If, on the other hand, the tariff is a flat one, and no special terms are imposed in this instance, then it may be best to put in the same 90 kilowatt-hour battery, but a steam plant of only two sets, and these 30 kw. each. These, with their overload capacity, would see the normal 80-kw. peak through comfortably, especially as the battery would be left "floating" to assist, if need be, and the com-

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pany's mains would only be brought into requisition on special festive occasions, on very foggy days, or when one steam set was temporarily disabled. There are, however, very few supply companies who would allow their mains to be used in this latter manner, and without exact knowledge of the company's terms it is useless to pursue the question any further.—E. C.

*Answer to No.* 693 (*awarded* 5*s.*).—The conditions given are not sufficiently explicit for a definite answer, but should the assumptions made in the following answer not be approximately correct, the same method may be adopted for determining the actual sizes of plant required by inserting the correct figures in place of those assumed. As it is necessary to provide plant of sufficient capacity to maintain supply during the longest winter load, in the following calculation the requirements of the longest load only are considered. In the question it is stated that the maximum demand is 80 kw., which will last about two hours a day, averaged all the year round. It is probable, therefore, that in the middle of winter the maximum load will last for about three or four hours, or, say 3½ hours per day. As the load during the remainder of the day is very small (5 kw., say), and can be taken by the battery, it will only be necessary to run the steam plant for one shift per day—viz., during the heavy load, and for charging the battery. On the above basis we might assume a working day of 10½ hours, during which time the steam plant is running continuously at full load. This will, perhaps, necessitate the fire being lighted and the boiler got up to pressure before the regular man commences his shift. For seven hours of this time the steam plant will supply the light required and will charge the battery, and for the remaining 3½ hours it will supply the heavy lighting load in conjunction with the battery.

Let W = required full-load capacity of steam plant in kilowatts.

1. Consider the seven hours during which the battery is being charged, and we have total output = lighting + battery charge, or 7 W = 7 × 5 + battery charge; or, transposing, we get battery charge = 7 W − 35 kilowatt-hours. Assuming energy efficiency of battery is 75 per cent., we have total battery discharge = 0·75 (7 W − 35) kilowatt-hours, and this is available during the remaining 17 hours of the day.

2. Consider the 17 hours during which the battery is discharging. For 3½ hours the battery will assist the steam plant, and for 13½ hours it will have to supply all the lighting at the rate of five units an hour, or a total of 67·5 units.

3. Now, the total battery discharge is made up of the discharge during the 3½ hours of maximum load and during the 13½ hours when the steam plant is not working. Therefore, from 1 and 2 above, we have 0·75 (7 W − 35) = discharge on maximum load + 67·5; or, transposing, we get battery discharge on maximum load = 0·75 (7 W − 35) − 67·5 = 5·25 W − 93·75 kilowatt-hours.

4. Since W is the full load capacity of the steam plant, we have steam plant output on maximum load = 3·5 W kilowatt-hours. Now, the total output during the maximum demand period is 80 × 3·5 = 280 kilowatt-hours, and this is equivalent to the sum of the battery discharge and steam plant output. Therefore, from 3 and 4, we obtain the equation 5·25 W − 93·75 + 3·5 W = 280; or transposing, we get 8·75 W = 373·75, or W = 42·71 kw. That is, the steam plant will require a full-load capacity of 42·7 kw., and from 1 it will be seen that the battery capacity will be 0·75 (7 W − 35), or 0·75 (7 × 42·71 − 35), or 198 kilowatt hours, and the battery will require to be capable of discharging at the rate of (80 − 42·7)—*i.e.*, 37·3 kw. for 3½ hours, so as to supply the maximum demand of 80 kw. in conjunction with the steam plant.

If the installation has to be complete in itself and reasonably immune from breakdown, it seems that the most economical scheme would be to provide two boilers and two steam sets of about 43 kw. each, or perhaps of about 36 kw. each, with an overload capacity of 20 per cent., and a battery of 200 kilowatt-hours capacity, capable of discharging at the rate of 37 kw. for 3½ hours. Under ordinary conditions the heavy load would be taken by the two steam sets, and the battery would only be used when the steam plant was not running, resulting in very little loss in the battery. Should one steam set or boiler break down or one boiler be down for cleaning, the other set in conjunction with the battery would still be able to cope with the whole of the load as shown above. On the other hand, if the supply company were used as a stand-by in case of accident, two boilers (to permit of one being cleaned), one steam set and battery, all of the same capacity estimated above would suffice, as under ordinary conditions the plant would be complete in itself, but should a breakdown occur supply could be taken from the company until the plant was again in proper working order. It will thus be seen that the saving effected in this case would be to the extent of one steam set.

In conclusion, the writer is of the opinion that the above sizes of steam plant and battery would give the best results, both as regards capital and revenue expenditure and as regards reliability, as the steam plant would always be running at full load or moderate overload, and consequently most economically, and in no case would it be necessary to run for more than a 10½ hour shift per day (in the summer the shift would be shorter), with a resultant minimum of labour.—H. A. N.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

In order to remind our readers of the ninth annual convention of this association, which will be held from June 29 to July 2, we reprint the programme which appeared in our issue of April 22, with a few additions which have since been arranged.

On the first day, Wednesday, June 29, the meeting will be at Derby, and will be commenced by the reception of the members by the Mayor. Mr. T. P. Wilmshurst will then give his presidential address, which will be followed by a paper by Mr. C. Shawfield, of Wolverhampton, on "The Commercial Practicability of Electric Traction by Surface Contacts"; and a paper on "The Organisation and Management of a Central-Station Meter Department," by Mr. A. J. Cridge, of Sheffield. The afternoon will be devoted to an excursion to Chatsworth and Haddon, by invitation of the Mayor and Corporation. The electricity works and the Osmaston-road car-shed of the Derby Corporation will be open for inspection during the convention.

The meeting on Thursday, June 30, will be at Nottingham, where, after a reception by the Mayor, two papers will be read and discussed. The subjects of these are as follows: "Polyphase Sub-Stations, their Equipment and Working," by Mr. S. L. Pearce, of Manchester; "Some Notes on the Bristol Electricity Works Fire," by Mr. H. Faraday Proctor, of Bristol. In the afternoon visits are arranged to the electricity and other works, and the annual dinner will be held that evening in the Mechanics' Institute at Nottingham.

On Friday, July 1, the meeting will be at Sheffield, where, after a reception by the Lord Mayor, the following two papers will be read and discussed: "Boiler-House Economies," by Mr. R. S. Downe, of Southport, and "The Financial Position of Municipal Electrical Undertakings," by Councillor Blakeway, of Southampton. The afternoon will be devoted to visits to Messrs. Hadfield's steelworks at Tinsley, and to the Corporation's tramway station, Kelham Island, and electricity works at Neepsend.

The annual general business meeting, for members only, will be held at Derby on Saturday, July 2.

All communications respecting the convention should be addressed to the secretary, Mr. C. McArthur Butler, Staple-inn-buildings, Holborn, London, W.C.

## APPOINTMENTS VACANT.

**Switchboard Attendant,** Swindon Corporation. Wages £1. 7s. 6d. per week, increasing £6. 10s. per annum for the first two years. Applications by July 5. See advertisement in last issue.

**Clerks,** Swindon. Salary, £91 and £78 per annum, increasing by £6. 10s. per annum. Applications by June 29. See advertisement in last issue.

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THE

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## THE BERMONDSEY CLAUSE.

From the proceedings of the Select Committee of the House of Lords presided over by the Duke of Northumberland, when considering electric lighting orders applied for by local authorities this session, we see every hope that the Bermondsey clause is dying. One of our contemporaries devoted to the gas interests will have much to say on the subject, as it did when the clause was first introduced, but on this occasion the jubilation will be less. We would remind it of a verse in one of Mr. Rudyard Kipling's Eastern poems, which runs as follows:

> And the end of the fight is a tombstone white,
> With the name of the late deceased,
> And the epitaph drear, "A fool lies here
> Who tried to hustle the East."

This Bermondsey clause was ably engineered by one of the London gas companies with the avowed object of protecting the people against the actions of the members they elect to the Borough Council. The hand inside the velvet glove was intended to crush the life out of a young undertaking, by compelling it to charge high prices during the first few years. That this clause has this effect we have repeatedly shown, and it is worth while to reproduce it in full: "The undertakers shall once in every year, after the first year's working of the undertaking, cause to be laid before them a statement and balance-sheet of the accounts of the undertaking drawn up in accordance with the form of accounts prescribed by the Board of Trade for a local authority under the Electric Lighting Acts, 1882 to 1888, and the undertakers shall thereupon fix annually the charges to be made for the supply of energy in the then ensuing year at such rates not exceeding the maximum rates specified in the order, so that, as far as is reasonably practicable, the revenue for the year shall not be less than the expenditure."

This clause has been opposed persistently by the Board of Trade, but it has been granted by certain authorities in order to avoid the opposition of the gas interests. Mr. T. H. W. Pelham, one of the assistant secretaries of the Board of Trade, gave evidence on this subject before the committee on Monday last which was most valuable. He explained that a flourishing undertaking, when applying for provisional orders for the extension of its areas, did not object to inserting the clause. We see that the Huddersfield Corporation have done this this year when applying for powers to supply in the area covered by the Longwood Gas Company. In such a case the clause is not so onerous, but Mr. Pelham showed that with new undertakings the clause was not calculated to accomplish the object in view. The Board of Trade considered that, if an electrical undertaking showed a loss, probably the best way of rectifying that loss would be to reduce the price, which would be impossible under the obligations of the Bermondsey clause. As the witness further showed, a local authority must be prepared to face a loss during the first two, three, or four years in order that it may eventually gain. Also the Acts provided that any profit above 5 per cent. must go to the relief of the rate. If the ratepayers were to benefit by the profits, it did not seem unfair that they should incur some risk of loss. Mr. Pelham went on to show that the clause was not clear in its meaning, and that suggested amendments were also objectionable. The committee deliberated on the subject for some time, and then the Chairman made the following statement, for the report of which we are indebted to the *Times*: "The committee find that the preamble of all the Bills is proved. With regard to the question raised under the 'Bermondsey' clause, the committee would be obliged to counsel if they would bring up a clause carrying out the

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following provisions: (1) the accounts of the undertakers shall be published annually in the form prescribed by the Board of Trade under the statute; (2) the local authority, at the end of five years after the undertakers supply energy in the case of a new, and of three years in the case of an existing, undertaking, and thenceforward triennially, shall, so far as is reasonably possible, revise its rates so that no loss shall be incurred by the ratepayers on the undertaking; (3) nothing shall prevent a local authority from entering into a contract to supply electrical energy on special terms, but the rates charged in future contracts shall be either subject to revision at the triennial revision or rise and fall (but not, excepting by consent, below any minimum named in the contract) *pari passu* with the general electric lighting rates fixed at the triennial revision, and the promoters in each case will decide which of these alternatives they prefer to be inserted in their order. It is not intended to prevent or discourage a more frequent revision of the rates, other than the contract rates, should the local authority desire to enter upon. The committee do not want the clause so drawn that it can possibly be so interpreted as to prevent a revision annually or bi-annually if the municipality prefer to make it. This clause, when drawn and passed by the committee, will be inserted in all the electric lighting orders in regard to which the point has been raised in substitution for the 'Bermondsey' clause." The draft of this clause is being prepared by Sir R. Littler, K.C., and will, without doubt, be a great boon to the industry. We shall be pleased to receive contributions for a tombstone to be erected in the board-room of a London gas company in memory of the Bermondsey clause.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### HOPKINSON TEST OF THREE-PHASE MOTORS.

SIR,—In my article on the above subject in your last week's issue, a slight oversight has been made in calculating efficiency of the motors in those tests in which the rotor starters were not shorted. The motor losses have been divided between the motors in proportion to their slips. This is quite correct when the motor starters are shorted, as then the slip is a measure of the load. When, however, the rotor starter is not shorted, this is not the case. The result in tests 7 and 10, Table IV., has been that the losses are improperly divided, making one machine to appear of very high efficiency (over 93 per cent) and the other of too low an efficiency.

Another point in reference to the belt losses is of interest. The losses due to the belt are (1) extra bearing friction, (2) power absorbed in driving and bending the belt, (3) power spent in heating the pulleys owing to belt slip. Losses (1) and (2) are fairly well measured by the last tests in the table, though (1) slightly increased with the load. But loss (3) is quite additional to losses (1) and (2). It can be accurately determined by measuring with a steel tape the relative circumferences of the two pulleys, and working out the belt slip in the way stated in the article. If the belt slip is 1 per cent., then that per cent. of the power transmitted by the belt is wasted in heating the pulleys, and to allow for this the efficiencies of the motors as calculated would have to be increased by approximately $\frac{1}{2}$ per cent. Unfortunately, Dr. Sumpner and I did not realise till after the tests were all over that this measurement was important. The pulleys were only measured roughly for the purpose of seeing whether they would be suitable for the load we required. I think one of the most interesting results of the tests is that the method described is capable, among other things, of determining accurately the percentage slip of belts used for driving. I have to thank Dr. Sumpner for calling my attention to the above.—

Yours, etc., R. W. WEEKES.

## REVIEWS.

**Testing of Electromagnetic Machinery.** SWENSON AND FRANKENFIELD. Macmillan. 12s. 6d. net.

From time to time, during recent years, we have had preached to us the superiority of American methods—both of education and business—over those current in this somnolent England of ours, with such persistence that we now practically take it for granted, consequently we felt, on taking up the book before us, that we ought to find the superiority referred to exemplified, in the all-important department of testing electrical machinery. Our expectation almost reached certainty when we read in the preface that the book was the outcome of 10 years' experience, and, moreover, was "based on the theory of education."

It was something of a shock, therefore, to find the nomenclature of the book anything but scientific. For instance, the same letter stands for several entirely different quantities; the same quantity is represented by different letters. The inconsistency is the more noticeable when the nomenclature is given, as it is, in tabular form in the very forefront of the book.

Whilst on this question of nomenclature, we should like to enter a protest against the use of German capitals to represent vector quantities; they are difficult to read and worse to write. Why not follow the practice—now being generally adopted in this country and initiated many years ago by Mr. Oliver Heaviside—of using Clarendon type? The result would, we feel sure, be to increase the efficiency of the book, and to make the importance of vector quantities patent to the dullest student.

Whilst the experiments are each of them self-contained, and rightly so, they are not, in our opinion, arranged in such a natural and logical sequence as to be of the highest educative value. We are introduced to the subject-matter with a description of the various kinds of instruments the student is likely to meet with in his work (curiously enough, *the* instrument useful above all others in connection with the testing of electromagnetic apparatus—viz., the potentiometer—is not described), and the natural sequence would be, to follow this with experiments in their calibration. Instead, the calibration experiments are scattered about, almost as though they had been forgotten when planning the book.

In our experience nothing conduces so much to getting at the heart of a matter—and this is the *raison d'être* of testing—as planning your tests in a strictly logical order and carrying them out in that order. How much more the losses due to hysteresis in iron would be realised by a student, if the experiments on these had been immediately followed by efficiency tests; and yet between the hysteresis experiments and the efficiency tests we have no less than 53 experiments intervening—quite enough to have made the student forget all about hysteresis and its results.

We feel quite sorry for the student who undertakes to determine the windings and connexions of a dynamo (say a 500-kw.) by measuring their resistances, and we sincerely hope we may never have to show anyone how to conduct experiment No. 3.

In the experiments given for the determination of the constant of a ballistic galvanometer, no warning is given that the deflection per coulomb, obtained by calibrating with a standard condenser, will not be the same as when calibrated with a standard coil, because in the latter case, owing to the test coil being permanently connected to the galvanometer, a constant damping is obtained, which, of course, is not the case with a condenser, unless a shunt of value equivalent to the test coil is introduced.

The classic methods of testing iron are adequately dealt with, although we would suggest to the authors the inclusion in a new edition, of the elegant method adopted by Prof. Ewing of eliminating the effects of a yoke and bad joints. This method was published in a paper read before the Institution of Civil Engineers a few years ago.

The fundamental equation given in experiment 25 for the determination of the air-gap of a dynamo from its magnetising curve appears to be wrong; it is given as

$$\phi = H A = \frac{4\pi N I A}{20 l},$$

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This should be

$$\phi = H\,A = \frac{4\pi N I A}{2 l}.$$

The resulting equation for $l$ is consequently wrong.

The method of determining the number of field turns on a dynamo, as given in experiment 41, is novel, and should prove useful not only where the information is not obtainable by another means, but as a check during construction.

Many useful methods of testing dynamos are given that are more or less standard. A method of testing circuit breakers is also given which appears to us deficient in one important particular—viz, that no attempt is made, nor indication given of its necessity, to determine the maximum value the current may rise to, during a short-circuit before the breaker could possibly open—a most important consideration. Hopkinson has shown that even with an ordinary 200-ampere circuit breaker, the current may rise to over 1,000 amperes before the switch opens.

In an appendix is given the report of the committee on standardisation appointed by the American Institution of Electrical Engineers, and to anyone who is fond of puzzles we would recommend the unravelling of Clause 52 as a piece of mental gymnastics.

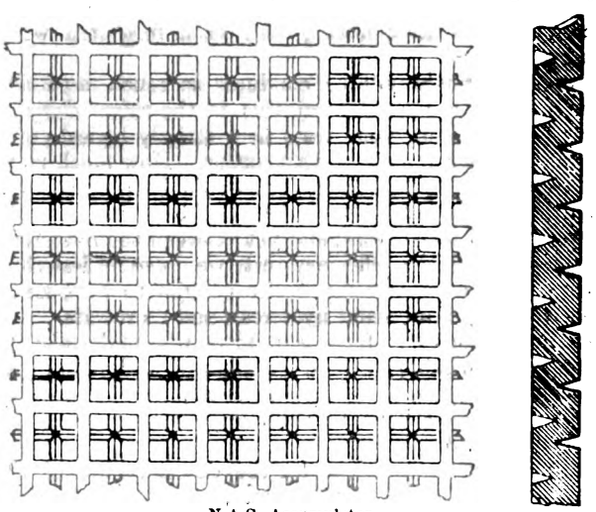
The book is well and clearly printed, and the line diagrams are good, but the process blocks, to say the least, are indifferent. For example, Fig. 16B is certainly not such as we habitually look for in any book bearing Macmillan's imprint.

As a handbook for students with a tutor at hand it will be useful, but as a book of reference for engineers, we are afraid its usefulness is strictly limited. G. W. G.

## TRADE NOTICES AND NOVELTIES.

### N.A.C. Accumulators.

The Northampton Accumulator Company, West Bridge Works, Northampton, have sent us a copy of their catalogue dealing with accumulators of their special types for lighting and central-station use, motorcars, and electric traction generally.



N.A.C. Accumulator.

These accumulators combine some excellent features. The plates are provided with double interlocking grids, each grid being made in two halves identical in shape, the outsides being flat and the insides bevelled, so that when the two halves are assembled and the paste filled in, the latter becomes locked in one unbroken piece throughout the plate, as shown in the accompanying illustration. Portable batteries, ignition cells, testers, etc., are also included in the catalogue under notice, which for the rest is conveniently arranged for reference and well printed.

**Chepstow.**—At Chepstow Police Court on Friday the Chepstow Gas and Coke Consumers' Company, Limited, successfully summoned the Chepstow Electric Light and Power Company, Limited, for not giving sufficient notice before commencing to dig or sink trenches for the purpose of laying down and constructing new electric lines or other works near to the mains or pipes or other works belonging to the gas company. A penalty of £1, with a daily penalty of £1, was imposed, the costs of the court to follow the decision.

## ON PRESSURE VARIATIONS IN POLYPHASE CIRCUITS.

BY W. R KELSEY, A.M.I.E.E.

The limiting of pressure drop within moderate limits in a distributing system—using the term in a wide sense, as including all conductors outside the generating station—is a matter which with direct-current and single-phase alternating generators is largely in the hands of the shift engineer, and depends mainly on a careful watching of the switchboard ammeters. If the feeders and outgoing mains are run from 'bus bars in the usual manner, the copper in these must obviously be proportionate to their loads, and, except in the impracticable case of every cable carrying the same fraction of its maximum, some inequality of pressure must arise; but no great difficulty arises in practice in this respect, and in stations where the units are small it is always possible to plug to a single generator. With interconnected two-phase and with three-phase systems pressure balance is less easily secured, and depends to a far greater extent on the external arrangement of the phase loads than on the regulation at the station. This is in consequence of the generating coils of the phases being carried on a single armature, and so being similarly and equally affected by any variation in the excitation.

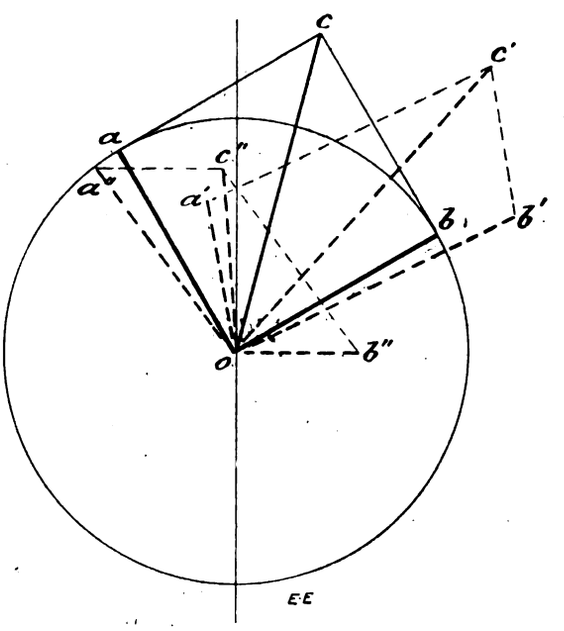



Fig. 1.

Considering, firstly, the case of a three-wire two phase system, the E.M.F.'s generated in the windings of each phase are, of course, given by the projection on an axis of the diagram (Fig. 1) of the two vectors, $o\,a$, $o\,b$, at right angles; the maximum E.M.F. between the outers being $\sqrt{2}$ times as great as that between either and the middle wire. If the load is entirely non-inductive and between the outers and middle wire, also equal in each phase, the same diagram can represent to a suitable scale the currents by $o\,a$, $o\,b$, and the middle wire is evidently carrying the resultant of the outer currents, its maximum being $\sqrt{2}$ times as great as either. If in addition a similar resistance be between the outers, the conditions still remain unaltered for the middle wire, and in both cases a perfect balance of pressure is maintained. If, however, one phase have an inductive load, or if the inductance be greater in one than the other, the lag is different in each, and in general the middle-wire current is no longer equal to $\frac{1}{\sqrt{2}}$ of the sum of the current in the outers, as shown by the two distinct cases indicated by broken lines in Fig. 1, where $o\,a$, $o\,b$ are currents in phase with the E.M.F.'s, $o\,c$ being their resultant current in the middle wire. With unequal magnitudes and phase lags, $o\,a'$, $o\,b'$ represent two currents having the resultant $o\,c'$, while $o\,a''$, $o\,b''$ represent a leading and a lagging current respectively, having the resultant $o\,c''$,

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The effect of the greater lag is, as with an ordinary single-phase generator, that the E M.F. of the phase is reduced by armature reaction, and this want of balance cannot be removed by alteration of the excitation, which must equally affect each phase. As a point of theoretical interest, it may be noted that with a capacity in one phase and inductance of a certain amount in the other, no current at all would pass through the middle wire, though the phases would be greatly out of balance in E.M.F. This condition is, however, out of the range of practical conditions.

The E M.F.'s and currents in a three-phase circuit, when the latter are in non-inductive equal resistances, may similarly be represented by three equal vectors 120deg. apart, as in Fig. 2. If the resistances in the different phases are unequal and inductive, the representation by vectors is not quite so simple, and the two necessary conditions that (*a*) the current in any one of the three wires must be the resultant of those in the other two, and (*b*) that the current in any one phase is determined (for constant

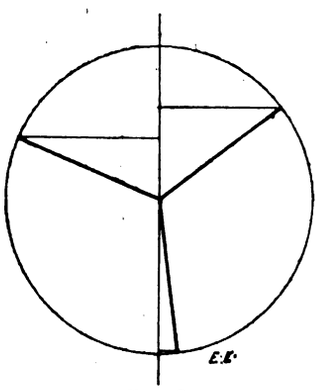


FIG. 2.

E M.F.) only by the impedance in that phase, are apt to seem incompatible. To simplify the matter, one may consider a three-phase supply with six wires, so that the phases are independent, as in Fig. 3. Then, obviously, the current in each has a value inversely as $\sqrt{R^2 + (2\pi \sim\sim L)^2}$. Since, neglecting armature drop, the E M.F. is the same at each terminal of the same polarity, the six wires may be reduced to three without disturbing the conditions, and the current in the single wire will at any instant be the sum of those which would exist in the two replaced. Hence, to obtain the vector diagram of the currents in all phases, let

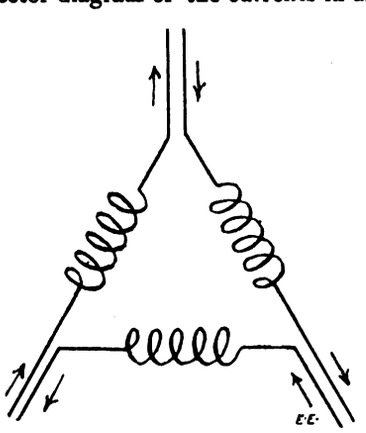


FIG. 3.

*o a*, *o b*, *o c* (Fig. 4) represent the E M F.'s, and O A, O B, O C to a suitable scale the currents in each phase, each being set at its particular lag relatively to its E M.F. Let these current vectors be produced beyond O, and O A', O B', O C' made equal to O A, O B, O C. Then the projections of these lines on any axis passing through O give the currents in each of the six wires of Fig. 3 at any instant. By combining the current in the following end of one phase with that in the leading end of the next, as O A with O C', O B with O A', etc., the vectors for the usual three-wire mesh grouping, O D, O E, O F, are obtained. A short examination of Fig. 4 will show that condition (*a*) is always obtained. The same construction applies to a star-connected system, the only distinction lying in the armature coils. It will be noted that in the mesh-connected armature the entire current output of the machine tends to divide up equally between the three windings, as internal drop in any phase will partly throw the load on the other phase windings; in the star connection this does not occur. With both, however, drop in the mains of any phase due to a

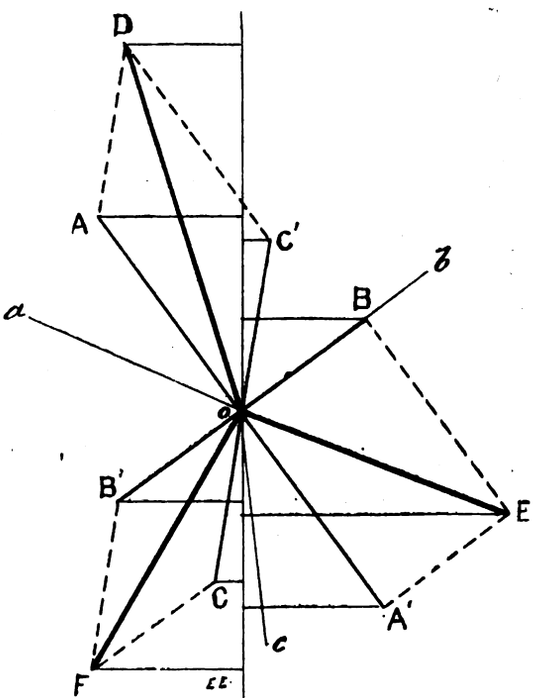


FIG. 4.

heavy load cannot be overcome without increasing the pressure of all phases.

The maintenance of balance is assisted by a load of three-phase transformers or motors, as these necessarily draw nearly equal current from all phases. The mere fact of connecting equal resistances across all phases tends to equalise pressures to some extent, as R + *r* becomes more

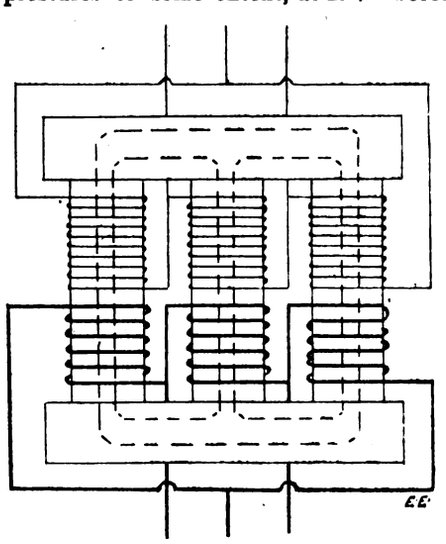


FIG. 5.

nearly equal to R the greater R is made. The action of the appliances mentioned is, however, entirely different from this and greater, as the following considerations show: For let at any instant the phases of the transformer (shown in Fig. 5) be in balance, and the central core carrying its maximum flux, then each of the end cores carries half that flux and their primary coils carry half the current in the central coil. If, now, the fluxes be in the same phases—*i.e.*, a maximum in the central core—but the voltage be less in the central phase than in the others, a smaller current passes round the central coil. As a result of this the flux in its core is less, but inasmuch as the current in the end coils is unaltered, the total magneto-motive force and flux are not reduced proportionately to the drop in the centre phase. Hence

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the flux and back E M F. in the end phases are reduced so that greater currents are drawn from them, while the flux and back E.M F. are increased relatively to the current in the middle phase, and thus a less current than that due to its fallen pressure is drawn from it. Evidently an arrangement that reduces the current drawn from a circuit in a greater ratio than the pressure drop, at the same time drawing an increased current from another circuit, exercises a powerful equalising action upon the two; and in practice the proportion of motor to lighting load in a three-phase circuit is usually sufficiently great to preserve fair balance.

With motors the reactance of the phases is usually equal for each; but with transformers this is not the case, unless a group of three single-phase transformers be employed, when the regulating advantage is, of course, lost. In the type of Fig. 5 the magnetic circuit of the end coils is longer and of greater reluctance than that between either and the central coil, and thus the reactance of one phase is less than that of the other two. A greater current is thus drawn from the one phase, and the primaries should be so connected as to distribute this extra demand of the different transformers equally between the three supply phases.

The arrangements of both primaries and secondaries in the system also have a bearing on the maintenance of balance; but discussion of this point is beyond the scope of the present article.

## FORTHCOMING EVENTS.

FRIDAY, JUNE 24.

**Physical Society.**—At 4.30 p.m., at the Royal College of Science, Exhibition-road, South Kensington, council meeting. At 5 p.m., "Chemical Dissociation and Electrical Conductivity," by Mr. A. E. Garrett and Dr. R. S. Willows; "The Magnetisation of Iron in Bulk," by Dr. W. M. Thornton.

SATURDAY, JUNE 25.

**Junior Institution of Engineers.**—Visit to the Chelsea generating station of the Underground Electric Railways Company and the London County Council pumping station in Lot's-road. (Saturday, July 9, an excursion is to be made to Dover.)

MONDAY, JUNE 27.

**Society of Arts.**—Conversazione, Botanic Gardens.

TUESDAY, JUNE 28.

**Institution of Electrical Engineers.**—9 to 11.30, conversazione, Natural History Museum, South Kensington, W.

WEDNESDAY, JUNE 29.

**Incorporated Municipal Electrical Association.** — Opening of ninth annual convention, Derby, Nottingham, and Sheffield, June 29 to July 2. Programme in another column.

**Prospective Events.**—July 14-16, annual meeting of the Association of Municipal Engineers at Shrewsbury. July, summer meeting of the Institution of Mechanical Engineers. Aug. 17, British Association at Cambridge. Aug. 29 to Sept. 3, 600 miles small car trials of the Automobile Club of Great Britain and Ireland.

## PERSONAL.

The Falkirk Council have increased the salary of the electrical engineer, Mr. J. M'Millan, by £30 per annum.

The Lowestoft Town Council have agreed that the salary of the accountant and his clerks be apportioned as follows: electric lighting undertaking, £100; tramways undertaking, £225; Education Committee, £125; general district fund, £250; borough fund (to include Burial Board, £52—total, £552.

The Glasgow Corporation have increased the salary of Mr. W. F. Calderwood, chief draughtsman, electricity department, by £25.

Mr. Wm. Briggs, head foreman in the electric department, on the occasion of his leaving to fill a similar position in the new yard of Messrs. Beardmore and Co., Limited, at Dalmuir, was presented with a magnificent American organ. Mr. Briggs, it will be remembered, recently tied for the appointment of burgh electrician at Govan.

The salary of Mr. Spaven, the general tramways manager at Portsmouth, is to be raised to £400 per annum forthwith, and then to £500 by two annual instalments of £50 each.

Last week Mr. H. P. Maybury was presented by the members of the Malvern Urban District Council and the inhabitants of the town with a handsomely-bound address and an inscribed silver tray, in appreciation of his services, whilst a piano was given Mrs. Maybury. The presentation was made by Sir Henry Lambert, chairman of the Council, and the address stated that during the 9½ years the recipient had filled the offices of town surveyor, gas, water, and latterly electrical engineer, he had successfully designed and carried out the following large undertakings: entirely new gasworks, sewage system for a large part of the district, sewage farm, water disposal system, electric lighting works, supplementing water supply by deep pumping, and building an isolation hospital. In all these works, the address continued, he had exhibited untiring zeal and great ability, while his capacity and sound judgment had been conspicuous in safeguarding the interests of the town and ratepayers.

The Bath Town Council have adopted several recommendations for increases of salary for officials in the electricity department. They include the raising of the salary of the chief electrical engineer (Mr. F. Teague) to £550 for one year from April 1 last, and that, in the event of the undertaking continuing to make satisfactory progress, a further increase to £600 per annum be made.

Mr. John Hesketh, at one time the borough electrical engineer of Blackpool, and now in charge of the Government Electrical and Telegraph Department, Queensland, has been appointed to represent the Commonwealth of Australia at the congress of electricians to be held at the St. Louis Exhibition in September next. Mr. Hesketh is further commissioned by the Government to enquire fully into recent developments in telephony and telegraphy throughout America.

## LUTON ELECTRICITY ACCOUNTS.

The accounts of the Luton electricity department for the year ending March 31, 1904, show a total expenditure on capital account to that date of £29,559. Herewith we give abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 693 | 3 | 9 |
| Distribution of electricity | 61 | 19 | 3 |
| Attendance and repairs to public lamps | 23 | 13 | 4 |
| Rent, rates, and taxes | 152 | 18 | 11 |
| Management expenses, salaries, etc. | 303 | 10 | 9 |
| Insurances and bad debts | 36 | 4 | 7 |
| Balance carried to net revenue account | 1,190 | 13 | 7 |
| | £2,462 | 4 | 2 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current for lighting and power | 2,160 | 12 | 7 |
| Ditto for public lighting | 186 | 17 | 4 |
| Rental of meters | 81 | 6 | 10 |
| Charging cells | 17 | 1 | 6 |
| Sale and repairs of apparatus, etc. | 16 | 5 | 11 |
| | £2,462 | 4 | 2 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 32,067 | 0 | 0 |
| Sundry creditors | 339 | 17 | 3 |
| Balance at credit of net revenue account | 42 | 17 | 3 |
| Sinking fund account | 2,601 | 0 | 3 |
| Reserve fund account | 50 | 9 | 3 |
| Balance due to treasurer | 322 | 18 | 11 |
| | £35,424 | 2 | 11 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 29,558 | 17 | 10 |
| Stores on hand | 3 | 11 | 8 |
| Sundry debtors for current supplied, etc. | 901 | 8 | 6 |
| Securities held at cost price | 2,403 | 6 | 10 |
| Interest paid in advance | 7 | 15 | 10 |
| Balance on deposit and in hand | 2,549 | 2 | 3 |
| | £35,424 | 2 | 11 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | |
|---|---|---|
| Quantity generated in B.T.U. | | 173,173 |
| Quantity sold { Public lamps 12,976; Private consumers by meter 147,868 } | | 160,844 |
| Quantity used on works | | 7,670 |
| Total quantity accounted for | | 168,514 |
| Quantity not accounted for | | 4,659 |
| Total maximum supply demanded (kilowatts) | | 185 |

Number of public lamps: 10 arcs, 27 incandescents.

## DEVONPORT ELECTRICITY ACCOUNTS.

The accounts of the above electricity undertaking for the year ended March 31, 1904, show a capital expenditure to that date of £96,130. Abstracts of the revenue account, balance-sheet, and electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 4,704 | 18 | 2 |
| Distribution of electricity | 184 | 7 | 3 |
| Attendance and repairs to public lamps | 63 | 10 | 10 |
| Rents, rates, and taxes | 303 | 1 | 8 |
| Management expenses, salaries, etc. | 865 | 1 | 3 |
| Law charges | 22 | 3 | 10 |
| Insurances | 77 | 2 | 2 |
| Discounts allowed | 81 | 1 | 0 |
| Balance, being gross profit for year | 6,409 | 7 | 4 |
| | £12,710 | 13 | 6 |

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| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| By sale of current | 12,412 | 3 | 8 |
| Sale of ashes and old material | 10 | 10 | 1 |
| Sale and repair of cables, fittings, etc. | 215 | 0 | 1 |
| Repairs to public lamps | 4 | 18 | 8 |
| Rents receivable | 68 | 1 | 0 |
| | £12,710 | 13 | 6 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Mortgage debt | 102,832 | 3 | 5 |
| Floating liabilities | 3,693 | 13 | 2 |
| Balance being excess of assets | 3,356 | 1 | 8 |
| | £109,881 | 18 | 3 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital expenditure | 96,130 | 17 | 1 |
| Stock redemption fund | 4,475 | 11 | 7 |
| Floating assets | 3,349 | 6 | 2 |
| Discounts on stock and issue expenses | 5,926 | 3 | 5 |
| | £109,881 | 18 | 3 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | |
|---|---|
| Quantity generated in B.T.U. | 1,504,085 |
| Quantity sold | 1,349,645 |
| Quantity used on works | 48,855 |
| Quantity accounted for | 1,398 500 |
| Quantity unaccounted for | 105,585 |
| Number of public lamps | 18 |

## BURY ELECTRICITY ACCOUNTS.

The accounts of the Bury Corporation electricity department for the year ended March 31, 1904, show a total expenditure on capital account of £73,489. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 1,787 | 19 | 6 |
| Repairs and maintenance | 278 | 8 | 4 |
| Management expenses | 666 | 17 | 3 |
| Distribution | 590 | 8 | 3 |
| Public lamps | 104 | 4 | 8 |
| Miscellaneous | 1,181 | 11 | 2 |
| Amount carried down to net revenue account | 3,495 | 7 | 4 |
| | £8,104 | 16 | 6 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current—private consumption | 6,581 | 14 | 3 |
| Ditto tramways | 422 | 13 | 9 |
| Ditto public lighting | 599 | 16 | 8 |
| Rental of meters, etc. | 158 | 9 | 1 |
| Ditto motors, etc. | 236 | 5 | 8 |
| Private construction | 97 | 17 | 1 |
| Incidentals | 8 | 0 | 0 |
| | £8,104 | 16 | 6 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Loans on mortgage | 45,829 | 0 | 0 |
| Sundry creditors | 2,643 | 16 | 9 |
| Cash owing to bank | 19,912 | 4 | 10 |
| Sinking fund, less loans paid off | 3,122 | 18 | 10 |
| Debt extinguished | 4,346 | 0 | 0 |
| Balance, being income beyond expenditure | 565 | 16 | 6 |
| | £76,419 | 16 | 11 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended on capital account | 72,080 | 0 | 4 |
| Sundry debtors for current, etc., supplied | 2,921 | 0 | 1 |
| Stock of stores | 1,418 | 16 | 6 |
| | £76,419 | 16 | 11 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Quantity generated in B.T. units | | | 731,183 |
| Quantity sold | Public lamps | 54 664 | 672,911 |
| | Tramways | 67,630 | |
| | Private consumers by meter | 550,617 | |
| Quantity used on works | | | 15,675 |
| Total quantity accounted for | | | 688,586 |
| Quantity not accounted for | | | 42 597 |
| Total maximum supply demanded (kilowatts) | | | 487·3 |

Number of public lamps: 34 arcs, 18 incandescents.

**Folkestone.**—The Earl of Radnor (lord of the manor) has been asked, unsuccessfully, by a deputation of the Town Council to withdraw his objection to the overhead system. In view of this decision, Mr. Merz, the expert employed by the Council, recommends the "G. B." contact system.

# COMPANIES' MEETINGS AND REPORTS

## UNITED RIVER PLATE TELEPHONE.

The ordinary general meeting of the Company was held on the 19th inst.

**Mr. J. Irving Courtenay,** who presided, stated that it was recognised by everyone that Argentina was advancing in every direction, and that, with the good government now seemingly assured, no country had better prospects of continued prosperity. The list of subscribers had increased by 800 during the year ended March last, and the improvement for the two months since completed was at a still higher rate. Sundry creditors were £1,000 more, most of which had since been paid. A sum of £10,000 had been put aside for renewal of plant, while a further sum of £15,000 had been placed to the reserve fund. On the credit side of the balance-sheet the additional outlay on capital account for the year amounted to £48,925, a considerable portion of which had been required in connection with new subscribers. There had been a large expenditure on underground plant and the extension of lines in the provinces. The final position was an available sum of £7,600 more than last year, out of which the directors recommended a dividend of 8 per cent.

The report was adopted, and the resolution increasing the capital of the Company by £60,000 further shares was carried.

## CAPE TOWN CONSOLIDATED TRAMWAYS.

The third ordinary general meeting was held on the 19th inst.

**Baron Emile B. D'Erlanger,** who presided, said that the amount owing to the Company by the Camps Bay Tramway Company and the Cape Marine Suburbs, Limited, was now £57,000, as compared with £58,802 last year. The dividends receivable, instead of being £14,237, were now £22,000—a substantial increase—and the cash at bank was £9,973, as against £10,000. The amount owing to the Oranjezicht Estate Company had been reduced from £37,750 to £19,941. On the debit side of the profit and loss account the interest on debentures amounted to £27,000, as against £10,000 last year, the interest having been paid on the whole of the year under review. He was fully confident, now that Chinese labour had been authorised, that the mining industry would revive, that it would bring a large white population into South Africa, and that the whole situation in the Transvaal and the Cape would be changed.

The report was adopted.

## ELECTRIC AND GENERAL INVESTMENT.

The report for the year ended May 31 shows a gross profit of £15,805. After deducting all general charges and the interim dividends already paid on the preference and ordinary shares, and providing for the proportion of the final dividend accrued on the preference shares to May 31, there remains a net balance of £6,813. The directors recommend a dividend of 1s. per share, making, with the interim dividend, 10 per cent. for the year. The balance of £5,813 is to be placed to the provision for contingencies, raising that fund to £41,575. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £10 per share.

## WEST AFRICAN TELEGRAPH.

The ordinary general meeting was held on the 16th inst. The Marquis of Tweeddale presided. The gross revenue for 1903 amounts to £62,514, including £1,321 for interest on reserve fund investments, which makes £61,193, against £70,399 in 1902. The decrease is stated to be due to the readjustment of the proportions of the South African joint purse, of which they now received a smaller share than heretofore, and to the loss of traffic with the French stations which has been taken over by the French Government under the arrangement explained at the last meeting. The withdrawal of the French stations from their system has also caused a considerable reduction in the items of expenditure under practically every head. The adoption of the report was seconded by Sir Henry C. Mance, and agreed to.

# NEW COMPANIES REGISTERED.

**London Electron Works Company, Limited.**—Capital, £26,000. Object: to acquire and take over as a going concern the business of a metallurgist and electro-chemist now carried on by A. de Back at Regent's Dock, Horseferry-road, Limehouse, as the London Electron Works Company, and to carry on the business of ironmasters, founders, metallurgists, electrical and electro-chemical engineers, etc.

**Motor Agencies, Limited (Edinburgh).**—Capital, £5,000. Objects: to carry on all or any of the businesses of motor agents, manufacturers of and dealers in all kinds of motors, motorcars, etc.

**Simpson Automatics, Limited.**—Capital, £2,000. Objects: to acquire and turn to account patents for ventilators and automatic machines generally, and to carry on the business of engineers, manufacturers of fire-alarms, ventilators, tubing, telephones, and electrical and other appliances, etc.

**Gratze Patents and Engineering Syndicate, Limited.**—Capital, £5,000. Objects: to carry on the business of manufacturers and repairers of and dealers in magnetic or other speed indicators, etc

**Sociedad Hidro-Electrica Del Ter.**—A contract has just been entered into between the Count Ramon de Berenguer, of Gerona, Spain, and Mr. W. T. McCaskey, York House, Norfolk-street, Strand,

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London, England, under the terms of which a company with the above title is to be formed to develop a water power of 1,500 h.p. on the River Ter, province of Gerona, Spain, and to distribute the force for lighting and other industrial purposes to Gerona, the capital of the province, San Feliu de Guixols, Palamos, and other towns in the vicinity. The capital of the company is to be 3,000,000 of pesetas, being 1,500,000 pesetas of series "A" or preference shares, and 1,500 000 pesetas of series "B," or ordinary shares. All the machinery apparatus and supplies will be purchased by Mr. W. T. McCaskey, York House, London.

## Liens Registered.

**Perth Electric Tramways, Limited.**—A trust deed, dated Dec 30, to secure £50,000 debentures, created Dec. 22, 1903, has been registered. Property charged—the company's undertaking and property, present and future, including uncalled capital. Trustees under deed of Dec. 30, 1903: Lord Arthur Butler, 7, Portman-square, W., and J. S. Austen, 68, Deshwood House, E.C.

**Provincial Tramways Company, Limited.**—Issue on May 27 of £40,000 debentures, part of a series created same date, to secure £125,000. Property charged — the company's undertaking and property, present and future. No trustees.

**Headley, Limited (Electricians, Truro).**—Issue on June 1 of £1,000 debentures, part of a series created May 12, 1904, to secure £2,000 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

**Gloucester Railway Carriage and Wagon Company, Limited.** Issue on June 8 of £3,100 debentures, part of a series created May 23, 1900, to secure the amount of the nominal capital for the time being, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £217,822.

**Automobile Proprietary, Limited (London, S.W.)**—Trust deed, registered June 13, for £22,500 debentures. Trustees: Colonel H. C. L. Holden, St. John's-park, Blackheath, and Sir J. H. A. Macdonald, of Edinburgh. Charged on leasehold premises in Piccadilly and Down-street, W., and all other assets for the time being, including an uncalled capital.

**Railway and General Engineering Company, Limited (Nottingham).**—A trust deed, dated May 25, 1904, to secure 35,000 4½ per cent. first mortgage debenture stock, has been registered. Property charged—freehold land, foundries, and other premises at Sneinton, Notts, and mines and minerals under part of such land (subject to any rights of the owner or lessee of mines and minerals under the other part of said land), and the company's general assets, present and future, including uncalled capital. Trustees: Sir William Blain, The Park, Nottingham, and E. Parry, Woodthorpe Grange, Nottingham.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Utrecht.**—The Municipality require tenders for the erection of a central electricity station by July 2.

**Heston and Isleworth**—The Council invite tenders for electricity meters. Tenders by July 4. See advertisement in last issue.

**Amelia (Perugia, Spain).**—The Municipality require tenders for an electric light installation. Tenders by Aug. 18.

**Rochdale.**—The Corporation require tenders for alterations, etc., of switchboards. Tenders by 27th inst. See advertisement in last issue.

**Rochdale.**—Tenders are invited for the supply and laying of high and low tension feeder cables, etc. Tenders by July 5. See advertisement.

**Edinburgh.**—The Council require tenders for cables for the year ending May 15, 1905. Tenders by June 27. See advertisement in last issue.

**Rochdale.**—The Corporation invite tenders for the supply of a 413-kw. steam dynamo. Tenders by July 1. See advertisement in last issue.

**Radcliffe.**—The surveyor has been instructed to obtain revised tenders from the firms who tendered previously for the special tramway track work.

**St. Pancras.**—The Borough Council require tenders for (1) lead-covered, armoured cables and (2) arc lamp carbons. Tenders by 28th inst. See advertisement in last issue.

**Penrith.**—The Council require tenders for oil or gas engines, dynamos, switchboard boosters, storage battery, and mains. Tenders by July 5. See advertisement in last issue.

**Talavera de la Reina (Province of Toledo, Spain).**—The above municipality require tenders for public lighting by electricity from July 1, 1904, to Dec. 31, 1908.

**Madrid.**—The Public Works Department invite tenders for the concession of an electric tramway in Bilbao, including supply of material and rolling stock, by July 6.

**Quantanamo (Cuba).**—Tenders are required for the establishment and working of a telephone system. Deposit, 200dol. Particular from Direction Générale des Communications, Havana.

**Batley.**—The Corporation invite tenders for the supply and delivery at their electricity works, New Ing Fields, of 1,000 tons each of nuts and slack coal. Particulars may be obtained on application to Mr. S. Derwen Jones, resident engineer. Tenders by noon on July 2.

**Loughborough.**—The Gas and Electric Lighting Committee invite tenders from manufacturers for electric cables (including laying), switchboard, steam, feed, blow-off, and other piping, and feed pumps, including erection, by 25th inst. See advertisement in former issue.

**Almeria.**—The Harbour Commissioners require a motor launch. The estimate is 29,000 pesetas, and the deposit required 1,450. Particulars from the Secretary of the above. Tenders by July 6.

**Alford.**—The Urban District Council invite tenders for lighting the town with gas or other light from Aug. 14, 1904, to May 14, 1905. Tenders to Mr. J. E. H. Sergeant, clerk, Alford, by 28th inst.

**Swansea.**—The Corporation invite tenders for the supply and erection of two tramway switchboards. Specifications, etc., may be obtained from the Town Clerk. Tenders by noon on July 1. See advertisement.

**Radcliffe (Lancs.).**—The Urban District Council invite tenders for the supply of direct-current electricity meters. Specifications, etc., may be obtained from Mr. S. Mills, Council Offices, Radcliffe. Tenders by June 27.

**Isle of Thanet.**—The Electric Tramways and Lighting Company, Limited, invite tenders for 12 months' supply of electricity meters. Specifications, etc., may be obtained from the Manager, Power Station, St. Peter's, Kent.

**Stourbridge.**—The Urban District Council invite tenders for the supply and laying of electric mains. Specifications, etc., may be obtained of the Electrical Engineer, Town Hall, Stourbridge. Tenders by noon on July 8. See advertisement.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for two electric 32-ton coaling hoists for Clydebank Dock. Specification, etc., may be obtained from Mr. Geo. H. Baxter, 16, Robertson-street, Glasgow. Tenders by noon on July 25.

**Hounslow.**—The Heston and Isleworth Urban District Council invite tenders for the supply of electricity meters. Specifications, etc., may be obtained from Messrs. J. and J. S. Enright, 68, Lincoln's-inn-fields, London, W.C. Tenders by July 4.

**Maidstone.**—The Electricity Committee of the borough invite tenders for the supply and delivery of coal to their electricity works, Fair Meadow, Maidstone, until June 1, 1905. Specifications, etc., may be obtained from the Borough Electrical Engineer.

**Erith.**—The Urban District Council invite tenders for (1) rails, fishplates, and bolts; (2) permanent-way construction. Specifications, etc., may be obtained from Mr. C. H. Fry, Council Offices. Tenders by 12 noon on July 11. See advertisement in last issue.

**Suakim.**—The Public Works Department require tenders for 220 miles of galvanised wire, 1,100 yards ditto, 1,500 screws and bolts, 6,000 insulators, 1,500 creosoted fir telegraph poles, and 3,000 oak poles, to be delivered at Suakim between Oct. 1 and Dec. 1.

**Manchester.**—The Highways Committee invite tenders for laying underground telephone pipes (Contract No. 10), with other appurtenant works. Specifications, etc., may be obtained at the City Surveyor's Office, Town Hall, Manchester. Tenders by 10 a.m. on July 11.

**Aston Manor.**—The Corporation invite tenders for the supply, delivery, and erection complete of pipework, etc. Specifications, etc., may be obtained from Mr. T. J. Ballard, Electricity Works, Chester-street, Aston Manor. Tenders before 12 noon on July 28. See advertisement.

**Exeter.**—The Corporation require (A) alternative tenders for a 200-kw. triple-expansion engine, traction generator, condenser, etc., or a turbo-generator and condenser; and (B) a 200-kw. two-phase generator, switchboard, etc. Tenders by July 1. See advertisement in last issue.

**Edinburgh.**—The Corporation invite tenders for the supply of a screw-cutting lathe 10ft. bed, 9in. centres, and a 4-h.p. electric motor for driving lathes, etc., at the fire brigade workshops, Lauriston-place. Specifications, etc., may be obtained from the Firemaster. Tenders by 29th inst.

**Stepney.**—The Electricity Committee invite tenders for the supply during the year of ampere-hour meters, demand indicators, arc lamp carbons. Specifications, etc., may be obtained from Mr. Wm. C. P. Tapper, 27, Osborn-street, Whitechapel, E. Tenders by July 4. See advertisement.

**Birmingham.**—The Corporation invite tenders for the supply of 30,000 tons of coal to the works of the electricity department, for delivery between Aug. 1, 1904, and July 31, 1905. Particulars can be obtained at the office of Mr. R. A. Chattock, M.I.E.E., 14, Dale-end. Tenders by 27th inst.

**St. Pancras.**—The Borough Council invite tenders for the supply and erection of main switchboard at the King's-road power-house, Camden Town, N.W. Specifications, etc., may be obtained at the offices of the Electricity Department, 57, Pratt-street, N.W. Tenders by 12 noon on July 19. See advertisement.

**Great Yarmouth.**—The Education Committee invite tenders for installing the electric light at the following schools at Great Yarmouth: Nelson (girls), St. George's (girls and infants), St. James's, Northgate, and Priory. Specifications, etc., may be obtained at the office of the Borough Surveyor. Tenders before noon on 27th inst.

**Ealing.**—The Council invite tenders for the supply to their electricity works of best cylinder oil, crank-chamber oil, paraffin, engine oil, mutton cloths, best rope waste, stoneware pipes, and cement. Particulars can be obtained from the Business Manager, Electricity Department, Town Hall, Ealing. Tenders by noon on July 1.

**Belfast.**—The Harbour Commissioners invite tenders for supply, erection, and setting to work on the Queen's Quay, Belfast, of two portable electric gantry cranes, each suitable for a working load of four tons at a radius of 50ft. Specifications, etc., may be obtained on application to the Harbour Office. Tenders by July 11.

**Manchester.**—The Electricity Committee invite tenders for the supply of direct-current motors, motor starters, low-pressure cables, cable troughing (iron and wood), service fuse boxes, bitumen, and box

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compound. Specifications, etc., may be obtained from the Secretary, Electricity Deparment, Town Hall, Manchester. Tenders by 30th inst.

**Manchester.**—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of cast-iron plates, etc., in gangway to condenser bay, engine-house No. 1; silencer and drain-tank in yard, and gangways in boiler-house No. 2. Specifications, etc., may be obtained from Mr. F. E. Hughes, Electricity Department, Town Hall, Manchester. Tenders by 30th inst.

**Handsworth.**—The Urban District Council invite tenders for the supply and delivery of the following in connection with the electric lighting: (4) water-tube boilers; (5) engines and dynamos; (6) overhead hand travelling crane; (7) storage battery; (8) arc lamps and posts; (9) switchboard and boosters. Specifications, etc., can be obtained from Mr. H. Ward, The Council House, Handsworth, near Birmingham. Tenders by July 11.

**Derby.**—The Corporation invite tenders for the making, erecting, setting to work, and maintaining in good order for twelve months on the site of the intended pumping station, of various machinery, including an electric light installation, consisting of compound high-speed engine and dynamo and sundry fittings, etc. Specifications, etc, may be obtained at the office of Messrs. James Mansergh and Sons 5, Victoria-street, Westminster. Tenders by noon on July 13.

**Greenwich.**—The London County Council invite tenders for the supply, delivery, and erection of three 3-ton electric travelling jib cranes and two electric locomotives upon the wharf of the electricity generating station now being erected by the Council at Greenwich. The jib cranes will be operated by three-phase alternating currents, and the locomotives by direct current. Certain parts of the locomotives—viz., the motors, controllers, wheels, and axles—will be delivered to the contractor by the Council. Specifications, etc., may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on July 12.

**Reichenberg (Austria Hungary).**—The project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of £40,000, and this it is proposed to increase to £80,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and working a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to directors Alfred Ginskey, Mafferdorf, and Dr. Richard Pirkl, Reichenberg.

## RESULTS OF TENDERS.

**Cardiff.**—The tender of Cowans Limited, Manchester, at £783, has been accepted for a sub-station switchboard for the docks.

**Yarmouth.**—The Town Council have accepted the tender of J. Baker and Co., Rotherham, for 50 tram tyres at 30s. each.

**Erith.**—The Urban District Council have accepted the tender of Messrs. Friday and Ling, 15, The Nursery, Erith, at £2,200, for extensions to the generating station.

**Warrington.**—The Corporation have accepted the tender of Mr. J. A. Ewart, Warrington, at £2,935. 15s. 8d., for the supply, delivery, and laying of steel rails, paving, etc., forming permanent way.

**Walsall.**—The tender of Messrs. Bumsted and Chandler for constructing and erecting an electric motor and ventilating fan in the engine-house at the generating station, at a cost of £60, has been accepted.

**Watford.**—The Urban District Council have accepted the tender of G. and J. Weir for the supply of one tandem compound Weir feed pump, complete with suction and discharge valves, for the sum of £183. 8s.

**Chester.**—The Town Council have received the following tenders: J. R. Crawford and Son, at £39. 10s., for painting the tramway poles; Babcock and Wilcox, to supply and fix three chain-grate mechanical stokers for £400.

**Dover.**—The Town Council have accepted the tender of W. Cory and Sons, 52, Mark-lane, E.C., at 18s. 3d. per ton, for supply to their electricity works of best large Welsh smokeless steam coal (about 4,000 tons) for 12 months.

**Natal.**—Mr. A. G. Knight, electrical engineer, 10, Bullen-street, Walmer-road, Port Elizabeth, has obtained the contract for the installation of electric light in the new administrative offices for the Port Elizabeth Harbour Board.

**Royton.**—The District Council have accepted the following tenders: Underwood and Bro., of Dukinfield, at £41,000, for constructing the tramways for Royton and Shaw; the Brush Electrical Engineering Company, at about £7,700, for the overhead equipment; W. T. Glover and Co., of Manchester, to supply and lay the cables for the tramways for the sum of £5,636. 14s. 2d.

**Wolverhampton.**—The Lighting Committee have accepted the following tenders: Belliss and Morcom, of Birmingham, and the Electric Construction Corporation, of Wolverhampton, for the supply of a 500-kw. steam generating set, amounting to the total sum of £2,374; Mr. H. Gough, of Wolverhampton, at £143. 18s. 6d., for supplying and erecting coal bunkers at the electricity station.

**Southampton.**—The Corporation have accepted the following tenders; North-Eastern Steel Company, Middlesbrough, at £5. 9s. 6d. per ton, for rails, fishplates, and anchor-joints; E. Allen and Co., Sheffield, at £9 per ton, for tiebars; Hadfield's Steelfoundry Company, Sheffield, at £27. 10s. per pair for points, and £12 each for crossings; Ibbotson Bros., Sheffield, at £16. 2s. 6d. per ton, for bolts and nuts.

**Radcliffe.**—The Electricity Committee have accepted the tender of the Lorain Steel Company for special tramway track work required at the junctions in Spring-lane and Ainsworth-road, and Callender's Cable and Construction Company to lay services to consumers' premises as required by the electrical engineer at schedule prices.

**Maidenhead.**—The Council have received the following tenders for a cable:

| | | | |
|---|---|---|---|
| Callender's Cable and Construction Company* | £179 | 5 | 0 |
| Henley's Telegraph Works Company | 180 | 0 | 0 |
| W. T. Glover and Co. | 183 | 0 | 0 |
| Callender's Cable and Construction Company | 183 | 15 | 0 |
| Siemens Bros and Co. | 185 | 0 | 0 |
| British Insulated and Helsby Cables, Limited | 187 | 10 | 0 |

* Recommended for acceptance.

# BUSINESS NOTES.

## TRACTION.

**Colne.**—The first electric tramcar between Colne and Trawden made a successful trip on Wednesday week.

**Sheffield.**—On Monday week, 27th inst., the Corporation's new generating station at Neepsend will be opened.

**Exeter.**—The Tramway Committee have recommended the acceptance of a tender to construct and equip 5½ miles of tramlines for £42,055.

**Kidderminster.**—The Town Council have passed a resolution expressing a hope that the tramway to Bewdley would be constructed without further delay.

**Perth.**—The Tramway Reconstruction Committee have agreed to recommend the formation of a single line with a turn-out in preference to a double line at High-street Port.

**Aberavon.**—A sub-committee has been appointed to meet the deputation of the electric tramway syndicate to discuss a system from Aberavon to Taibach and the beach.

**Wolverhampton.**—A satisfactory trial trip has been made on the tramway track to Wednesfield. The Tramway Committee have taken premises for the purpose of a tramway waiting-room.

**Acton.**—It is reported that the electric train service between Mill Hill Park and Park Royal, and Twyford Abbey and Harrow, has been considerably improved, and trains now run half-hourly.

**Bolton.**—The Corporation Tramways Committee have decided to discontinue the issue of workmen's weekly tickets. Daily tickets will still be available, however, and the time extended to 8 p.m.

**Aberdeen.**—On Saturday evening a trial run was made in one of the cars on the Deeside section of the Aberdeen Suburban Tramways. The car left the tramway depôt at Mannofield and was run as far as Bieldside.

**Blackburn.**—The traffic returns for the week ending June 10, 1904, show that during that period 184,301 passengers were carried on the Blackburn Corporation tramways, an increase of 36,364 passengers over the corresponding month last year.

**Hipperholme.**—The Halifax Tramways Committee are considering whether to construct the tramways from Brighouse to Bailiffe Bridge at once or defer it until next spring. An extension from Bailiffe Bridge to Hipperholme is suggested.

**Pontypridd.**—The British Electric Traction Company having declined to accept £4,644 as the purchase price of the old tramway undertaking, the matter has been left in the hands of Mr. Bramwell, Mr. Hamilton (Leeds), and the clerk.

**Wednesbury.**—Last week, in accordance with notices issued by the South Staffordshire Tramways (Lessee) Company, Limited, the steam cars travelling on their routes between Wednesbury and Darlaston and Wednesbury and Dudley were withdrawn.

**Lowestoft.**—The last report of the Tramways Committee shows that the total receipts since the commencement to 16th inst. amount to £8,412, the total number of passengers carried was 1,871,270, total mileage run 235,776, average receipts per car per mile 8·5d.

**Darlington.**—On Saturday a through electric car service between Cockerton and Eastbourne was established at Darlington. On this, as well as on the Harrowgate-hill route, where the cars ran from the Market-place, many passengers travelled, the total being estimated at 12,000

**Luton.**—The Limbury Parish Council have asked the Luton Town Council to continue the tram system as far as the borough boundary near the Bisset Windmill. The question of the Wellington-street route is to be considered and decided upon by the whole Council sitting in committee.

**Warwick.**—Messrs. Glover and Sons, of the Packmores, Warwick, have been given the contract to supply the steel for the British Electric Traction Company's power house near the Emscote canal bridge, which is now in course of construction. The foundations were laid a fortnight since.

**Ashton and Stalybridge Tramways.**—The through running of tramcars over these two tramways has been interrupted owing to want of agreement as to the division of fares between the two authorities—i.e., the Ashton local authority and the Stalybridge, Mossley, Hyde, and Dukinfield Joint Electricity Board.

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**Thornaby.**—At the last meeting the Mayor explained that the clauses in the Bill of which they were in favour had been passed by the House of Commons. He considered they had secured the equivalent of a gift of £10,000 in Consols. They would receive a minimum of £280 a year, which was equal to a rate of 2d. in the £.

**Stockport.**—At a meeting of the shareholders of the Stockport and Hazel Grove Tramways Company last week it was decided to leave the directors to carry to an end the negotiations with the Stockport Corporation Tramways Committee relative to the proposed sale of the undertaking to the Corporation, referred to in our last issue.

**Elbe Tunnel.**—The Hamburg Senate has voted favourably upon a project for a tunnel under the Elbe, in which it is proposed to construct through the tunnel an electric "tube" railway, chiefly for the benefit of the workmen connected with the shipyards and other establishments on the left bank, who mostly live on the right bank.

**Huddersfield.**—The following is a summary of the statement of receipts for May: traffic receipts, £5,827. 2s. 10d.; parcel tickets, £6. 1s. 3d.; scholars' tickets, £18; miscellaneous receipts, £7. 16s. 4d.—total, £5 859. 0s. 5d. Miles run, 144,385; passengers carried, 1,062,685. The receipts showed an increase of £484. 10s. 0½d.

**Egyptian Delta Light Railways Co.**—An extraordinary general meeting of this company will be held in London on the 5th prox. for the purpose of considering resolutions authorising the proposed purchase of the Metropolitan and Cairo-Helouan Railway, and the increase of the capital of the company by the creation of 11,103 preference shares of £10 each.

**Warrington.**—A proposal is on foot for establishing an electric car service between Manchester and Warrington. Mr. J. J. Webster, the engineer appointed by the Corporation to superintend the widening of Warrington Bridge by the erection of cantilevers, has been instructed to prepare estimates and quantities for the work preparatory to tenders being invited.

**Leeds.**—The very heavily loaded tramlines in Briggate, between Boar-lane and Commercial-street, were smartly relaid between midnight on Saturday and the time of the first car on Monday, the Sunday traffic being diverted *via* Vicar-lane. Over 300 men were employed, and everything was finished, including the laying of the wood block paving, by the afternoon.

**Birmingham.**—The Tramways Committee of the City Council and the Aston Corporation having agreed upon terms upon which cars should run to and from Aston, through cars commenced to run between Steelhouse-lane and Aston Cross at 1d. fares on Thursday week. The opening of the new tramway route from Birmingham (Navigation-street) to the Cotteridge, King's Norton, was fixed for yesterday.

**Croydon.**—The by-laws relating to tramways are to be amended, in order to enable a definite excess number of passengers to be carried in wet weather. A further sum of £10,000 beyond the amount already sanctioned is required in connection with the reconstruction and equipment of the tramways, which sum includes £7,164 for the purchase of the 10 bogie cars, and application will be made for sanction to a loan.

**Dundee.**—The result of the past year's working of the tramway system shows that the gross receipts amounted to £44,437, and the working expenses, including maintenance of lines, to £28,420. After meeting interest, sinking fund, depreciation, etc., a surplus of £1,237 has been carried to the credit of the suspense account. The gross receipts, compared with those of last year, show an increase of £2 432, an increase in passengers of 781,058, and an increase in mileage of 34,290 miles.

**Derby.**—The Osmaston-road tramway route is nearing completion, and last week a number of the old cars were placed on the line and commenced carrying passengers. The work of laying the new line in Midland-road and London-road is proceeding, and substantial progress has been made. On the Normanton-road the overhead electrical apparatus has been erected, and the electric lamps fixed on every alternate standard brilliantly light up the thoroughfare. The overhead wires have also been fixed in Burton-road.

**Yarmouth.**—The monthly returns from May 5 to June 2 shows that 97,654 passengers were carried at 1d. and 9,477 at 2d., the receipts being £493. 14s. 3d. The aggregate returns from April 1 to date were: receipts, £758. 17s. 8d. in 1903 and £814. 9s. in 1904, an increase of £55. 11s. 4d. The average daily receipts showed an increase of 17s. 7½d. The borough surveyor is preparing levels and specifications for the approval of the Board of Trade of the new lines, and especially in regard to the Gorleston tramways.

**Ilford.**—The report on the first year's working of the electric tramways shows that 5,274,025 passengers were carried; the receipts were £23,217. 17s. 9d., or about £7,000 more than the committee estimated. There was a balance of £4,570, which it is proposed to devote to a suspense account. The motormen and conductors are to be paid ½d. per hour extra and a bonus of 10s. per quarter, entitling them to a further ½d. per hour, for freedom from accident. The committee will also consider the question of reducing fares.

**Heaton Norris.**—The Manchester Corporation are prepared to advance the amount required for the purchase of the tramways undertaking within the Council's district at 3½ per cent. Application is to be made for sanction to borrow £1.000, under the provisions of Section 19 of the Manchester Corporation Tramways Act, 1899, and Section 20 of the Tramways Act, 1870, for the purpose of providing for the costs and charges already, and to be hereafter, incurred in relation to the acquisition of the tramways within the Council's district.

**Dundalk.**—It is reported that the Dundalk and Blackrock tramway scheme has now a reasonable chance of being carried to a successful conclusion. The promoters of the local tramway and lighting scheme have entered into a contract with the Industrial Engineering Company, of the Newton Ironworks, Hyde, to put down a complete equipment for the tramway and lighting purposes. Mr. Harrison Jones, of the firm of Rotter and Jones, Westminster, has recently been in Dundalk in the capacity of consulting engineer. The prospectus of the Dundalk scheme will be ready for issue in a few weeks.

**Glasgow.**—A resolution that the Corporation disapprove of the action of the Tramways Committee in denying citizens the right of employment because they are physically unable to conform to certain standards of height, and of denying employment to those citizens who are over 45 years of age, has been remitted to the committee to give a report as to whether there was an age and height limit for men. The annual statement shows a gross revenue of £724,851, leaving a net profit balance of £80,737. after paying £139,644 for renewal and depreciation and another £62,000 for special depreciation.

**Bath.**—The Bath Rural District Council have received a letter from the Board of Trade with reference to the suggested regulation for the electric trams stating, with regard to the suggestion that the brake power must be of sufficient strength to stop the car on the steepest hill over the system within four cars' length, that they would amend the clause to include the provision of a slipper or other track brake approved by the Board for use on the rail. On the suggestion for an automatic arrangement to release the wheels if they commenced to skid, the Board were advised that it would not be practicable to adopt such an arrangement.

**Newcastle-on-Tyne.**—On Saturday the Gosforth Park section of the Tyneside Company's tramway system was opened for public use. Representatives of the tramway men on Monday interviewed the chairman of the Tramways Committee (Alderman Baxter Ellis) on the question of the men's grievances. Mr. A. E. Le Rossignol, general manager of the service, was also present. After three hours' discussion Alderman Ellis promised that the views of the men should be laid before the committee at its meeting next week, the men on their part agreeing to suspend further action for the redress of their grievances until after that meeting.

**Walsall.**—The following particulars respecting the working of the tramways during the past two months have been reported. Four weeks ending April 30, 1904: number of passengers, 353,345; receipts, £1,981; car miles run, 46 706; receipts per car mile run, 10·18d. For weeks ending May 28, 1904: number of passengers, 360,404; receipts, £2,026; car miles run, 47,475; receipts per car mile run, 10·24d. Wages paid: four weeks ending April 28, 1904, £592; four weeks ending May 26, 1904, £655. The borough surveyor has been requested to report as to the estimated cost of taking up the old lines on the Pleck section and laying down double lines, the old setts being used as far as expedient in the construction of such new lines.

**Leamington.**—The Tramways Committee last week reported that they had considered a letter from the Leamington and Warwick Electric Company stating that they feared it was now impossible for them to complete the reconstruction of the tramways by Aug. 9 next, and suggesting the desirability of postponing the work till the autumn. They also stated that they proposed to apply to the Board of Trade for an extension of the time for carrying out the work, and asked the Council to undertake not to exercise powers of purchase conferred by clause 8 of the Leamington Tramways Order, 1901. The committee recommended that the Council intimate that they would not exercise their powers of purchase in August next, and would offer no objection to one year's extension of the period fixed by the order. The report was agreed to.

**Northampton.**—The Town Council have referred to the Finance Committee a recommendation, which has been passed, that Mr. Gottschalk, who for many years was manager under the tramway company, and who has retained the post during the three years the trams have been running as a Corporation concern, should be made general manager with control over the whole of the undertaking, and that an electrical engineer should be appointed under him. Also that Mr. McMahon, the electrical engineering assistant, who was temporarily engaged under the direction of the borough engineer preparatory to and during the installation of the electric system, be appointed electrical engineer to the trams with the management of the refuse destructor plant, at a salary of £275 per annum, rising to a maximum of £300.

**Wood Green.**—The electrification of the tramways belonging to the Metropolitan Electric Tramways, Limited, is now approaching completion. During the whole time of reconstruction the service of horse cars has been maintained, with a result that something like 14 million passengers have availed themselves of this service during the past year. The first electric car, however, was seen in the neighbourhood of Wood Green last week, and it is understood that the motormen's school for training the horse drivers to the new system of traction has now been transferred from the company's premises in Hackney to the electric cars which are running experimentally over the lines worked by horse traction. It is expected that the Board of Trade inspection will take place by the end of the month, and that a service of electric cars will be started immediately after.

**Greenwich.**—The London County Council have decided not to proceed further with the application to Parliament in the present session for powers in respect of the construction of a tramway across Blackheath owing to the Borough Council having declined to contribute towards the cost of widening Shooter's-hill-road. A deputation is to wait upon the County Council and lay before them an alternative proposal for forming a tramway to the Herbert Hospital *via* Westcombe-hill and the Old Dover-road, a route which in the committee's opinion, would offer considerable advantage over that across Blackheath. The deputation will also discuss the question of the amount of the contribution—£25,083—asked from the Council for the purpose of carrying out the electrification of the tramway from Greenwich to Catford. The Highways Committee of the London County Council recommend the purchase of the London, Deptford, and Greenwich Tramway Company's undertaking for £95,500.

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**Birkenhead.**—The third annual report on the working of the Corporation tramways has been issued by Mr. W. Wyld, the recently-appointed general manager. The returns show a steady and satisfactory increase compared with the previous year. The passengers carried numbered 11,327,932, being an increase of 936,947, and equal to carrying the population of Birkenhead twice a week through the year. The increase of workmen's fares was especially satisfactory, the 2d. tickets showing an increase of 87 per cent. and the 1d. tickets an increase of 14 per cent. The total income amounted to £56,073, which was an increase of £3,197 on the previous year. The expenditure, however, showed a proportionately larger increase. The gross profit after deducting working expenses was £21,325. After deducting interest charges and sinking fund there remained a net profit of £1,885. No fatal accident has occurred during the year—in fact, since the new lifeguard has been in operation 27 million passengers have been carried without a fatality. The trial of the covered cars having proved satisfactory in every way, it has been decided that another 12 cars be fitted with covers in readiness for next winter's traffic.

**Brighton.**—It is proposed that the tramways engineer train suitable conductors as motormen for service with the tramcars, the training to be in the conductors' own time and at their own expense. The following letter has been received by the Council with reference to the proposal from the tramways engineer: "I regret, however, that I am unable to recommend you to entertain the proposal, the principal reason being that you have no route at present of an easy gradient on which men could be put after qualifying generally to operate a car on the level; and in my opinion, from my experience, it would be not only unfair to the men themselves in allowing them to attempt a task which from the outset is known to be impracticable, but fraught with the greatest danger. It could not reasonably be expected that any man who might prove himself competent to work a car on the level could then be taken on to the severe gradients which exist on all your routes, excepting Lewes-road. Personally, I have the strongest desire that it should be possible for conductors who are physically fit to be able to qualify for the position of motormen, but until such time as you have reasonable facilities for training the men in proper and safe stages, I can only in the strongest possible manner advise you that to attempt such a thing under existing conditions would be to court disaster."

**Accidents.**—In the House of Commons on Tuesday, Mr. Bell having asked the President of the Board of Trade whether his attention had been called to a recent fatal accident to a child at Jesmond, a fatal accident to Joseph Innes at the Manors Station on the 13th inst., an accident to James Hughes on the same date, and an accident to Philip Gilroy at the Newcastle Central Station on the 14th inst., all of them through coming in contact with the live rail on the electric section of the North-Eastern Railway, and whether he would consider what steps are necessary, and what means can be adopted to protect such rails upon electric railways in existence, and which may be constructed in future, Mr. G. Balfour made the following reply: "The Board of Trade have received information from the railway company in regard to each of these unfortunate accidents. I may mention that in the last-named case the injury appears to have been slight, not necessitating absence from duty. I have ordered an enquiry into the circumstances attending the fatal accident at Manors Station, and the report made by the Board's inspecting officer will receive careful consideration." Two Bootle men, named William Mathews and Patrick Flood, were making their way to the Lancashire and Yorkshire Railway Company's electric power station at Formby last week. In crossing the line from Altcar Camp, Flood struck against the "live" rail, and was killed. His mate, in attempting to pull him off, was badly injured. At the subsequent inquest the jury found that the death of Flood was purely accidental. Steps are being taken by the Amalgamated Society of Railway Servants to secure protection for the workmen in particular, and incidentally for the general public, in connection with the live wires on electric railways. The Railway Servants suggest the provision of wooden casing rising above the top level of the rail.

**London County Council Trams.**—Electric cars were run for the first time between Blackfriars and Westminster Bridges and Streatham on Sunday. In connection with the erection of the Greenwich generating station, the Highways Committee recommended on Tuesday: (*a*) That a clause be inserted in the form of contract for the erection of the pump-house and coal bunker, the provision of a water supply, and the construction of foundations for the turntables and cranes, and for the making-up of road levels for the Greenwich electricity generating station, providing for the work to be carried out within 12 months, and for a penalty of £50 a week in respect of the period by which the time of completion may exceed the time fixed in the contract, and, should the work be completed in less than that time, for the payment to the contractor of a bonus at the rate of £25 a week in respect of the time between the actual date of completion and that specified in the contract. (*b*) That the operation of the standing order, which requires that all tenders where the estimated expenditure exceeds £500 shall be opened in the Council by the chairman, be suspended so far as regards tenders for the execution of the work referred to in the foregoing resolution; that the chairman or the vice-chairman of the Highways Committee be authorised to open such tenders during the summer vacation, and to accept that which in his opinion may be the most advantageous to the Council; that the solicitor do prepare, and obtain the execution of, a contract to give effect to any tender that may be accepted for the work; and that the seal of the Council be affixed to such contract when ready. The Council endorsed the recommendation of the Building Act Committee that the plans be approved which were submitted by Messrs. Kincaid, Waller, Manville, and Dawson, on behalf of the Bermondsey Borough Council, for the construction of works in connection with the erection of coal bunkers, boilers, and conveyors at the generating station of the Bermondsey electric lighting works. It is suggested to link up the tramways of North and South London by a scheme which involves the acquisition by the Council of Charing Cross railway station and Hungerford Bridge, the making of a new road bridge wide enough for a double line of tramway, and the provision of a new railway terminus on the Waterloo side of the river for the South-Eastern and Chatham Railway Company. It is also proposed to spend £19 500 in connection with the erection at Streatham of a sub-generating station for the working of the Streatham tramlines is to be submitted to the London County Council.

## LIGHTING AND GENERAL.

**Derby.**—The electric mains are to be extended to the Osmaston Estate.

**Exeter.**—The electric light is to be installed at the police court at a cost of £65.

**Boring Plant.**—Particulars of a sale of boring plant appear in another issue.

**Loughborough.**—Sanction has been received to borrow £5,000 for electric lighting.

**Electric and General Investment Co.**—The transfer books are closed till July 6 inclusive.

**Berwick.**—The proposed electric lighting of the town hall front has been referred back to committee.

**Sudbury.**—Preparations have been made to put Sudbury into telephonic communication with other places.

**Newcastle-under-Lyme.**—The new electric lighting works erected by the Corporation were formally opened on Wednesday.

**Ryde.**—The General Purposes Committee are considering the desirability of lighting the town hall buildings with electricity.

**Brynmawr.**—The St. Mary's Church Council are prepared to favourably consider the introduction of electric light into the parish church.

**Mexico Electric Tramways.**—The transfer register of the 6 per cent. preference shares will be closed to June 30 for payment of the dividend.

**Weymouth.**—It is expected that the borough will be lighted by electricity early in September. The esplanade will be illuminated by arc lamps.

**Belfast.**—The Board of Trade have appointed Prof. Maurice F. Fitzgerald as an inspector for the purposes of the Belfast Electric Lighting Order, 1890.

**Thomas Parker, Limited.**—The directors have resolved to carry to next year's account the available balance of £1,410, after writing off the usual depreciations.

**Stockton Heath.**—The Warrington Corporation's offer to supply Stockton Heath with electricity will again be considered at a parish meeting on Monday next.

**Bridgend.**—The net profit on the electric light works for the first year was £222. The Council will soon be in a position to supply consumers at 1½d. per unit.

**Chester.**—The weekly charges for lighting the workmen's cottages have been fixed at 4d. a week for the summer six months and 6d. a week for the winter six months.

**Taunton.**—In order to meet the demand for the hire of motors, the Council are entering into a seven years' arrangement with the Langdon-Davies Motor Company, Limited.

**Blackpool.**—The Tramways and Electricity Committee have decided to reduce the price of street-lighting in accordance with the recommendation of the electrical engineer.

**Carnarvon.**—The Electric Light Committee are considering the question of a site for the proposed electric light works, and they have been empowered to select an engineer.

**Coventry.**—It is stated that after paying interest and sinking fund charges, the electricity department of the Coventry Corporation will for the past financial year show a profit of £775.

**Grimsby.**—Mr. Vignoles (electrical engineer) in his last report shows that the number of units sold was 63,911, an increase of 14,148 compared with the corresponding period of last year.

**Sale of Plant.**—Particulars of a sale of engineers machine to at the Crypto Works, Clerkenwell, E.C., on July 11 and 13, by Messrs. Fuller, Horsey, Sons, and Cassell, appear in another column.

**Western Telegraph Co.**—The coupons of this company's second issue of 5 per cent. debentures, due 30th inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C.

**Norwich.**—The Electricity Committee's recommendation that Mr. F. M. Long, the city electrical engineer, visit the St. Louis Exhibition, and that a sum not exceeding £80 be granted for the purpose, has been approved.

**Coventry.**—The Electric Light Committee's report, which showed a gross profit of £1,860 over the previous year and a net profit of £775—the first in the history of the undertaking—was adopted on Tuesday.

**Gramophone and Typewriter, Limited.**—The directors announce an interim dividend of 10 per cent. on the ordinary shares for the quarter ending June. The transfer books will be closed from 24th to 30 h inst. inclusive.

**Clydach.**—At the Rhyndwyclydach Parish Council meeting on Thursday week it was decided to apply for permission to adopt the Lighting Act. It is intended to erect electric lighting plant for Clydach and Trebanos, Swansea Valley.

**Swinton and Pendlebury.**—The Urban District Council are negotiating with Edmundson's Electricity Corporation for taking over the Council's electricity order and supplying the district with electricity for lighting and power purposes.

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**Cheshunt.**—The North Metropolitan Electric Supply Company are taking over the Urban District Council's electric lighting order. The Council is to be able to acquire the works at the end of 21 years at a price based upon the profits of the preceding three years.

**Derbyshire and Nottinghamshire Electric Power Bill.**—There being no opposition to this Bill, it has been referred to the consideration of the Committee on Unopposed Bills in the House of Commons. The Bill has already passed the House of Lords.

**Thornaby.**—At the last Town Council meeting the Parliamentary and General Purposes Committee reported that they had considered the surveyor's report on the construction of a combined refuse destructor and electricity station, and agreed that the subject be deferred for the present.

**Wisbech.**—We understand that the Town Council have finally settled their arrangements with the National Electric Construction Company, and will now make a formal application to the Board of Trade for sanction to purchase Virginia Waters for the purpose of the proposed electric lighting works.

**Electric Lighting Orders.**—The Select Committee of the House of Lords has passed the whole of the municipal electric lighting orders brought forward this session subject to the omission of the Bermondsey clause and the introduction of a new clause, the gist of which is given in our leading article.

**Ilford.**—During the last year £10,270 was received for private lighting, £5,114 for public lighting, £583 for arc lamps, £260 for slot meters, and £3,521 from the tramways undertaking. The total income was £20,443, and the expenditure £10,987. The gross profit was £9,355, and the net profit £2,876.

**Sunderland.**—The Corporation having opposed the Bill for confirming the Board of Trade authorising the County of Durham Electric Power Company to supply electric light in certain districts around Sunderland by petition, and not making an appearance before the committee, have been condemned to pay costs.

**Hove.**—With regard to a note in a former issue that the Corporation will shortly be laying underground mains in Aldrington, a supply of current being taken in bulk from the Brighton Corporation, we are informed that Messrs. Handcock and Dykes, of Westminster, have been retained to prepare the necessary specifications.

**Wireless Telegraphy.**—The installation of a service of wireless telegraphy at Lake Baikal is expected to be in working order by the end of the week. It will consist of three stations, one of which will be on board the ice-breaker, which will thus be enabled to communicate with both shores during its passage across the lake.

**Firth of Forth Telegraph.**—During the past fortnight the telegraph cable-laying steamer "Monarch" has been at work in the Firth of Forth, repairing and relaying the telegraph cable. With a view to lessening the risk of injuries to the cables by ship's anchors fouling them, it has been decided to alter the position of two of the three cables.

**St. Austell.**—The Rural District Council have received a letter from the Board of Trade intimating that the St. Austell Electric Lighting Company were about to put in force the electric lighting order of 1901. Expert opinion will be taken on the matter. Messrs. Pearce, Lovering, and Nicholls are acting as a sub-committee on the matter.

**Acton.**—An enquiry has been held into the application to borrow £54,091 for purposes of electric lighting. It will be remembered that, in order to save the electric lighting order, which the Board of Trade threatened to revoke on account of its powers not being exercised, the Council recently entered into an agreement with the Metropolitan Electric Supply Company.

**Heathman's Ladders.**—We have received a new illustrated catalogue from Messrs. Heathman and Co., Parson's Green, S.W., who have local depôts at 7, Penzonville-road, N., and 37, Endell-street, W.C., giving particulars of their various kinds of patent telescopic scaffold towers, ladder towers, extension ladders, scaffold trestles, fire escapes, tower wagons, etc.

**Louth.**—The Corporation decided at their last meeting to work their electric lighting order themselves, and not to enter into the proposed agreement with the National Electric Construction Company. They have therefore applied for sanction to a loan of £17,000, and their consulting engineers, Messrs. Handcock and Dykes, are at present engaged on the preparation of the necessary plans.

**Willesden.**—The new extensions to the polytechnic institute are to have a very complete installation of electric light and power. In addition to the ordinary lighting of the extensive classrooms and lecture hall, "power points" are provided for use in experimental work, and also electric motor driving for various machines. The consulting engineer is Mr. Frederic H. Taylor, of Westminster.

**Stirling.**—In his annual report Mr. A. C. Hanson, the resident electrical engineer, states that the number of units generated during the year ending May 15 last was 228,790, as against 194,076 the previous year. The result of the year's working was that, instead of having a deficit of £37 as estimated, there was a surplus of, approximately, £80. The Council will reduce the charges for meter rents.

**Cardiff.**—On Tuesday Mr. Ellis reported that there were 1,022 consumers connected, with a total equivalent of 111,335 8-c.p. lamps. The total at the corresponding period last year was 88,182. They had, therefore, an increase of 26 per cent. in total connections. The estimated revenue was: from street-lighting, £508; ditto, private supply, £1,311—a total of £1,819. The estimated revenue for the corresponding month last year was £1,451.

**Huddersfield.**—The borough electrical engineer in his last report stated that in June the number of consumers was 1,931, an increase of 13 on the previous month. In June, 133,886 lamps were connected, an increase of 259 as compared with the preceding month. During the month of May the number of units metered was 96,788, as compared with 125,275 in the corresponding month of last year, or a decrease of 28,487 unit, equal to a falling off of 22 per cent.

**Yarmouth.**—The Electric Light Committee's annual report shows a net profit on last year's working of £1,293 after paying all capital charges, interest, and rebate. The sales of current yielded £13,486, and meter rents £381. The expenditure for generation, distribution, etc., was £7,989, leaving a gross profit of £5,853. From the last account £878 was brought forward, £500 was transferred to the relief of the rates, £1,926 paid in interest, and £2,472 to the sinking fund.

**Devizes.**—At a recent meeting of the Devizes Joint Isolation Hospital Committee it was agreed to instal the electric light at the new hospital which is in course of erection, the supply being obtained from the Wells County Asylum. A contract has been accepted, amounting to £232. 7s., for laying the cables, providing and fitting the lights, etc. The light will cost 6d. per Board of Trade unit, and the asylum authorities reserve the right to cut off the supply at any time that it may be necessary.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Egyptian Delta Light Railways, Limited, further issue of £50,000 4 per cent. debentures of £100 each, Nos. 2,701 to 3,200; Potteries Electric Traction Company, Limited, further issue of 2,500 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 42,001 to 44,500, and 2,500 ordinary shares of £10 each, fully paid, Nos. 52,001 to 54,500; Underground Electric Railways Company of London, Limited, £3,599,200 5 per cent. profit-sharing secured notes, Nos. A1 to A8,450 of £100, B8,451 to B9,561 of £200, C9 562 to C10,335 of £500, and D10 336 to D12,480 of £1,000 each, in lieu of the fully-paid provisional certificates now quoted.

**Ipswich.**—The Electric Supply and Tramways Committee on Wednesday submitted the following statement on the working of the department for the period ending March 31: (1) Electric supply—generation expenses, £1,490; distribution, £276; management and miscellaneous, £541; making a total of £2,109; income—energy supplied, lighting, etc., £659; ditto, traction, £1,782; meter rents, £8; retest fees £7; rent, £4; total, £2,462. On the actual working expenses, therefore, the profit was £353, but the interest on loan, bank interest, and repayment of principal amounted altogether to £2,517 so that the charge upon the rates was £2,163. (2) Tramways: expenditure—power, £1,686; traffic expenses, £3,097; general ditto, £758; repairs, £548; total, £6,091. Receipts, £5,644. There was a loss of £446, which, added to the interest on loan and repayment of principal, makes a total charge upon the rates of £1,919.

**Manchester.**—The Electricity Committee's annual report shows a capital outlay for the past year of £396,805, making a total at March 31, 1904, of £2,110,432. Additional borrowing powers are now being sought, under resolution of the City Council, to the extent of £135,000, principally for extension of mains, and the sanction of the Local Government Board is expected shortly. The total output of electricity from the works during the past 12 months amounted to 38,610,922 units, as compared with 22,198,241 units of the previous year, an increase of 73·93 per cent. The quantity measured and accounted for during the same time was 31,597,253 units, showing a difference of 7,013,669 units, or 18·17 per cent., being the quantity used in distribution or otherwise not accounted for. The total mileage of mains laid at March 31, 1904, equals 284 miles 1,427 yards. The net profit for the year was £6,808. 12s. 7d. The total Board of Trade units sold in 1895, the first full year of work, was 1,168,382. In 1900 the figures had risen to 6,355 872. Two years later the amount sold was 10,502,299, and last year the amount was 28 966,624. The amount used for traction was nil up to the end of 1901. Then in 1902 it was 1,951 930 units, which increased in the following year to 7,986,072, and last year to 17,125 857. The number of units used for public lamps last year was 41 553, about 1,200 more than in the previous year, but less than in the years 1901, 1900, and 1899.

**South Shields.**—The report of the electrical engineer (Mr. J. H. Cawthra) of the working and financial position of the electricity works for the year ending March 31 last shows a total expenditure to date of £149,356, against £145,815. The gross revenue for the year amounted to £17,165, as against £15,717 the previous year. The working expenditure was £6,601 (£6,117. 13s.), the gross profit for the year being £10,564 (£9,599). Out of that amount £4,869 was devoted to interest on loans and £4,070 to sinking fund, leaving a balance on the year's working of £1,625. The units sold were 1,299,289 (1,148 965) an increase of 150,324, equal to 13 per cent. The total revenue showed an increase of 9 per cent., the gross profit an increase of 10 per cent., while the percentage of gross profit to the total capital expenditure was 7 per cent, compared with 6·6 per cent of the previous year. The amount required this year for interest and sinking fund showed an increase of 6·8 per cent., and the net profit was equivalent to an increase of 31 per cent. The number of lamps connected have risen from 47,674 to 53,837, being an increase of 6,163, equal to 13 per cent., whilst the consumers connected had increased from 906 to 1,010, this being an increase of 11 per cent. The average price obtained per unit for current supplied to private consumers works out at 3·8d., whilst the price obtained for street-lighting was 1·31. per unit, a decreased compared with last year's figures of 0·1d. for both private and street-lighting, equal to 3 and 8 per cent. respectively. The actual cost of producing the energy sold was 1·10d. per unit, against 1·15d. of the previous year, which is equal to a decrease of 4 per cent., and the whole works costs were 0·65d. compared with 0·76d. of the previous year, equivalent to a reduction of 14 per cent. Further, the total cost per unit sold, including interest and redemption charges, amounted to 2·75d., against 2·91d. of the previous year.

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**Oban.**—The Town Council, after considering the supplementary report by Messrs. D. and C. Stevenson on the new intercepting sewer works, last week decided that the money required for necessary alterations and additions at the electricity station be provided by the sewerage department, and that the necessary power for working the plant be supplied by the electricity department at a rate to be afterwards adjusted.

**Electric Signals.**—In order to test the efficiency of electrical as against ordinary mechanical interlocking for the operation of railway signals and points, the Midland Railway Company have placed a contract with Messrs Siemens Bros. for the equipment of a section of their lines with an electric signalling apparatus. The apparatus will take the form of a 48-lever box, which will be situated in the way and works sidings at Derby.

**New Issues.**—The Sunderland District Electric Tramway debentures (bearing 5 per cent. interest) are offering at par. They are secured as a first charge over the whole of the company's undertakings. There should be a very fair opening for the company, and the general manager of the Liverpool Overhead estimates a net traffic revenue of £26,000 per annum. An issue has been made of £200,000 4½ per cent. first debenture stock at £87 per cent. by the Birmingham and Midland Tramways, Limited.

**Newport (Mon.).**—We have received the following general particulars: Units sold—private lighting, 674,199; public lighting, 141,625; power, 114,678; traction, 641,860. Works costs, 1·10d. per unit; management costs, ·21d.—total costs, 1·31d. per unit. Revenue from private lighting, 4·29d. per unit; public lighting, 1·71d.; power, 1·62d.; traction, 1·50d. There is a deficit for the year of £225, but had the old charges prevailed there would have been a profit, as the reductions decreased the revenue by £1,000.

**Clitheroe.**—At the last Town Council's meeting, the Town Clerk reported that he had written to the Postmaster-General complaining of the defective telephonic communication, and that he had received a reply stating that if the Council could show cause for thinking that the Telephone Company did not provide sufficient channels between Clitheroe and the Blackburn exchange, the attention of the company would be drawn to that point. A resolution was passed to the effect that the telephonic communication of Clitheroe was dilatory and imperfect.

**Bedford.**—The electrical engineer has been empowered to purchase 12 5-ampere Ferranti meters at £2. 17s. 6d. each. The electric light accounts for the year ended March 31, 1904, show a profit on the year's working of £744, which sum, together with the sum of £23, the profit for the year 1902-1903, is to be transferred to the credit of the general district fund. The electrical engineer considers it will be necessary to carry out work in connection with the requirements of the undertaking during the next eight or ten years which he estimates at £44,950.

**Swansea.**—The Electric Lighting Committee's financial statement shows that the electric undertaking during the three years of its existence has been highly satisfactory. The interest has been fully paid and sinking fund set aside fully up to date, and there remains a balance of £740. The question of telephone intercommunication is still under consideration, and counsel's opinion is being obtained on the question of applying for a mandamus. A system of telephones, 15 in number, at a cost of £15 per annum, is to be installed at the Swansea Hospital by the Corporation.

**London County Council.**—At Tuesday's meeting it was agreed to lend the Bermondsey Borough Council £28,589 for electric lighting, dust destructor, and other works. The Highways Committee recommended that the estimate of £3,500, submitted by the Finance Committee, be approved, and that expenditure on capital account not exceeding that amount be authorised, in connection with the provision of additional electric cables, to be temporarily laid between the Loughborough Junction generating station and the Clapham sub-station of the London County Council tramways.

**Mexborough.**—The Urban District Council have decided to apply for a loan of about £5,500 for the extension and development of the electric light undertaking. The following items have been approved: engines and dynamos, two new sets, £1,316; boiler and foundations, including connections, £800; 100 connections (estimated by Mr. Senior as two years' prospective), £600; extensions to distributors, £420; switchboard extensions, £75; pipework extension in engine-room, £75; alterations to tank, hot-well, etc., £200; new tools and instruments, £31; contingencies and supervision, 5 per cent. on the whole—making, as stated, an approximate total loan of £5,500.

**Islington.**—At the last meeting of the Borough Council the recommendation that a contract should be entered into with Messrs. Crompton and Co., Limited, for the supply of 78 Crompton lamps was agreed to. The Council have also resolved upon the provision of additional steam valves and pipes and the modification of existing steam-mains, with the object of reducing radiation losses in the electric lighting station, and thereby effecting considerable economy in running the works. Also that an automatic flue gas-analysis recorder should be obtained and the fitting shop engine supplemented by a motor. The estimated cost of carrying out these suggestions was—additional steam-valves and modification of steam-mains, £281; automatic flue gas-analysis recorder, £42; motor for fitting shop, £127—total, £460.

**Newcastle (Staffs).**—At the last Council meeting Mr. Elliott made a statement of the year's working and finances of the gasworks. Speaking of the new electric lighting works, he thought the gasworks had nothing to fear from the competition of the electric light. Though they might lose a few large gas consumers through their taking the electric light, the engines at the electricity works would consume a large quantity of gas. So far from having exceeded the estimates in building and equipping the electric lighting works, they had borrowed £8,000, the works were complete and the cables laid, and they had only spent a little less than £6,000. Though they might not make a profit for a year or two, he did not anticipate, with economical management, any loss whatever; and if it was cautiously and not recklessly pushed, he thought they might look forward to a prosperous undertaking.

**Books Received.**—"Protection in Germany: A History of the German Fiscal Policy during the Nineteenth Century," by William Harbutt Dawson. P. S. King and Son, Orchard House, Westminster. The volume is one of a series by the same author, entitled "Protection in Various Countries."—"The Country Gentlemen's Estate Book, 1904," edited and compiled by Wm. Broomhall, of the Country Gentlemen's Association, Limited, 2, Waterloo-place, Pall-mall, S.W.—There has also appeared the twenty-fifth edition of the indispensable "Molesworth," or, to give the little pocket companion its full title, "Pocket-Book of Useful Formulæ and Memoranda for Civil and Mechanical Engineers," by Sir Guildford L. Molesworth, K.C.I.E., P.I.C.E., etc., and Henry Bridges Molesworth, M.I.C.E. Revised and enlarged with an electrical supplement by Walter H. Molesworth. London: E. and F. N. Spon, Limited, Strand; New York: Spon and Chamberlain.

**Sports.**—A most enjoyable day was spent last Saturday by those who accepted the invitation of the chairman and directors of Messrs. Crompton and Co. to inspect the Arc Works, Chelmsford, and attend the annual athletic sports of the club connected with this firm. As usual, a tour of inspection of the workshops was made, and great interest was taken in the different steges of manufacturing dynamos, motors, switchboards, arc lamps, and various other electrical accessories. Afterwards a luncheon took place at the clubhouse adjoining the works. The visitors included the Mayor of Chelmsford, Sir Carne Rasch, M.P. for Mid-Essex, Colonel Crompton, Mr. T. Callender, Mr. F. R. Reeves, and others, including quite a number of ladies. Speeches were brief, as they should be on such an occasion, Colonel Crompton being anxious that the visitors who had seen the men at work an hour or so previously should also see them at play. Luncheon over, the visitors at once proceeded to the athletic sports, where some very close contests were witnessed for the valuable prizes which were presented to the winners later in the evening by Mrs. Crompton.

**Watford.**—The Urban District Council have been discussing the advantages of pumping water by electricity, thereby saving capital for water supply purposes. Mr. C. Hawksley has been asked to consider the suggestion, and the electrical engineer is obtaining particulars from the various Continental authorities who use electricity for pumping, and has reported as follows: "I find that there are a large number situated in Germany, many of them ranging in size from 300 h.p. to 3,000 h.p., and I would recommend in particular that the installations in the neighbourhood of Dortmund, also at Cologne, Geneva, and Berlin, receive the further consideration of this Council. Moreover, I am of opinion that it would be greatly to this Council's advantage to pump their water by electricity, as no increased capital expenditure would be incurred by this department, and that on the extensions at the waterworks would be decreased, as no boilers would be required, nor buildings to accommodate same, whereas the load factor at the electricity works would be greatly improved." Mr. Colebrook is making further enquiries into the matter. The last report of the Electric Light Committee shows that the number of consumers connected at date was 335.

**Falkirk.**—At the last meeting of the Town Council a statement was made by Treasurer Fairlie, convener of the Electric Lighting Committee, as to the progress made during the year. He said that at May 15, 1903, the capital expenditure amounted to £21,030, and at May 15, 1904, the expenditure was £25,370. This increase had been involved by extensions of mains, new machinery, etc. The revenue totalled £2,146. Of that £1,482 was derived from private consumers and £663 from public lighting. The cost of generating the electricity, management charges, etc., amounted to £1,095, which left a balance of £1,051 to be carried to next revenue account. At the beginning of the year there was a debit balance of £201, and after paying interest, sinking fund, and income tax, the debit at the end of the year was £163. The units sold during the year amounted to 128,855. The cost of generation was ·94d. per unit sold; total cost, including management, 2·04d. per unit sold; average price obtained, 3·73d. for private consumers and 2·84d. for public lighting per unit. The connections made up to date amounted to an equivalent of 7,931 8-c.p. lamps, and the applications to date, exclusive of the new poorhouse, amounted to 9,183 8-c.p. lamps. At the present time the output was nearly double what it was at this period last year, and they had the prospect of a considerable number of new consumers. Taking everything into account, Treasurer Fairlie thought they should not have less than £1,000 of extra revenue this year, which should put the undertaking on a very satisfactory footing at the end of another year.

**Croydon.**—It has been resolved to extend the system of electric lighting, and to borrow a further sum of £20,000 for new mains. The Electricity Committee have, by agreement with the South London Electric Supply Corporation, arranged to supply current to a house in Central-hill, situate just outside the borough boundary, the conditions as to acknowledgment and determination being the same as those entered into by that Corporation in respect of similar arrangements with this Council. An order has been placed with Messrs. Ferranti, Limited, for extensions to the main switchboard, rendered necessary by the installation of the new 750-kw. alternator, which will be erected this summer. The cost of this work will amount to £197. In order to reduce the liability of breakdowns on the arc circuits in Brighton-road, it has been agreed to expend £1,300 on extending the present high-tension main and the erection of a sub-station. The estimated immediate return on applications received and saving on arc current equals 17 per cent. of capital outlay. An extension of mains is to be made owing to an application from the builder for a supply of 770 electric lights for 70 flats now being erected in Portland-road, South Norwood. This will cost £800, and supposing that only 75 per cent. of the tenants use the electric light, will amount to about £400 per annum, being a return of 50 per cent. on the capital outlay. The

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estimated revenue at the end of the first year will amount to about £200, being a return of 25 per cent. on the capital outlay. In addition, alterations and extensions in the centre of the town will be carried out at the estimated present cost of £519.

**Radcliffe.**—The dynamos at the new electric lighting works were started last week for the initial charging up of the 256 accumulators. The works, which will supply current both for lighting and tramways, are in charge of Mr. M. B. Henry, late of Nelson. The buildings consist of boiler and pump house, engine, battery, and store rooms, engineer's office, committee-room, men's room, and other conveniences. There are two Lancashire boilers capable of developing a steam at a pressure of 160lb. per square inch. The boilers can be fed by three supplies from the river, town's water, and the water coming away from the condensers. Of the two pumps, one is electrically driven. The compound engines, built by Messrs. Browett, Lindley, and Co., are direct coupled to Messrs. Mather and Platt dynamos, to be used for either lighting or tramway work. They are capable, normally, of yielding 120 kw. Each of the compound engines can run for a short time at 25 per cent. overload, and at this the dynamos can also furnish 150 kw. each for a short time. The following charges for the supply of electricity have been adopted—viz.: for lighting, 5d. per unit; for power, 2d. per unit, subject to the following scales—viz.: For lighting—for consumption exceeding 1,000 units per annum, 4¾d. per unit; 1,500 units, 4½d.; 2,000, units, 4d. For power—for consumption exceeding 2,000 units per quarter, 1¾d. per unit, also subject to a discount of 5 per cent. if account be paid within 21 days from date of demand, and a minimum charge of 10s. per quarter if the charge for electricity in any quarter does not exceed that sum. Meters will be fixed and let out to consumers free of charge, but sub-meters will be charged for at the rate of 5s. per annum. The specification for direct-current electricity meters prepared by Messrs. Lacey and Sillar has been approved.

**Salford.**—In the annual report of the Lighting and Cleansing Committee, Mr. Hamblett, the superintendent, stated that the actual net expenditure for the year was £55,107. 9s. 2d, or £672. 10s. 10d. less than the estimates. The total weight of the refuse of all kinds collected during the year by the night and day cleansers was 104,906 tons. That was a decrease of 4,890 tons on the total collections of the year before. The population of Salford for the year would be 226,000. The number of inhabited houses in the borough was 45,070. Taking those figures as factors of calculation, the total weight of the refuse of all kinds collected in the borough during the year yielded an average of rather more than 9½cwt. per head of the population, and an average of more than 45cwt. per inhabited house. The total weight of street sweepings collected was 23,047 tons, a decrease of 3,131 tons on the collections of the year before. This decrease was largely owing to the substitution of electric in place of horse traction on the tramways and weather conditions. The total weight of rubbish burnt in the three destructors during the year was 54,204 tons, a decrease of 562 tons on the previous year. A number of streets are lighted by 107 electric arc lamps, each of 1,000 nominal candle-power. All the electric lamps were used during the months of October, November, December, January, February, and March from lighting time until about 11 o'clock at night. At that hour each alternate lamp was switched off, and the remainder left lighted until extinguishing time. During the other six months of the year each alternate lamp was employed throughout the night. The committee paid to the Electricity Committee £14. 10s. per lamp per year. That price included the supply, erection, cleaning, and maintenance of the lamps, and also carboning and current. The switching on and off was done by the committee's lamplighters. The cost of the electric lamps for the year was £1,505. 8s. 4d.

## PROVISIONAL PATENTS, 1904.

JUNE 13.

**13332. Improvements in the manufacture of electric cables.** Charles James Beaver and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

**13343. Improved means for obtaining unidirectional currents of high voltage.** La Société Anonyme Westinghouse, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 17, 1903, being date of application in France.) (Complete specification.)

**13353. Improvements in or relating to electrically-propelled vehicles.** Reuben John Cooper Collins, 21, Steerforth-street, Earlsfield, London.

**13360. Improvements in electrical measuring apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13369. Improvements in or relating to the electric ignition apparatus of internal-combustion engines.** Charles William Higgs, Robert Julian Heinke Fox, and Thomas Barker Hopkinson, 32, Holborn-viaduct, London.

**13376. Improved casing for protecting electric leads.** Siemens Bros. and Co., Limited, and George Elliott Kerss, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 14.

**13399. Improvements in electric arc lamps.** August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

**13434. Improvements in connection with arc-lamp standards.** David Martin, 55, Chancery-lane, London.

**13424. An automatic electrical apparatus for simultaneously locking and unlocking the doors of railway carriages.** Edward Barber, William Henry Pilkington, Frederick Austerberry, and John Hood Bell, 33, Cannon-street, London.

**13427. Brake for overhead electrically-driven locomotives.** Wallace Fairweather, 65, Chancery-lane, London. (The Brown Hoisting Machinery Company, United States.) (Complete specification.)

**13428. Electrical locomotive.** Wallace Fairweather, 65, Chancery-lane, London. (The Brown Hoisting Machinery Company, United States.) (Complete specification.)

**13433. Improved process and apparatus for cleaning out accumulator batteries.** Heinrich Hicking, 36, Chancery-lane, London. (Complete specification.)

**13463. An electric block signal system.** Louis Charles Werner, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**13466. Improvements in electric incandescent lamps.** Herman Plauson, 7, Southampton-buildings, Chancery-lane, London.

**13468. Improvements relating to electric switches.** William M. Scott, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 31, 1903, being date of application in United States.) (Complete specification.)

**13476. Improvements in electric plug and socket extensions.** William Hargreave Kelsey, 7, Southampton-buildings, Chancery-lane, London.

**13483. Improved electric regulating apparatus of variable resistance and for direct reading.** Emile Fauvin, Eugène Amiot, and Edouard Cheneaux, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Nov. 28, 1903, being date of application in France.) (Complete specification.)

**13489. Process of and apparatus for electrical separation.** Friedrich Oscar Schnelle, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 15, 1903, being date of application in Germany.) (Complete specification.)

JUNE 15.

**13516. Mechanical ear, used for the suspension of overhead trolley wire.** William Edward Taylor, 16, Dale-street, Blackpool.

**13527. Improvements relating to electrical measuring and indicating devices.** George Huges, 8, Portobello Harbour, Dublin.

**13532. Improvements in and relating to the prevention of accidents on tramway systems through the breaking of overhead wire.** John Morgan, 55, Chancery-lane, London.

**13543. Improvements in electrical switches.** Andreas Peter Lundberg and Gustaf Charles Lundberg, 477, Liverpool-road, London.

**13564. Improvements relating to the regulation of electric motors.** The Johnson-Lundell Electric Traction Company, Limited, 7, Southampton-buildings, Chancery-lane, London. (Johan Gustav Viktor Lang, Germany.) (Complete specification.)

**13567. Improvements in envelopes for vapour electric conductors.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 15, 1903, being date of application in United States.) (Complete specification.)

**13568. Improvements in bearings for the shafts of measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13569. Improvements in electric controllers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13570. Improvements in controlling switches for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**13585. Improvements relating to electric motors.** Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 19, 1903, being date of application in France.) (Complete specification.)

JUNE 16.

**13596. Improvements in electric alarm clocks.** Frederick Walter Baynes, 51, Elmside, Exeter, Devon.

**13623. An improved handle for rotary brushes and other devices driven by electricity.** John Maclean, 100, Wellington-street, Glasgow.

**13643. Improvements in and connected with signals in telephonic exchange.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

**13686. Improvements in clocks controlled by reversals of electric current.** Franklin Wise Howard, 46, Lincoln's-inn-fields, London. (The Firm Magneta Fabrik Electr. Uhren, Switzerland.)

JUNE 17.

**13698. Improvements in and connected with electrical motor-starting switches.** Ughtred Horsfall, Joseph Crowther, and Arthur George Brown, 49, Deansgate, Manchester.

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**13763. Improvements in or connected with electrical railways.** Henry Edmund Theodoric Vale and Frank Lionel Monkhouse, 9, Tempest Hey, Liverpool.

**13766. Improvements in apparatus for winding coils for continuous-current dynamo and motor electric machines.** Arthur William Tomkins, 3, Brown-street, Market-street, Machester.

**13769. Improvements in automatic electrical signalling apparatus for railways.** Algernon Hamo Binyon, 53, Chancery-lane, London.

**13720. Improvements relating to electrical traction overhead conductor equipment.** Charles Adolph Schierwater, 10, St. George's-crescent, Liverpool.

**13724. Improvements in electric drills.** William Obed Duntley, 65, Chancery-lane, London. (Complete specification.)

**13728. A new or improved outside protector for the terminals of secondary or electrical storage batteries.** Sidney George Prince, 114A, Chancery-lane, London.

**13733. Electric plug adaptor.** William Thomas Piper, 2, High-street, Beckenham, Kent.

**13736. Improvements in apparatus employed for measuring wave-lengths in wireless telegraphy.** John Ambrose Fleming, University College, Gower-street, London.

**13758. Improvements in and relating to portable electric lamps.** Harry Cross Hubbell, 77, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 2, 1903, being date of application in United States.) (Complete specification.)

**13759. Process for the production of titanium from its oxygen compounds electrolytically.** Wilhelm Borchers and Wilhelm Huppertz, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 18, 1903, being date of application in Germany.) (Complete specification.)

**13779. Improvement in system of electrical distribution.** Gano Sillick Dunn, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act. 1901, June 18, 1903, being date of application in United States.) (Complete specification.)

JUNE 18.

**13806. Improvements relating to electric ignition of internal-combustion engines.** Francis William Aston, Sennal House, Harborne, Birmingham.

**13862. Improvements in and relating to electric arc lighting systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**13863. Improvements in and relating to elastic fluid turbines** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**13864. Improvements in and relating to the construction of dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.)

**13865. Improvements in means for transforming the energy of alternating currents.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 18, 1903, being date of application in United States.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published July 7, 1904.*

1903.

**10652. Electric controllers or switches.** Mascord.

**12993. Automatic electric circuit makers and breakers.** Statter and Simeon.

**13378. Method of constructing dynamo-electric generators.** Johnson.

**13582. Starting switch for electric motors.** Ahlquist.

**14079. Controlling systems for electric motors.** British Westinghouse Electric and Manufacturing Company, Limited. (Westinghouse Electric and Manufacturing Company.)

**14164. Gas or vapour electric apparatus, such as mercury vapour lamps for lighting or other purposes.** Le Tall. (Cooper-Hewitt Electric Company.)

**14211 Electric switch and circuit breaker.** Veritys, Limited, and Selby.

**14671. Electrical shot-firing or like apparatus.** Wood and Clifton.

**15369. Operating cords of the trolley arms of electric tramcars.** Taylor, Moorhead, and Kingscote.

**16360. Means for breaking electric circuits.** Auel and Spurrier.

**17663. Electric accumulators.** Becker.

**19547. Magnetic excitation of alternate and three-phase current machines.** Thompson. (Berliner Maschinenbau-Actiengesellschaft vorm. L. Schwartzkopff.)

**23978. Overhead electric current conductors.** Giraud. (Date applied for under International Convention, Nov. 5, 1902.)

1904.

**4748. Magnetic combined speed indicator and speed-limit alarm.** Oades and Gratze.

**8394. Apparatus for automatically operating electric switches, gas cocks, or other like controlling devices.** Russ.

**8999. Means for protecting the live parts of electric switches or the like.** McDevitt.

**10189. Apparatus for heating liquids by means of electrical current.** Waterman.

**10370. Secondary or storage battery plates.** Boult. (Potter.)

**10858. Receiving apparatus for wireless telegraphy.** Cerebotani and Silbermann.

**11111. Electrically operated hoisting winch.** Gustin.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | .. | ⅝-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | .. | ¼-⅜ |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | .. | 5¼-6 |
| —— 5 per cent. Cum. Pref., 1-100,000 | 5 | .. | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | .. | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | .. | 3½-3⅝ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | .. | 87-90 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | .. | ¾-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | .. | 1-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | .. | 94-99 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | .. | 73-78 |
| Callender's Cable, Debentures | 100 | .. | 104-108 |
| —— Ordinary | 5 | .. | 9½-10¼ |
| —— 5 per cent. Pref. | 5 | .. | 6¼-6⅝ |
| Crompton and Co. | 3 | .. | 1⅝-2⅛ |
| —— 5 per cent. Debentures | 100 | .. | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | .. | ¼-½ |
| —— "A" Shares, 01-017,139 | 5 | .. | ¼-1⅛ |
| —— 5 per cent. Debentures | 100 | .. | 75-79 |
| —— 4 per cent. Deb. Stock, Red. | 100 | .. | 73-78 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | .. | 1⅛-1⅜ |
| —— 7 per cent. Cumulative Pref. | 2 | .. | 2¼-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | .. | 97-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | .. | 9¼-9⅝ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | .. | 93-98 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 11½-12½ |
| —— 4½ per cent. Preference | 5 | .. | 5-5¼ |
| —— 4½ per cent. Debentures | 100 | .. | 107-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | .. | 19-20 |
| —— 4 per cent. Debentures | 100 | .. | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | .. | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | .. | 36-39 |
| —— 5 per cent. Bonds | 100 | .. | 101-104 |
| **Electric Lighting and Supply.—** | | | |
| Blackheath & Greenwich District Ordinary 1,801-101,800 | 1 | .. | ⅝-¾ |
| —— 4½ per cent. Deb. Stk. Certs., Red. and Conv. | 100 | .. | 120-125 |
| Bournemouth and Poole, Ordinary | 10 | .. | 11¼-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | .. | 8½-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | .. | 10¼-11½ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | .. | 101-104 |
| Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red. | 100 | .. | 100-103 |
| Brompton and Kensington, Ordinary | 5 | .. | 10¾-11¼ |
| —— 7 per cent. Preference | 5 | .. | 10¼-10⅝ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000 | 5 | .. | 7-7⅛ |
| —— Nos. 20,001-30,000 | 5 | .. | 7-7⅛ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | .. | 12½-13¾ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | .. | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | .. | 7⅛-8 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4¾-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | .. | 102-104 xd |
| Chelsea Electricity Supply | 5 | .. | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | .. | 107-110 |
| City of London, Ordinary | 10 | .. | 11-11½ |
| —— 6 per cent. Cumulative Pref. | 10 | .. | 13-14 |
| —— 5 per cent. Debenture Stock | 100 | .. | 121-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | .. | 102-105 |
| County of London and Brush Provincial, Ordinary | 10 | .. | 7¼-8¼ |
| —— 6 per cent. Cum. Pref. | 10 | .. | 11-12 |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | .. | 106-109 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | .. | 5⅜ 6 |
| —— 6 per cent. Cum. Pref. | 5 | .. | 5⅜-5⅝ |
| —— 4½ per cent. First Mort. Deb. | 100 | .. | 105-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | .. | 1¼-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 | .. | 90-95 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | .. | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | .. | 100-103 |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | .. | 7¼-8¼ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | .. | 12-13 |
| —— per cent. Debenture Stock Red | 100 | .. | 102-105 |
| Kensington and Knightsbridge and Notting Hill | 100 | .. | 102-105 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | .. | 9¾-10¼ |
| London Electric, Ordinary | 3 | .. | 1¼-1⅜ |
| —— 6 per cent. Pref. | 5 | .. | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | .. | 93-96 xd |
| Metropolitan Ordinary | 10 | .. | 19½ 20¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | .. | 109-113 |
| —— 5½ per cent. Mortgage Debenture, Red. | 100 | .. | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | .. | 98-101 |
| —— Preference | 4 | .. | 100-103 |
| Notting Hill Electric Lighting | 10 | .. | 13-14 |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | .. | 98-101 |
| Oxford Electric, Ordinary, 1-96 and [illegible]-14,310 | 5 | .. | 5¼-6 |
| —— 4 per cent. Debenture Stock | 100 | .. | 98-101 |
| Royal Electrical Company of Montrea. 4½ per cent. First Shares Mortgage Debentures | 100 | .. | 100-103 |
| Smithfield Markets Electric Supply, Ltd., ord., 1-12,000 | 5 | .. | 2⅝-3¼ |
| —— 4 per cent. Debenture Stock | 100 | .. | 85-90 |
| South London, Ordinary | | .. | 3¾-4¼ |
| St. James's and Pall Mall, Ordinary, 101-30,080 | 5 | .. | 14-15 |
| —— 7 per cent. Pref. | 5 | .. | 8-9 |
| —— 5½ per cent. Deb. | 100 | .. | 97-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | .. | 4¼-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | .. | 4¼-5 |
| Westminster, Ordinary | 5 | .. | 12¾-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | .. | 6¼-6⅝ |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| **Electric Railways.—** | £ | £ |
| Central London, Ordinary | 100 – | 92-95 |
| —— 4 per cent. Pref. | 100 – | 102-105 |
| —— ,, ,, deferred | 100 – | 81-84 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 113-116 |
| City and South London, Consolidated Ordinary | 100 – | 50-52 |
| —— 4 per cent. Debenture Stock | 100 – | 106-109 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 123-126 |
| —— ,, ,, ,, '96 | 100 – | 120-123 |
| —— ,, ,, ,, '01 | 100 – | 118-122 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10 10½ |
| —— Ordinary, 1-60,000 | 10 – | 3½-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 99-101 |
| Waterloo and City, Ordinary | 100 – | 89-92 |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 1-260,007 | 5 – | 5-5½ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 – | 132-137 |
| Blackpool and Fleetwood Tramroad | 10 – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1½-2½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3⅜-4½ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 98-103 |
| British Columbia Electric Railway Co., Ord. Def. | 100 – | 100-103 |
| —— Ord Pref. | 100 .. | 98-101 |
| —— Non-Cum. 5 per cent. Pref. | 10 .. | 10½-10⅝ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 – | 103-105 p.c. |
| —— 4½ per cent. Vancouver Power Deb. | 100 .. | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 9⅜-10½ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10⅜-11½ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 116-119 |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 – | 2½-3½ |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 – | 5½-5⅝ |
| —— "B" 5 per cent. Cm. Pf., 1-27,500 | 5 – | 5-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 107-110 |
| —— Prov. Cert., all paid | 100 – | 103-106 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅛-2⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4⅞-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 – | 98-101 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 .. | 100-103 |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Cork Electric Tramways and Lighting Co., Ordinary | 10 – | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 12½-13½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18-19 |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 – | 108-110 |
| Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000 | 5 – | 3½-4 |
| —— 4 per cent. Debenture Stock | 100 – | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8 8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 11-11½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 104-106 |
| Metropolitan Electric Trams., Deferred 1,000 001-1,514,016 | 1 – | ¼-½ |
| —— 5 per cent. Cum. Pref., 500,001-814,016 | 1 – | ¾-1 |
| New General Traction, Ordinary | 5 – | ⅛ |
| —— 6 per cent. Cum. Pref. | 5 – | 1-2 |
| —— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.) | 100 – | 88-93 |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12-12½ |
| —— 5 per cent. Cum. Pref. | 10 – | 9⅜ 9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk. | 100 – | 100-103 |
| Potteries Electric Traction, Ordinary, 20,001-40,000 | 10 – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9-10 |
| —— 4½ per cent. Debenture Stock | 100 – | 101-104 |
| South Lancashire Electric Traction and Power Company— | | |
| —— £250,000 Ordinary | 1 – | 1 |
| —— £101,132 6 per cent. Preference | 1 – | 1 |
| —— £528,09 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 104-106 |
| —— Deferred Stock | 100 – | 85-88 |
| —— 6 per cent. Cum. First Pref. | 10 – | 11-13 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 11-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5-5½ |
| —— 3½ per cent. Deb. Stock, Red. | 100 – | 99 101 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 103-105 |
| Oriental Telephone and Electric Company | 1 – | 15/16-1 1/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 18 | 1,501 | 1,154 | + 347 | + 869*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 18 | 326 | 307 | + 19 | — | 8 | 8 | Sept. 25 | 12,503 | 2,979,276 | 290,099 | 1·00 | 10·34 | 1,560 | 4·7 |
| Barking Corporation | ,, 18 | 37 | — | — | — | 1½ | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 19 | 1,117 | 1,114 | + 3 | - 51 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways | ,, 18 | 5,653 | 4,733 | + 920 | + 8,194 | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 17 | 1,046 | 737 | + 309 | + 852 | 24 | 24 | March 25*g* | 40,964 | 7,234,106 | 826,558 | 1·36 | 11·87 | 1,705 | 7·44 |
| Blackpool Corporation | ,, 16 | 793 | 774 | + 19 | + 656 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 18 | 559 | 652 | - 93 | - 777 | 16½ | 16½ | Dec. 31 | 30,923 | 2,049,677 | 584,989 | 3·62 | 12·68 | 1,932 | 6·99 |
| Bolton Corporation | ,, 19 | 1,829 | 1,804 | + 25 | - 104 | 38 | 38 | March 31*g* | 85,704 | 17,761,605 | 1,896,247 | 1·15 | 10·75 | 3,430 | 5·87 |
| Bournemouth Corporation | ,, 15 | 1,019 | 885 | + 134 | + 638 | 10½ | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 18 | 4,671 | 3,485 | +1,186 | + 9,174 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 19 | 935 | 859 | + 76 | + 21*h* | 7½ | 6½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 17 | 5,146 | 4,514 | + 632 | — | 51½ | 51½ | Dec. 31 | 223,480 | 41,192,899 | 5,724,114 | 1·30 | 9·38 | 4,348 | — |
| Burnley Corporation | ,, 18 | 1,081 | 699 | + 382 | — | 10 | 7 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 19 | 354 | — | — | — | 8¼ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 18 | 2,030 | 1,832 | + 258 | + 919 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 18 | 203 | 187 | + 16 | + 288 | — | — | ,, 31 | — | 2,216,583 | 320,129*h* | — | — | — | — |
| Central London Railway | ,, 18 | 6,532 | 6,674 | - 142 | - 2,807*h* | 6 | 6 | ,, 31 | 367,225 | 45,305,110 | 1,276,971*a* | 1·87 | 66·6*a* | 59,076 | 35·6*a* |
| City & South London Railway | ,, 19 | 2,521 | 2,948 | - 427 | - 2,651*h* | 6⅜ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 16 | 489 | 605 | - 116 | - 803 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 19 | 198 | 231 | - 33 | - 123 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 18 | 229 | 220 | + 9 | - 237 | 4½ | 3 | — | — | — | — | — | — | — | — |
| Dublin & Lucan Electric Ry. | ,, 19 | 129 | 125 | + 3 | + 210*h* | — | — | Dec. 31 | 5,796 | 364,796 | 102,087 | 3·81 | 13·62 | 359 | 7·68 |
| Dublin U. T., electric cars | ,, 17 | 4,167 | 3,733 | + 429 | } — | 46 | 46 | March 31 | 126,121 | 24,553,133 | 3,429,356 | 1·23 | 8·82 | 2,741 | 5·06*h* |
| Dublin S. District, Electric | ,, 17 | 1,000 | 861 | + 139 | | | | | | | | | | | |
| Dundee City Tramways | ,, 15 | 869 | 832 | + 37 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 18 | 774 | 595 | + 179 | + 1,011 | 10·75 | 10·75 | March 31*g* | 25 341 | 9,971,337 | 650,224 | 0·61 | 9·35 | 2,357 | — |
| Glasgow Corporation | ,, 18 | 14,650 | 13,717 | + 933 | - 1,782*h* | 124 | 124 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Gloucester Corporation | ,, 1 | 224 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 15 | 3,105 | 2,532 | + 573 | + 1,073 | 31½ | 30½ | — | — | — | — | — | — | — | — |
| Huddersfield Corporation | ,, 18 | 1,312 | 1,130 | + 182 | — | 34 | 34 | March 31 | 56,631*h* | 9,738,213 | 1,218,539 | 1·4 | 11·14 | 1,618 | 6·38 |
| Hull Corporation, E. S. | ,, 18 | 2,167 | 1,713 | + 454 | + 2,671 | 25 | 19 | ,, 31 | 87,707*h* | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 11 | 495 | 395 | + 99 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 15 | 139 | 148 | - 9 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 15 | 221 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 18 | 5,798 | 5,078 | + 720 | +69,582 | 77 | 77 | March 25*g* | 262,656 | 57,239,779 | 5,773,651 | 1·11 | 10·91 | 3,283 | — |
| Leicester Corporation | ,, 11 | 1,086 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 11 | 10,917 | 10,179 | + 738 | + 4,496 | 103 | 101 | Dec. 31 | 504,304 | 108,906,472 | 11,705,425 | 1·11 | 10·34 | 5,000 | 6·88 |
| Liverpool Overhead Railway | ,, 19 | 1,575 | 1,620 | - 45 | - 18*h* | 15½ | 15½ | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 11 | 12,303 | 9,300 | +3,003 | +18,239 | 40 | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 11 | 177 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 18 | 12,613 | 10,871 | +1,742 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 18 | 126 | 57 | + 69 | + 604 | 3 | 3 | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 18 | 3,799 | 3,313 | + 486 | — | 38½ | 38½ | March 25*g* | 150,334 | 33,474,122 | 3,379,119 | 1·08 | 10·93 | 4,175 | 6·17 |
| Newport (Mon.) Corporation | ,, 18 | 514 | 376 | + 138 | + 1,462 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 18 | 1,964 | 1,544 | + 420 | + 2,198 | 29 | 29 | Sept. 30 | 47,651 | 9,168,137 | 868,157 | 1·24 | 13·17 | 1,643 | — |
| Rochdale Corporation | ,, 20 | 131 | 150 | - 19 | — | 4½ | 4½ | March 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 16 | 489 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Salford Corporation | ,, 20 | 3,994 | 3,900 | + 94 | + 4,594 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 18 | 180 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 19 | 4,704 | 4,328 | + 376 | + 2,013 | 53½ | 53½ | Mar. 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 16 | 966 | 1,187 | - 221 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 15 | 345 | 269 | + 76 | + 218 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 17 | 618 | 262 | + 356 | + 2,819 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 19 | 1,314 | 1,232 | + 82 | + 387 | 18·48 | 18·48 | ,, 31*g* | 59,930 | 13,987,121 | 1,270,957 | 1·03 | 11·3 | 3,243 | 6·4 |
| Wallasey U.D.C. | ,, 18 | 783 | 645 | + 137 | + 387 | 10·5 | 10·5 | ,, 31*g* | 31,474 | 5,685,182 | 654,742 | 1·30 | 11·53 | 3,593 | 7·03 |
| West Ham Corporation | ,, 16 | 1,108 | — | — | — | 1¾ | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 15 | 607 | 215 | + 392 | — | 7½ | — | — | — | — | — | — | — | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
*b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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## MECHANICAL STOKERS.

BY W. ROGERS.

At the present time a great diversity of opinion exists among station engineers and other steam users as to the advantages to be obtained by employing mechanical stokers, and more so with regard to the type of stoker it is most advantageous to employ. Nearly 50 years have elapsed since mechanical stokers were first introduced, the early forms being, of course, very inefficient in the extreme, but notwithstanding this fact, the improvement in mechanical stokers has not been a gradual process such as one might have expected—in fact, real progress has practically been confined to the last 10 years. It is really difficult to explain the reason for this seeming contempt for improvement amongst the older makers of mechanical stokers, but it is very evident that the large number of failures attending the employment of machine firing in the early days, owing to the stokers having been fitted to work under impossible conditions, has done a great deal towards stifling the industry, which has, however, greatly improved within the last few years. Notwithstanding the numerous difficulties met with in the past, the mechanical stoker of the present day may be said to have reached a very efficient form, although the ideal stoker has yet to make its appearance. Before dealing with the question of machine firing, it may be well to enquire into the conditions necessary for the smokeless combustion of bituminous fuels and high boiler efficiencies, which conditions engineers have tried to satisfy by employing mechanical stokers. As is well known, the tendency of all coals, and more especially bituminous coals, to produce smoke depends upon the rate of combustion: therefore, to obtain freedom from smoke, it is necessary to have a slow rate of combustion, which in turn depends upon the frequency of the supply of fuel to the furnace, and also on the quantity supplied at each firing; it may, therefore, be said to depend upon the period allowed for the complete combustion of a given quantity of the evolved gases. It follows, therefore, that the chief requirements necessary for obtaining smokeless combustion are (1) an air supply sufficient to enable the evolved gases to complete their combustion; (2) the regular firing of small quantities of fuel at frequent intervals. (For more complete information on the subject of smokeless combustion of bituminous fuel readers are referred to an excellent paper by Mr. Booth, read before the British Association at Belfast, a copy of which will be found in the *Electrical Engineer*, of Oct. 17, 1902.) The first requirement is of great importance, and it should always be borne in mind that the improvements effected in the steam-raising capacity of a boiler by the employment of any system of machine firing are limited by the chimney draught, and that it is impossible to burn more fuel per hour by machine firing than could be burnt by hand firing with the same chimney draught. Many of the numerous failures attending the employment of machine stokers in the early days may be put down to the fact that steam users who were troubled with inefficient boilers sought to cope with their difficulties by installing machine stokers, when all they required was increased chimney draught. Mechanical stoking may be said to satisfy the second requirement of smokeless combustion by (1) supplying to the furnace at regular intervals small quantities of fuel, the time between each charge being sufficient for the gases to effect their combustion; (2) avoiding the loss occasioned by the admission of excess of air over that necessary for combustion, through the frequent opening of the firedoor when firing by hand. It will, therefore, be seen that the employment of a mechanical stoker giving a regular feed of fuel and automatic cleaning of the fires ensures greater economy and efficiency than is possible with hand firing. As will be readily understood, the clockwork regularity of the supply of fuel to the furnace has the effect of increasing the average temperature of the furnace gases, by decreasing the great fluctuations in temperature which it is impossible to prevent when a furnace is fired by hand. As a proof of the above remarks, reference will be made to Fig. 1, which gives curves showing the variation in temperature of the furnace gases of a boiler employing machine stoking, the same boiler being submitted to another test with hand firing. The curves show very clearly the great advantages attending the employment of machine stokers. The stoker employed in the above tests was the Proctor radial shovel stoker, which will be fully described later on. There are two distinct classes of mechanical stokers—namely, those of the underfeed and top-feed type. Those of the latter type may be again sub-divided into two forms—viz, coking and sprinkling stokers. The underfeed type of stoker also acts on the coking principle. We shall first consider stokers of the top-feed type.

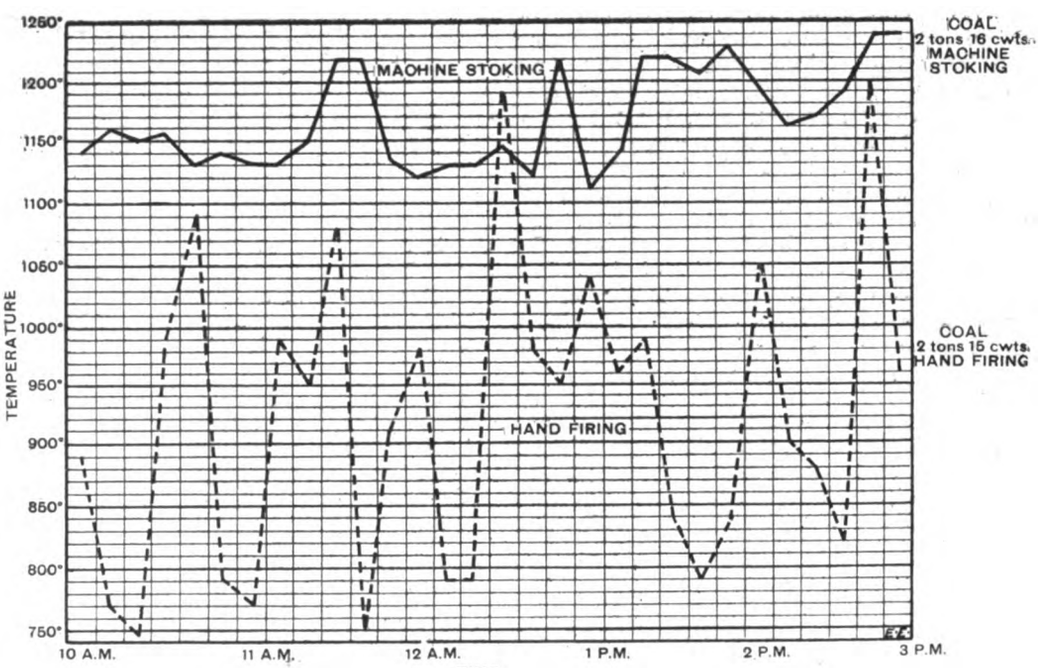


FIG. 1.—Boiler Test, Down-take Flue. Duration, five Hours. Machine Stoking *v.* Hand Firing.

*Coking Stokers.*—These may be either of the chain-grate or ram type. The chain-grate stoker, as its name implies, consists of a number of cast-iron links about 9in. long, fastened together, forming an endless chain, which works over drums at the front and back. In the ram type of stoker the coal is pushed by means of a ram on to a coking plate situated at the front end of the furnace, where its volatile gases are given off, and is gradually worked to the back of the furnace, the residue falling into the ashes pit. The coking type of stoker is generally considered to be the most perfect smoke preventer it is possible to obtain; this is owing to the fact that the coking process is the natural method of smoke prevention, and the coking stoker fulfils

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the requirements of smoke prevention by introducing the fuel at the front end of the grate on to the coking plate, and allowing the evolved gases to thoroughly mix and then pass over the incandescent fire by which they are completely consumed, if the air supply be sufficient. Under ordinary conditions the coking process is a slow one, the rate of combustion being limited by the chimney draught.

*Sprinkling Stokers.*—The action in a sprinkling stoker is a good imitation of hand firing. Coal is allowed to fall from a hopper on to a dead plate in front of the furnace, the fuel being knocked on to the fire by the release of a shutter, the intensity of the blow of this shutter being varied by an arrangement of springs and cams, so that the fuel may be thrown to the front or back of the furnace as required, which permits of an even thickness of fire being obtained.

*Underfeed Stokers.*—These are of two types—viz., the ram and the screw-feed type. The ram type consists of a U-shaped tapering trough, which extends the length of the grate. The feed motion to the fuel is given by a ram operated at frequent intervals by a piston in a steam-cylinder fixed in front of the stoker. As the fuel is pushed along the trough it rises to the surface, where it cokes, afterwards being burnt. The air necessary for combustion is supplied by a blower through tuyere blocks or air ducts situated at the edge of the trough. The valve that distributes the steam to the cylinder at required intervals is worked by an automatic trip gear, which will be fully described later on. The screw-feed type of stoker is very similar in construction, but the feed is given by a continually revolving helix in the trough, which takes the place of the ram in the former type of stoker. The grate is of an inverted V-shape, its sides being built up of tuyere blocks, through which the air is passed. As the coal rises to the top of the trough it falls down the sides, a good distribution of fire being thus obtained.

Having briefly described the principles of the different forms of mechanical stokers, we will now further consider each type in detail, and to enable the construction to be more clearly understood, reference will be made to the several illustrations representing the different types of stokers. It may be well to remark that the writer does not intend it to be assumed that each illustration represents the best make of stoker in its own particular class, his intention being merely to show an illustration in each of the different classes of stokers. For clearness we shall deal with each class in the same order as they have already been described, so reference will be made to Fig. 2, which represents a well-known make of coking stoker—viz, the Babcock and Wilcox chain-grate stoker. This stoker has been designed for the efficient and smokeless combustion of semi-bituminous fuels. As already stated, the grate takes the form of an endless chain, built up of cast-iron grate bars passing over drums at the front and back, the front drum being revolved by a worm and wormwheel, The speed of the grate is about 25ft. per hour. The frames of the stoker are provided with wheels running on rails placed at the sides of the ashpit. The whole stoker can thus be brought out clear of the boiler, which greatly facilitates repairs. Fuel is fed over the whole width of the grate, the thickness of fire being regulated by the adjustment of the vertically lifting firedoors. The feed of the fuel is slow, and the gases evolved from the fresh fuel as it drops on to the grate readily perfect their combustion by passing over the incandescent fuel further on. The speed of travel of the grate may be regulated by a ratchet and pawl attachment on the driving worm, which latter gears into a wormwheel, on the shaft of which are the drums which revolve the grate. This stoker can thus be instantly adjusted to suit the class of fuel and the varying demands for steam, by altering the thickness of fire and the speed of the grate. In practice it is generally found that with a particular quality of fuel the fires are kept in good condition with a definite thickness of fire: therefore, during a run it is better to keep a constant thickness of fire, and meet the varying demands for steam by altering the speed of the grate. Of course, it is quite possible that the bunkers may contain coal of varying quality, but the fireman can generally count on getting coal of uniform quality to last through his shift. The fires never want cleaning by hand, and by the time the fuel at the front end has reached the back of the furnace it is completely consumed, the residue ash being deposited in the ashes pit. The advantages claimed for this type of stoker are: (1) high efficiency; (2) low cost of upkeep; (3) easy manipulation; (4) smokelessness when burning a low class of fuel; (5) requires small driving power; and, lastly, hand firing may be resorted to in case of accident to the driving gear.

Fig. 3 is an illustration of Proctor's radial shovel stoker, representing a stoker of the sprinkling type. To use the words of the inventor, this stoker has been designed

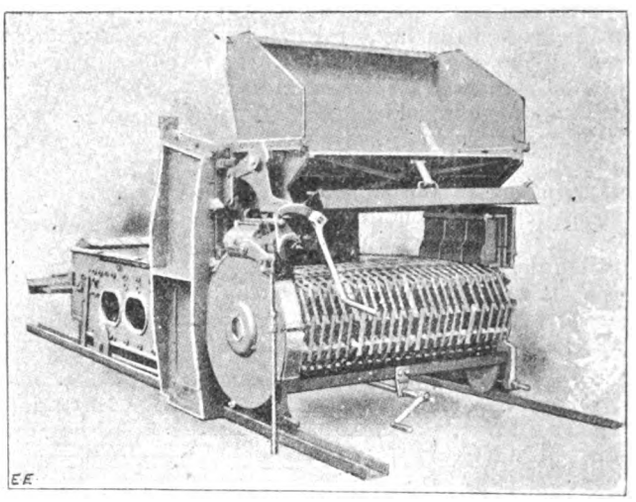

FIG. 2.—Babcock and Wilcox Patent Mechanical Chain-Grate Stoker, with Firedoor Open.

with the intention of developing what has always been considered the best method of stoking—viz., good hand firing, which consists in firing lightly and at frequent intervals, keeping the fires as regular and even as possible. This result is obtained mechanically by this stoker, which is so arranged that by the action of a spring, shovel, and tappet it distributes a small quantity of fuel to different parts of the fire, thus keeping a level fire the full length of the grate. The action of the moving firebars keeps the air spaces free from clinker, and the fire in a loose condition, the clinker being worked off the back end of the bars into a clinker chamber. The quantity of coal to be burnt can be regulated by adjusting the regulating screw

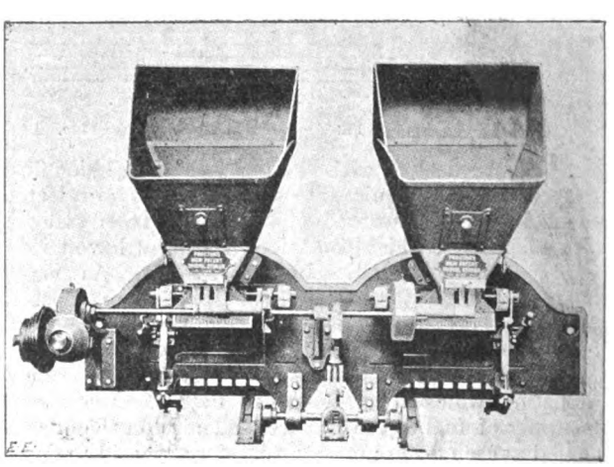

FIG. 3.

of the ram which supplies coal to the shovel. To enable the shovel to distribute the fuel equally over the firebars, it is made in the form of a V; also for the purpose of covering the whole length of the firegrate, the tappets are placed at different distances from the centre of the lantern wheel, giving more or less travel to the shovel, and thus varying the tension upon the springs, which allows the fuel to be thrown to any part of the grate.

We shall now return to the underfeed type of stoker, and reference will be made to Fig. 4, which shows a section through Erith's underfeed stoker. This stoker differs from all other types by having no grates, the ashpit being completely closed off by solid dead plates, which are kept cool

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by the forced draught. There are no moving parts in contact with the fire, the coal being fed from below the fire line at regulated intervals by a simple ram-motion. As the fresh coal rises it reaches the coking stage, at which the evolved gases pass upwards through the incandescent fuel, being thus completely consumed. The operation of this stoker is exceedingly simple, and will be readily understood from what follows. As already stated, the coal is fed by a ram actuated by steam and making strokes at regulated intervals of one to three minutes, without attention. The steam-driven ram makes a regular thrust down in the fresh coal below the fire line, its auxiliary rod moving with it down the bottom of the trough, thereby giving the fuel an upward and backward movement at each charge. The steam-valve of the ram cylinder is tripped at regular intervals by an automatic trip gear, provision being also made to trip the steam-valve by hand when a quick feed is desired, as, for instance, when building up the fires after cleaning. This trip gear, which is self-

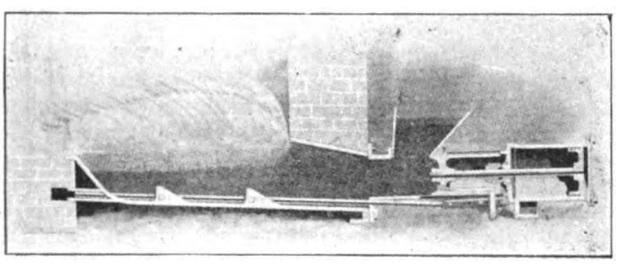

FIG. 4.

contained, works by gravity, no steam or shafting being required. As will be seen in the illustration shown in Fig. 5, this trip gear consists of a hollow rocking beam carrying at each end a hollow vessel partly filled with water. When the beam is nearly horizontal steam is shut off from the ram cylinder, the ram being then at rest in its forward position. The water runs by gravity through the hollow beam from the upper to the lower vessel, and as soon as the weight of the lower vessel overcomes the counterweight, the latter falls over and opens the forward steam-port and admits steam, which draws the ram backwards. As the ram moves backwards it reverses the position of the water-vessels, consequently the actions are also reversed, thereby giving the ram its charging stroke.

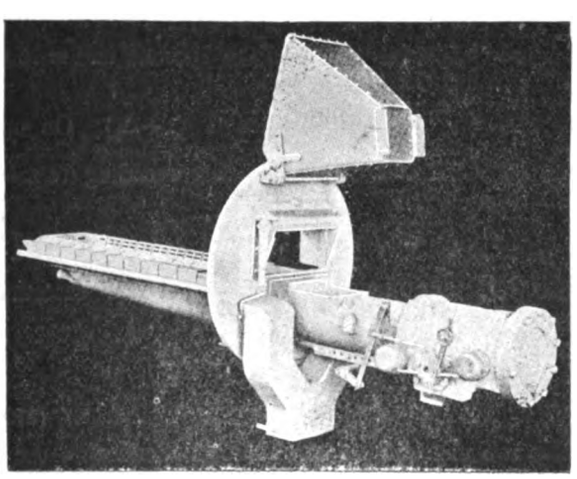

FIG. 5.

The valve on the rear water-vessel controls the rate of flow of the water, and thus the intervals between the charges of coal can be exactly regulated. The steam consumed by the ram is quite nominal, as steam is only admitted to the cylinder at the instant of the stroke, and cut off in the intervals, the usual rate of feed being one stroke every two or three minutes: it is, therefore, a very economical method of feeding the fuel. The air supply necessary for combustion is supplied at low pressure by a simple fan blower, and is regulated by a damper. The air enters the closed ashpit, and reaches the furnace through the tuyere blocks, which are placed along the top of the coal trough—viz., above the fresh coal and the working parts, but below the fire. It will, therefore, be seen that the air is thoroughly mixed with the gases evolved during the coking of the fresh fuel as it is forced up into the fire, the mixture of air and gases passing through the mass of burning coal, ensuring almost complete combustion. The chief advantages claimed for this type of stoker are: (1) smokeless combustion of cheap fuels; (2) no waste of fuel owing to no grates being employed; (3) few working parts, and none in contact with the fire; (4) large range of capacity; (5) complete control of feeding the fuel, and of air supply; (6) low cost of upkeep and saving in labour. Having described the different types of stokers, it will be necesary to consider the advantages and disadvantages of the different systems of stoking.

*Coking System.*—This system of stoking is considered the most economical, as it (1) fulfils the requirements necessary for complete and smokeless combustion of fuel; (2) produces a good thick fire; (3) is well adapted for the construction of a good combustion chamber; and, lastly, it is possible to obtain almost complete freedom from smoke, which is impossible with any other system of stoking.

*Sprinkling System.*—A universally admitted fault of this system is its liability to quickly choke the flues with fine dust. From the point of view of smoke prevention, it is, therefore, greatly inferior to the coking system. As a steam raiser, however, a stoker of this class is considered quite equal to the coking type. It is practically the only stoker that can be forced, and for this reason the sprinkling stoker has found much favour in different parts of the country. Some engineers consider that machine stokers are only labour savers when applied to a long range of boilers, but in the writer's opinion a single boiler fired by a machine stoker having a large hopper capacity has certainly much to recommend it. In conclusion, the writer does not think an apology necessary for dealing with the subject of mechanical stokers in such an elementary strain, as it is only by a thorough understanding of elementary principles that perfection in practical working can be obtained, and this fact particularly applies to the mechanical stoker, being, as it is, such an important adjunct to economical steam-raising plant.

## THE VOLTAGE DROP OF ALTERNATORS.*

BY DR. H. BEHN-ESCHENBURG.

The writer published a method for the predetermination of alternator voltage drop some 10 years ago which seems to have come into general use owing to its great simplicity and handiness. With the introduction of new types of generators, however, differences between the experimental results and the results obtained by this method became apparent, and it is the object of the present paper to suggest a simple correction to the method. The method referred to depends on the determination, either experimentally or by calculation, of the short-circuit characteristic of the generator, and from this and the open circuit or magnetisation curve the calculation of the internal impedance of the machine at the various stages of saturation. This impedance, multiplied by the load current of the machine, was then assumed to represent the counter E.M.F. The chief source of inaccuracy is the assumption that the magnetic resistance or reluctance of the system at a given magnetomotive force set up by the direct-current winding on the magnets, was unaffected by the magnetomotive force set up by the alternating current in the armature. This assumption is obviously allowable so long as the magnetic resistance remains approximately constant—*i.e.*, so long as the no-load characteristic remains approximately a straight line. Evenly for highly-saturated generators, it is allowable so long as the saturation is principally produced by so-called leakage circuits which are looped with the magnet coils but not with the armature coils, or are looped with the armature coils but not with the magnet coils.

A second method for determining alternator voltage drop has since been introduced by Mr. Rothert and others.

* Translation in abstract from the *Elektrotechnische Zeitschrift*, May 19, 1904, of a paper read before the Zürich Physical Society.

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This method (to be called the "second method" below) also depends on the short-circuit characteristic. From this the equivalent magnetomotive force of the magnet coils is determined corresponding to a given counter magnetomotive force of the loaded armature coils. In this case the assumption is made that the magnetic resistance of the whole system remains unchanged so long as the sum or difference of the magnetomotive force of the magnets and the magnetomotive force of the armature, determined from the short-circuit current, remains unchanged. This assumption, again, is only correct if the magnetic resistance of the generator is approximately constant, or if the whole flux of the magnet coils enters the armature coils without leakage, and the whole flux of the armature coils enters the magnet coils without leakage.

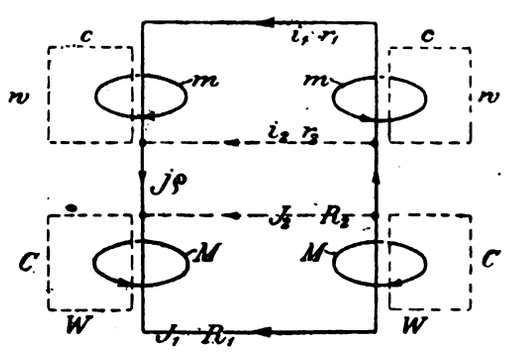


FIG. 1.

The drop calculated by the first method is always greater than the observed value, while the second method gives results which are too low. For the sake of simplicity, only the usual type of alternator with rotating radial pole magnets and stationary armature (Fig. 1) will be considered, and the drop on a purely inductive load will be investigated. When the drop on inductive load is known, the drop at any other power factor can readily be obtained with fair accuracy by the use of the well-known diagram.

The magnetic circuit (shown in Fig. 1) may be represented diagrammatically by an electrical circuit as in Fig. 2, replacing E.M.F.'s by the magnetomotive forces of the coils, and the resistances of the conductors by the magnetic resistances of the different sections of the circuit. Kirchhoff's law can then be applied with accurate results. Besides the main flux of the system which passes through

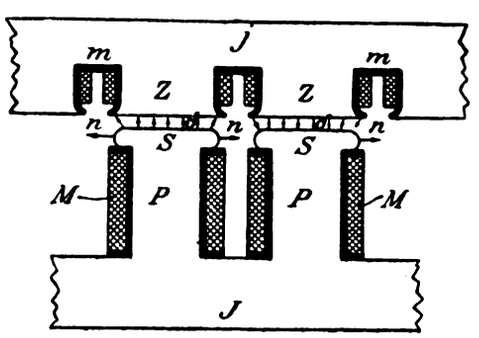


FIG. 2.

the coils, M and $m$, there are several leakage fluxes to be considered. An appreciable flux passes through the magnet coil and the air without passing through the armature coil, and *vice versâ*. Also a flux exists as a shunt to the main flux, and passes across the edges of the pole-shoes on the magnets and between the points of the teeth, Z, on the armature.

In Fig. 2 the main flux produced by the coils, M and $m$, and passing through the magnet cores, P, the yoke, J, the air-gap, $\delta$, the iron teeth, Z, and the iron yoke, $j$, is shown by the full line rectangle, whilst the leakage affecting either magnet coils or armature coils alone is shown by the small dotted rectangles at the side, and the leakages between the pole edges and between the armature teeth are shown by the dotted lines in the centre.

Let the magnetomotive force of the magnet coils be called M, and that of the armature, $m$, and assume that $m$ is opposed to M. Let the flux in the magnet poles, P, and the yoke, J, be called $J_1$; the magnetic resistance of these parts be $R_1$; the flux in the yoke, $j$, be called $i_1$, and the resistance to it $r_1$; the leakage flux passing through the magnet coils alone C, and the resistance to this flux W; the leakage flux passing through the armature coils alone $c$, and the resistance to this flux $w$; the leakage across the pole-tips $J_2$, and the resistance to it $R_2$; the flux across the armature teeth $i_2$, and the resistance to it $r_2$; the flux through the air-gap $j$, and the resistance of the air-gap $\rho$. Then

$$i_1 r_1 + i_2 r_2 = m \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$J_1 R_1 + J_2 R_2 = M \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$i_2 r_2 + J_2 R_2 - j r = 0 \quad . \quad . \quad . \quad . \quad (3)$$

$$J_1 = J_2 + j \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$i_1 = i_2 + j \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$c_w = m \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$C_w = M \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For the purpose of the drop calculation we are interested in the fluxes $i_1$ and $c$, as these determine the voltage of the armature coils, and the flux $J_1$, as that determines the saturation of the magnets.

Considering that for any properly-designed machine the resistances of the leakage paths must be very great compared with the resistances of the useful path, the quotient, $\frac{R_1}{r_2} \cdot \frac{\rho}{r_2}$, will be seen to be negligibly small compared with (1), and we get:

$$R_0 i_1 = M - m \left(1 + \frac{\rho}{r_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2}\right) \quad . \quad . \quad (8)$$

$$R_0 J_1 - M \left(1 + \frac{\rho}{R_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2}\right) - m \quad . \quad . \quad (9)$$

$$R_0 = \left(1 + \frac{r_1}{r_2} + \frac{R_1}{R_2}\right) \rho + r_1 + R_1.$$

$R_0$ is, therefore, practically the total resistance of the main path. Now, the actual E.M.F. induced in the armature coils is

$$E = K (i_1 + c)$$

$$= \frac{K}{R_0} \left(M - m \left(1 + \frac{\rho}{r_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2} + \frac{R_0}{w}\right)\right) . \quad (10)$$

M is proportional to the exciting current, and $m$ to the armature load current; K is a constant.

Let $1 + \frac{\rho}{r_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2} + \frac{R_0}{w}$ be called $(1 + \Delta_1)$. On open circuit the value of $i_1 + c$ is that corresponding to $m = 0$. So that then

$$E = E_0 = K \frac{M}{R_0} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Where $R_0$ must be determined from the saturation corresponding to

$$R_0 J_1 = M \left(1 + \frac{\rho}{R_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2}\right)$$

$$= M (1 + \Delta_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

These two expressions (11) and (12) determine the no load characteristic of the machine. When the armature winding is on short-circuit, $E = 0$

$$\therefore i_1 + c - 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

This condition is fulfilled when

$$M_K = m_K \left(1 + \frac{\rho}{r_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2} + \frac{R_0}{w}\right)$$

$$= m_K (+ \Delta_K) \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

where the flux in the magnet coil, P, is given by

$$J_K R_0 = M_K \left(1 + \frac{\rho}{R_2} + \frac{R_1}{R_2} + \frac{r_1}{r_2}\right) - m_K.$$

It is obvious that $J_K$, and, therefore, the saturation of the magnet system, will be very small if the leakages are reason-

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able, so that for short-circuit we may put $R_0 = \rho$, from which it follows that

$$\Delta_K = \frac{\rho}{r_2} + \frac{\rho}{w}.$$

If, therefore, $M_K$ and $m_K$ are known from the winding data of the machine, the value of $\Delta_K$ may be obtained from the short-circuit characteristic. Turning again to the two methods for determining the voltage drop, according to the first method the terminal voltage is

$$E' = E_0\left(1 - \frac{m}{m_K}\right),$$

where $E_0$ is the open-circuit voltage and $m_K$ the magnetomotive force of the short-circuit current at the excitation, M, and $m$ is the magnetomotive force at the load for which the drop is to be determined. Inserting the values given by equations (11) and (14) we get

$$E' = K\frac{M}{R_0'}\left(1 - \frac{m}{M}(1 + \Delta_K)\right),$$

where $R_0'$ corresponds to the flux, $J_1'$, on open circuit at the magnetomotive force, M, or

$$J_1' = \frac{M(1 + \Delta_2')}{R_0'}.$$

Now the real values according to equation (10) are

$$E = \frac{K M}{R_0}\left(1 - \frac{m}{M}(1 + \Delta_1)\right),$$

$$J_1 = \frac{M(1 + \Delta_2) - m}{R_0},$$

so that according to the amount by which $R_0$, $\Delta_1$, and $\Delta_2$ change, the want of proportionality between the voltage drop and $m$ will change. The error, therefore, depends firstly on the difference in the magnetic resistances, $R_0$ and $R_0'$, and, secondly, on the difference between the leakage coefficients, $\Delta_K$ and $\Delta_1$. The former error makes the calculated drop too small and the latter makes it too large.

An examination of the equations shows that a first correction is obtained by putting

$$E' = K\frac{M}{R_0'}\left(1 - \frac{m}{M}(1 + \Delta_K)\frac{R_0'}{\rho}\right) \quad . \quad . \quad (A)$$

and a second correction by putting

$$E'' = E'\frac{R'_0}{R_0''} \quad . \quad . \quad . \quad . \quad . \quad . \quad (B)$$

$R''_0$ being obtained from the open-circuit characteristic for the excitation, $M - \frac{m}{(1+E)}$, where $E$ must be taken as an assumed value for $\Delta_2$, and is usually about ·2 for good modern machines. $\Delta_2$ depends to a certain extent on the saturation being higher for highly-saturated machines and lower for less saturated ones, but the error introduced by a wrong value being assumed for $\Delta_2$ (or $E$) is extremely small. In the same way, a very small error only is introduced into the first correction (A) if $\frac{R_0}{\rho}$ is always assumed to equal 2.

The second method of calculation, dealt with in the same way, shows that a first correction is obtained by putting

$$E' = \frac{K}{R_0}\left(M - m(1 + \Delta K)\frac{R_0}{\rho}\right),$$

and a second correction by putting

$$E'' = E'\frac{R_0'}{R_0''},$$

$R_0''$ being determined for the excitation $M - \frac{m}{1+E}$, putting $E$ as equal to about ·2 again.

As an example, the application of both methods with their corrections to a modern three-phase generator made by the Maschinenfabrik Oerlikon is given below. The output of the machine was 1,200 kilovolt-amperes at 14,000 volts and 375 revolutions, 50 ~. The open-circuit E.M.F. as a function of the excitation was obtained, and also the short-circuit current as a function of the excitation. The generator was then loaded on a similar machine running as an unloaded synchronous motor, and the terminal voltage as a function of the excitation was thus obtained at 30 amperes and 60 amperes with a power factor = 0.

These four curves are shown in Fig. 3, together with a curve marked $W_0$, representing, in any units, the ratio of magnetising current to open-circuit voltage. The dot-and-dash curves represent the voltages calculated by the first method (uncorrected), the plain dash curves represent the values calculated by the second method (uncorrected), whilst the full lines show the observed values. It is clear that for values of about 100 exciting amperes and upwards the machine is highly saturated, so that for this portion the value of ·2 may safely be assumed for $\Delta_2$.

The value of $\Delta_K$ is obtained thus: Each magnet coil has 100·5 turns, the armature coil for each phase and pair of poles has 60 turns, so that $m = \sqrt{2} \times 1{\cdot}5 \times 60 \times J$ approximately, where J is the armature current. From the short-circuit curve we see that an exciting current of 50 amperes gives a short-circuit current of 70 amperes,

$$\therefore (1 + \Delta_K) = \frac{2 \times 100{\cdot}5 \times 50}{\sqrt{2} \times 1{\cdot}5 \times 60 \times 70} = 1{\cdot}13.$$

Taking the 100-ampere and 200-ampere excitation points, the open-circuit voltages are seen to be 16,300 and 19,100 volts respectively.

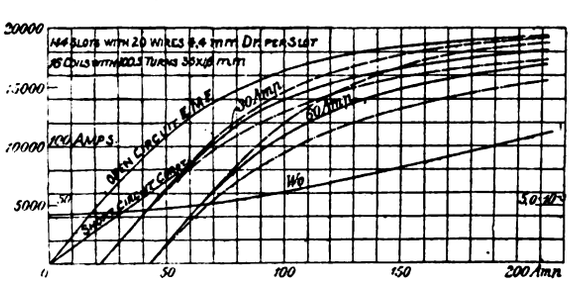


FIG. 3.

By the first method the voltage drop for the 100-ampere point at a load of 60 amperes would be

$$16{,}300 \times \frac{60}{140} - 7{,}000 \text{ volts},$$

for an excitation of 100 amperes corresponds to a short-circuit current of 140 amperes. The terminal voltage would therefore equal $E' = 9{,}300$. The magnetic resistance, $R_0'$, is proportional to $W_0$, which equals 61 units at 100 exciting amperes. The first correction of the 7,000 volts must be in the ratio $\left(1 + \Delta_K\frac{R_0}{\rho}\right) : 1 + \Delta_K$. $\rho$ is equal to the initial value of $W_0$—that is, 42 units—so that in place of 7,000 we must use

$$7{,}000\,\frac{\left(1 + {\cdot}13\,\frac{61}{42}\right)}{1{\cdot}13} = 7{,}400 \text{ volts}.$$

Subtracting, we get $E' = 16{,}300 - 7{,}400 = 8{,}900$.

This voltage, E', has to be still further corrected for the magnetic resistance corresponding to an excitation of $M - \frac{m}{1+E}$, where $M = 201 \times 100$; $m = \sqrt{2} \times 1{\cdot}5 \times 60 \times 60 = 7{,}600$; $E = {\cdot}2$. This excitation is 13,800 ampere-turns, or 69 exciting amperes, and this corresponds to $W_0 = R_0'' = 51$; so that the above value of $E' = 8{,}900$ must be increased in the ratio of $\frac{R_0'}{R_0''} = \frac{61}{51}$, and becomes 10,700. The observed value was 10,800, which is a very good check. In the same way, for the 200-ampere excitation and 60-ampere armature current, the first method gives a calculable terminal voltage of 15,000; whilst when both corrections are applied the result is 16,700, and the observed value was 16,800 volts.

When the second method is applied, the uncorrected value of the terminal voltage for 100 amperes excitation works out at 11,900; whilst with both corrections applied

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it is 10,900, and the observed value was 10,800. At 200 amperes excitation the corrected value is 16,500 by the second method, and the observed value 16,600. The writer has found equally good agreement in the case of some 10 other generators.

By means of this comparatively simple correction, therefore, the results of both methods are brought into very close agreement with the tests, and this good agreement may be considered as a confirmation of the theory underlying the method, as well as a further justification for the treatment of a magnetic circuit exactly analogously to an electrical circuit.

## THE TUITION (?) OF ELECTRICAL ENGINEERING.*

BY JAMES PIGG, ASSOC MEMBER.

*(Concluded from page 856.)*

In a lesson headed "Insulators, Conductors, Armatures, Commutators, and Current Phases," there is a good deal of information of a novel character concerning the "ether of space," but space forbids its being extracted fully. In the same lesson are examples in the calculation of the conductivity of electrical conductors. Much will doubtless be of interest.

"It is interesting to know how to calculate the conductivity of electric conductors: but before introducing the matter the following elementary instruction will probably not be out of place. The word equation means equal to, and the expression A+B=C, means that A added to B is equal to the sum of C. Suppose A to be 3, B to be 5, then 3+5=8, that is C is equal to 8, and A×B=C, means that A multiplied by B is equal to C, as 3×5=15. That is C is equal to 15. The word equation then simply means a balance. Coming back the subject, then notice that for a given current that is one of the same voltage and amperage the conductivity varies in the ratio of the square of the diameter divided by the length. That is as the square of the diameter increases, the conductivity increases, and as the length increases, the conductivity reduces. For example: Call two wires A and B. Let A be one mile long, and one-eighth of an inch in diameter, then the proportion of its conductivity is $\frac{1^2}{1}=1$. Let B be 4 four miles long, and two-eighths of an inch in diameter, then its conductivity will be proportional to $\frac{2^2}{4}=1$. This means that the conductivities of the two wires are the same for the same current. B is four times as long as A, but B's diameter is double that of A, and as the square of 2=4, so 4 divided by 4 is equal to 1. If both wires were the same in length, the conductivity of B would be four times greater than that of A, because $\frac{2^2}{1}=\frac{4}{1}=4$.

"Again the current resistance of conductors vary as the length divided by the square of the diameter. To make this clear repeat A and B and suppose their lengths to be equal to four miles, then for A $\frac{4}{1^2}=4$, and for B $\frac{4}{2^2}=\frac{4}{4}=1$. This means that for equal lengths and different diameters the current resistance varies directly as the length of the conductor, and inversely as the squares of the diameter. The resistances electric currents meet with in conductors vary directly as the amperage and inversely as the voltage when the watts of current are equal. Suppose a case in which the current power is equal to 3,000 watts, and the amperage of A to be 10, and the voltage 300. The amperage of B to be ·5 and the voltage to be 6,000, then the resistances in the two cases, supposing the conductors to be of equal length and diameter will be as follows $A=\frac{10}{300}=\frac{1}{30}$ and $B=\frac{\cdot5}{6,000}=\frac{1}{12,000}$. Consequently the current resistance on A is $\frac{1}{30}$ divided by $\frac{1}{12,000}=\frac{12,000}{30}=400$, that is the resistance of a current of 10 amperes and 300 volts is 400 times greater than one of ·5 ampere and 6,000 volts, and yet both currents have a mechanical efficiency at the point of generation of 3,000 watts. . . . For long-distance transmission the current should always have a high voltage and a low amperage, but unless the insulation is extra good the leakage with a high pressure always exceeds that of a lower one, and the consequence of this is you can employ a smaller and cheaper conductor for a high voltage you must give close attention to the perfect insulation of the cable as these pros and cons. require attention."

The measurement of electrical quantities is a fascinating subject, and, perhaps, as the tangent and line galvanometers are of *such extreme importance* for this purpose at the present date a good deal of attention is devoted to them under the heading of "Measurements of Electric Currents," and the information afforded is fully up to the standards to which attention has already been directed.

"The electric current strengths are proportional to the tangents or the sines of the deflection of the Galvanometer needle, and the resistances of an electric current are inversely proportional to the lengths of the tangents of deflection: that is a short tangent indicates a high resistance, and a long tangent indicates a low resistance. For example: Suppose the deflection of a Tangent Galvanometer was 45deg., and if the introduction of 2·5 ohms of resistance reduced the deflection to 26½deg., what was the resistance of the circuit before the 2 5 ohms of extra resistance was introduced? To solve this question, remember that when the resistance to an engine is doubled, the speed is halfed, when the power remains the same. The same is true of an electric current. The length of the tangent of 45deg. is equal to 1, and if the 2·5 ohms introduced were equal to the original resistance, then they would double the current resistance. Hence, as the lengths of the tangents are inversely proportional to the resistance, if the resistance was doubled, the length of the tangent of deflection would be halfed, or reduced from 1 to ·5. Now, the length of the tangent of 26½deg. is equal to ·5. Consequently the original resistance was the half of 5 or $\frac{5}{2}=2\cdot5$ ohms.

"This problem can be better solved as follows:—If the tangent of 26½deg. is half that of 45deg., then the resistance for 26½deg., is double that of 45deg. The tangent 26·5 = ·5, and the tangent of 45deg. = 1, then $\frac{1}{\cdot5}\times2\cdot5=5$, and $\frac{5}{2}=2\cdot5$ ohms.

"On a sine Galvanometer the sines of the angles of deflection are inversely proportional to the resistances. Hence the following problem has an easy solution: If a current gives a deflection of 72deg. when short-circuited, what will be the current resistance when the deflection falls to 36deg., with an increased resistance of 15 ohms; if the deflections of the needle for the same current are inversely proportional to the current resistance when the deflection diminishes from 72deg. to 36deg. by introducing an increased resistance of 15 ohms, the result will be as follows: When the sine of 72deg. = ·95105, and the sine of 36deg. is ·58778: then as ·58778 : ·95105 : : 15 to 24, or $\frac{95105\times15}{58778}=24$ ohms, the resistance sought for."

"To measure the current strength or resistance with the tangent Galvanometer, before the current is turned on, the plane of the ring must be set in line with the needle, or in the line of the magnetic meridian, and to find the current strength with the sine Galvanometer the ring must also be set in the line of the needle before the current is turned on, and after the first deflection is read of in degrees by the circumferenter, the instrument must be turned round through a quarter of a circle to let the deflection be read a second time, when the meaning of the two deflections found is the sine reading correctly. The reason of this is the earth's pull on the needle is thus neutralised . . . ."

Wiremen will no doubt value the following extract headed "The Sizes of Leads or Conductors," and will probably paste them on the lids of their tool boxes.

"The Board of Trade limit of the sizes of leads or conductors is based on the unit of 2,000 amperes per square inch of section of a pure copper conductor, whose resistance is $\frac{1}{10000}$ of an ohm per linear yard.

"Many formulas are given for finding the sizes of conductors, but the following is a simple and correct one, and is therefore preferred. In the following equation the letters represent: $a$ = the area of transverse section of a conductor; $c$ = the current strength in amperes; $l$ = the length of the conductor in yards $\frac{2.000}{40,000}=\cdot05$ the resistance as a fraction of a contra volt per linear yard of a copper conductor, one square inch in section. The area of section of a conductor for any other number of amperes than 2,000 is found as follows:

$$a=\frac{c}{2,000}\times\frac{(2,000+(\cdot05\times l)}{2,000}$$

What then should be the area of end section of a conductor 3,000 yards long to carry a current of 2·5 amperes, then

$$a=\frac{2\cdot5}{2,000}\times\frac{(2.000+(\cdot05\times3,000)}{2,000}=\cdot001343 \text{ of a square inch,}$$

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, May 9.

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and the diameter of a round conductor of the same area is $\sqrt{\frac{\cdot001343}{\cdot7854}} = \cdot041363$ of an inch. The sizes of conductors are expressed according to the S.W.G., that is the legal standard wire gauge, and this is found as follows: A lineal inch is divided into 1,000 parts called mils, then $\cdot041363 \times 1{,}000 = 41\cdot363$ mils, and the gauge size is therefore $\frac{1{,}000}{41\cdot363} = 24$ gauge nearly.

"As an example, what is the standard gauge of a wire ·082 of an inch in diameter?

"Answer: $\cdot082 \times 1{,}000 = 82$ mils. The S.W.G. is therefore equal to $\frac{1.000}{82} = 12\cdot19$ gauge, or $\frac{1}{082} = 12\cdot19$ gauge."

The abstractor does not remember to have ever seen, in any of the accepted text-books, the difference between the series-wound and shunt-wound dynamos explained in quite the same way as in the subjoined extract.

"When a dynamo is run with a single circuit, it is said to be all in series, which means that the induced current of the armature is passed at once through the field coils, and from thence right on to the work it has to do, and back to the armature where it was generated. A dynamo run in series with the work it has to do, is like a locomotive engine that is constructed to damp the boiler fire and open the door when it comes to a heavy bank, with the result that both the volume and pressure of the steam is reduced just when the pressure should be increased; or the arrangement is the analogue of a locomotive that increases the pressure and the volume of the steam when running down a bank, for, as the current resistance due to work increases, the power of the induced current reduces, because the armature current is then of smaller potential that what passes through the coils of the field magnet; in other words, as the work increases, the power reduces, or as the work reduces, the power increases. Consequently the work and the power never balance, and the arrangement is known as an ungovernable one. To remedy the defects of the single series system, the shunt division of the current is adopted, but as it does not supply a true balance of the power and the work, it is not in all cases satisfactory. The mode of action of the shunt is as follows: The current on leaving the brushes of the dynamo is divided, part of it proceeding at once through the coils of the field magnet, and the other part proceeding to the point where work has to be done. A partial balance of the power and the work is obtained by this shunt arrangement, by making the resistance of the field magnet coils such as equalises the resistance due to the work, but when the resistance of the work increases or reduces, the balance is lost. As an example of this it is found that when the work resistance reduces, the current leaves the shunt, and thus arrests current production, for in this way the inductive power of the field magnet is reduced. Again, when the work resistance increases, the potential of the shunt current increases beyond the balance of the work, consequently where a safe and steady balance of the power and the work is required, the system called the compound winding of the field magnet is adopted. Compound winding consists of the union of the series and shunt systems. . . . The mode of action of compound winding may be explained as follows: When the resistance due to work increases, the potential of the shunt coils increases, and that of the series coils reduces. When the resistance due to work reduces, the potential of the shunt coils reduces, and that of the series coils increases, but as the number of ampere-turns of the series coils is much less than those of the shunt, we obtain the following relationship: When the resistance due to work reduces, the potential of induction of the series coils increases a little, while the potential of induction of the shunt coils reduces more than the series coils increase. The result is, compound winding is made to balance the power against a variable load."

Consider the following carefully, and compare it with the explanations given in the ordinary text-books:

"There are two kinds of electric currents, namely, direct, or those that flow on in one direction, and alternate, or those that pulsate in jerks in opposite directions. . . . There never is a truly continuous current of electricity generated by magnetic induction, because such streams are made up in all cases of alternate impulses. Even the so-called continuous-current dynamo produces an alternate current that is made direct by the commutator. If, then, the current of this dynamo is at first alternate, it is so because it is generated in impulses, and therefore is polyphase, or somewhat variable in E.M.F. and current strength. The alternate current gives a diagram, in which the phases in a period are distinctly seen, and the three-phase current is one in which advantage is taken of the three phases in a period to conduct and return them by a cable containing three insulated conductors. . . .

"As a current for lamps in series requires to be differently constituted to that for the same number of lamps in parallel, here observe the peculiarities of each. First, the current for lamps in series must have for its factors an amperage equal to that required for one lamp. Second, its E.M.F. must be equal to that of one lamp multiplied by the number in the series. For example: When there are 12 lamps in series, and the E.M.F. for one lamp is 100 volts, the current strength for one lamp ·6 amperes, the 12 lamps will require 12 times 100 volts to force the current through the series, or $12 \times 100 = 1{,}200$ volts. No more than ·6 amperes are required, as the quantity of current that will render the filament of an incandescent lamp illuminating will do so for the whole. The watts of current for the series will be equal to $1{,}200 \times \cdot6 = 720$, or a little less than three-quarters of a kilowatt. As the resistance will be equal to $\frac{E}{C} = R$, $\frac{1200}{\cdot6} = 2{,}000$ ohms. It will here appear strange that the resistance looks greater than the pressure, but when it is known that $C^2 R = C E$, that is, the square of the current strength multiplied by the resistance, is equal to the current strength multiplied by the E.M.F., the anomaly disappears, for $2{,}000 \times \cdot6 \times \cdot6 = 720$ watts, and $1{,}200 \times \cdot6 = 720$ watts. This means that the power is equal to the work, for $1{,}200 \times \cdot6 = 720$ watts of power are equal of $2{,}000 \times \cdot6 \times \cdot6 = 720$ watts of work. . . . ."

A few extracts from a "Catechism" may be useful to those who have not considered the subjects from quite the same standpoints taken by the catechist.

"What occurs when a strong current of electricity is forced through a small conductor?—The molecules of the conductor are forced too far apart, and then electricity is converted into heat, for heat waves are of greater amplitude than electric ones."

"If the field magnet of a dynamo A, was supplied with current of constant strength from another and independent dynamo called B, what two things would occur if the speed of the armature B was reduced to one-half?—The coulombage or quantity per second, and the E.M.F. of the current would both be reduced to one-half their true value at full speed."

"What occurs with a current when the work it has to do is suddenly thrown off?—The amperage increases and the voltage reduces, the same as occurs in a steam-engine when it loses its load by a belt jumping off, as then it runs wild, consuming an increased volume of steam at a reduced pressure."

"How could you tell by looking at a voltmeter and ampmeter when the current had lost its load?—The voltmeter would show a fall, and the ampmeter a rise."

"How could you tell by the readings of the voltmeter and ampmeter that the load was increasing?—When the load is increasing the voltmeter shows an increase of E.M.F., and the ampmeter shows a decrease of current flow. The same principle as rules the behaviour of steam, for example, when the load of a steam-engine increases, its velocity reduces, and the consequence is, the pressure of the steam rises, because the volume of the steam consumed reduces while the fire is as active as ever. When a boiler fire is active and the engine is standing, the pressure increases and the steam blows off, but the quantity escaping at the blow-off valve, is very small compared with the quantity consumed by the engine when doing work. This is the exact analogue of an electric current when the load increases, the current pressure or voltage increases and the current flow or amperage reduces."

"Does the amperage reduce in the same ratio, as the voltage increases when the work the current has to do increases?—The fall of the amperage is not so great as the increase in the voltage, and it is for that reason that heating trouble arises when the resistance due to increased work occurs; for example, in starting an electric tramcar the insulation of the coils of the armatures would be burnt off, or what is called burnt out if the current was not sent through a rheostat in the circuit, for the electric pressure is then so great that it forces a current flow, that is too great for the conductivity of the armature coils, and the result is, the current does the work of converting itself into heat. The extra resistance due to setting a tramcar in motion is due to its inertia when at rest."

"Whether are copper or iron conductors most subject to heating when strong currents are sent through them?—Strange to say, copper conductors are more subject to heating than iron ones, the reason being the specific heat of iron is considerably more than that of copper. In relation to specific heat; that of water is the highest of any known body, consequently it is taken as 1, and copper is only ·0951 of that of water, while iron is ·1138 or it is $\frac{\cdot1138}{\cdot0951} = 1\cdot196$ that of copper. Not only is the specific heat of iron greater than that of copper, but an iron wire of the same conductivity as a copper one has six times the capacity for heat, or $1\cdot196 \times 6 = 7\cdot176$."

"What is the special trouble that arises in starting motors run with the alternate current?—The special trouble is that, these motors require a special small direct-current motor to

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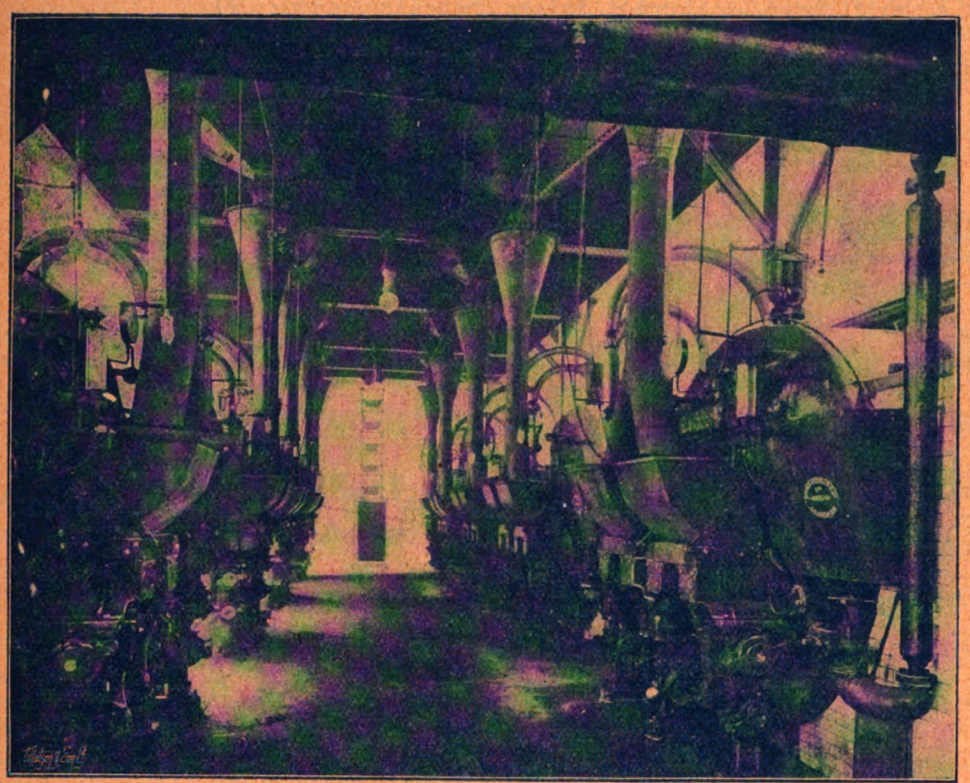

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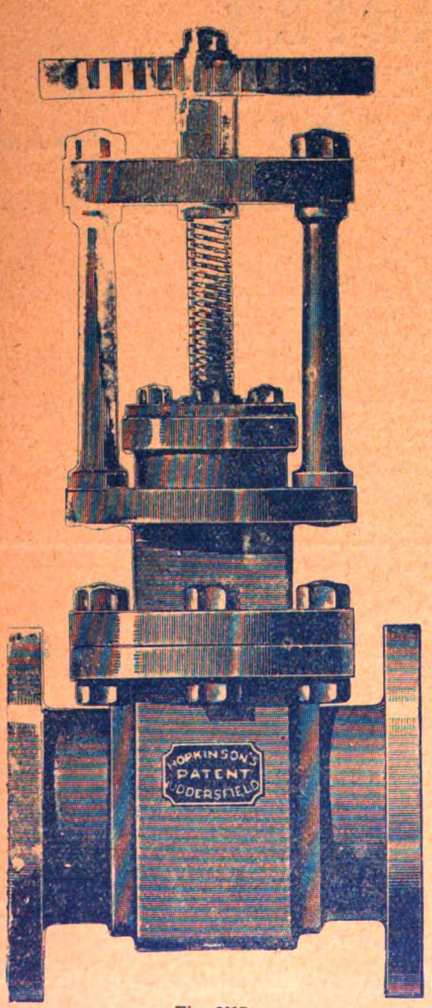


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